Lecture Notes in Networks and Systems 1694

João Vidal Carvalho ·
António Abreu · Manuel Silva ·
Eusébio Ferreira da Costa ·
José Alfredo Ferreira Costa *Editors*

Perspectives and Trends in Education and Technology, Volume 2

Selected Papers from ICITED25

Springer

Lecture Notes in Networks and Systems 1694

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ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-3-032-09079-9 ISBN 978-3-032-09080-5 (eBook)
https://doi.org/10.1007/978-3-032-09080-5

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Preface

This book—Perspectives and Trends in Education and Technology, Volume 2: Selected Papers from ICITED25—from the LNNS Series is composed of the best selected papers accepted for presentation and discussion at the 2025 International Conference in Information Technology & Education (ICITED25). The ICITED is a multidisciplinary conference with a special focus on new technologies and systems in the education sector and was held between July 10 and 12, 2025. The ICITED25 was supported by the Federal University of Rio Grande do Norte, in Natal, Brazil, and by IADITI—International Association for Digital Transformation and Technological Innovation.

The International Conference in Information Technology & Education is an international forum for researchers and professionals in the education sector, which enables the discussion of the latest innovations, trends, and concerns in several areas, in the education sector, associated with information technologies and systems. It is an event for professionals in the sector, in search of technology solutions, where academics, IT experts, and business managers meet to discuss new ideas that help them maximize the potential of learning processes through technology.

The ICITED25 Scientific Committee is composed of a multidisciplinary group of 145 experts who assessed some 275 papers from 28 countries, received for each of the main topics proposed for the conference: a) ICT and Virtual learning; b) Pedagogical & Didactical Innovations; c) Technologies issues in Education in the different scientific areas; d) Quality in Education; e) Technological Issues in Education and Research; f) Educational Software and Serious Games; g) Curriculum Design and Innovation and h) University-Industry Collaboration; SPECIAL SESSIONS: DTLP'25—Digital Transformation in the Teaching and Learning Process; EU-AIEdu'25—EXPERIENCES IN THE USE OF ARTIFICIAL INTELLIGENCE IN EDUCATION; E4TLI—EDUCATION FOR TECHNOLOGICAL LITERACY AND INCLUSION. SPECIAL TRACKS: Digital Literacy x Media Literacy—New Literacies and Education in Brazil; Cultural Tourism, Education and Marketing; New Technologies in Accounting Education; Internationalization in Higher Education as a challenge; Education and the problems of the contemporary world.

The papers accepted for presentation and discussion at the conference are published by Springer and will be submitted for indexing by ISI, SCOPUS, EI-Compendex, Google Scholar, and SpringerLink. We thank all those who contributed to the ICITED25 conference (authors, committees, workshop organizers, and sponsors).

We deeply appreciate your involvement and support, which were crucial to the success of the conference.

July 2025

João Vidal Carvalho
António Abreu
Manuel Silva
Eusébio Ferreira da Costa
José Alfredo Ferreira Costa

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Research Skills and Integration with University Teaching and Community Engagement

Quintero Cordero Yolvy Javier(✉), Alejo Betty Pastora, Bustillos Peña Mayra Alejandra, and Molina Prendes Norma

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Summary. Research skills in university professors must be significant in order to achieve greater integration with the functions of teaching and community outreach. In this sense, this research aims to describe the perception of teachers in relation to the importance they give to research as an integrative element. It focuses on the quantitative paradigm, being descriptive. The survey was used as data collection technique. The study was applied to three universities located in Quito; the population consisted of 299 teachers, of whom 274 answered the questionnaire. The results show that, of the twelve sub-indicators analyzed, eleven show a "moderate" level of use of research as a factor of integration with teaching and community engagement. The responses of the managers coincide with those expressed by the teachers in the sense that each substantive function works independently of the others, and only in some cases is there an overlap of the three functions. Strategic guidelines were proposed to overcome the situation.

Keywords: research competencies · integration · teaching · community engagement · strategic guidelines

1 Introduction

As a result of the Third World Conference on Higher Education of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) [19], six fundamental principles were established that guide the path to be followed by higher education institutions (HEIs) towards their transformation for the benefit of humanity. a) inclusion, equity, and pluralism; b) academic freedom and participation of all stakeholders; c) inquiry, critical thinking and creativity; d) integrity and ethics; e) commitment to sustainability and social responsibility; and f) academic excellence. It is understood that such principles must be carried out through the substantive functions of universities and other higher education entities, that is, research, teaching, and outreach to communities.

The cited document itself (III World Conference) indicates that curricula appropriate to the needs of society and research with academic and social relevance through projects for community improvement are strategies that can have a positive impact on the construction of a sustainable world. As can be seen, there is a close correspondence with the research function since, through it and making use of appropriate methodologies,

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2025
J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 1–9, 2025.
https://doi.org/10.1007/978-3-032-09080-5_1

problematic situations are diagnosed and solutions are provided. The increasingly rapid development of humanity is due to the research process, and universities have played a significant role in this. Universities are builders of knowledge through their teacher-researchers; it would be impossible to achieve successful university training without the active participation of scientific research in harmonious integration with the functions of teaching and community outreach.

In reference to the research topic, Maldonado and Estévez [8] carried out research whose objective was to carry out an analysis of the research skills of higher education teachers. For this purpose, the documentary methodology was used in order to reflect on the importance of the research process in higher education. The results attest that research constitutes a key element for teachers in the different areas of knowledge since it allows them to know how the goals involved in the teaching-learning process in higher education are achieved. In harmony with the above, it was also possible to determine the traits that define a teacher-researcher: analytical of his own educational context, rational constructor of reality, innovative, transformative, and active promoter, and guarantor of optimal education.

Similarly, Romero et al. [15] conducted a study focused on determining the relationship between the training of the tutor teacher and the quality of research teaching at the Universidad Regional Autónoma de Los Andes, Ecuador, specifically in the law program, as a measure for the selection of research professors. Three instruments were used in the collection of data inherent to the study: to select the experts who would evaluate the teachers at Universidad Los Andes; to determine the level of satisfaction of law students; and to assess the quality of research teaching.

The conclusions show that there is a direct and significant relationship between teacher training and teaching-research results. Likewise, a direct and significant relationship was detected between teacher training and the level of student satisfaction. It is assumed that the training of tutor teachers and research teachers is essential for a teaching-learning process based on research and that it complements teaching and the projection of university extension to raise the levels of quality in the educational process, motivation, and student satisfaction.

Research skills and their integration with the educational process.
Research competencies constitute a whole process made up of skills, abilities, intuition, and analytical capacities that research teachers build with the intention of solving social problems Gómez et al., [5]. Therefore, the proper interweaving between research, teaching, and connection with society necessarily implies structuring the educational process with a sense of identity and relevance, addressing strategies that allow comprehensive training Pinchao et al., [14]. Research implies the possession of competencies that allow planning, execution, and evaluation of them with an ethical sense, collaborative work, and an adequate methodology with the manifest intention of solving problems in the environment Casimiro et al., [2].

In this regard, Marcillo [9] explains that teaching involves the task of research, allowing teachers and their students to focus on the analysis and understanding of science for their professional development. Likewise, by connecting with the community, a dialectical relationship is established that implies a higher good: the creation of social solutions. On the other hand, Novillo [12] explains that the function of connecting

with the community offers the opportunity not only to exchange learning between the community, teachers, and students but also seeks to confront the latter with the harsh social problems, aims to sensitize them, and enthusiastically incorporates them into research projects to improve the living conditions of the community, in accordance with the achievement of the Sustainable Development Goals (SDG).

In summary, the teacher-researcher must strive towards the construction of an organizational structure that defines the role of research in the university, proposing lines of research in accordance with the 2030 agenda for the achievement of sustainable development goals, projection and search for the necessary resources, focusing on the functions of tutoring and advising students, and directing their creative thinking towards research. Likewise, they must demonstrate their communication skills regarding the orientations of their research and present evidence that demonstrates the viability and benefits of its execution through an appropriate, technical, and professional exposition. All this, in conjunction with efforts with their peers, critically and ethically analyzing the different positions to reach a consensus that allows a refined and harmonious process.

Detecting the contextual needs of the training process is linked to the reflective act carried out by the teacher regarding the best methods, techniques, and procedures to face the teaching-learning process together with his students. Marcillo, [9]. The procedural diversification of learning is related to the teacher's ability to know the level of learning in students, both as a group and as an individual. It is essential to influence them to try new methodologies and techniques to address the problem under study. On the other hand, the methodological conciliation of the treatment of problems of the profession refers to the epistemological orientation to treat the problems that arise from research tasks, philosophical assumptions, strategies and techniques, and other methodological procedures because research must have its epistemological field clearly delimited, which is what gives it legitimacy and validity.

The didactic management of interactive-investigative strategic learning seeks to integrate students with teaching in the achievement of the investigative fact; that is, it is the joint action in the application of techniques, procedures, and methods for problem solving. It is a process of learning how to learn to investigate collaboratively, and the only way to do it is by doing it together. This subsystem is made up of three components: duties and ethical dilemmas of the profession; the heuristic to be interested in problem solving; and the assessment and self-assessment of individual and group work. Marcillo, [9].

Finally, the didactic-participatory management of significant research tasks gives the teacher the ability to manage research tasks so that students can engage in research that is closely linked to their discipline of study but with an interdisciplinary and transdisciplinary vision. Interdisciplinarity allows for a broader vision, observing and correcting errors arising from a science limited by its own knowledge. Transdisciplinarity implies transversality, the exchange of methods, instruments, and procedures, which generates a dialectical management of global understanding of the processes. This subsystem is made up of three components: dynamics of logical problem solving; dynamics of information management; and dynamics of active appropriation of the content. Marcillo, [9]; Acosta, [1]; and Martínez, [10].

The dynamics of logical problem solving are connected to the teacher's ability to emphasize investigative tasks that involve logical thought processes, which involve reflection, metacognition, searching, encounters, and disagreements. It is about activating the student's metacognitive capacity, the plasticity of the brain, which allows

generating new ideas and changes in the ways of conceiving reality (Marcillo, [9]; Rubio, [16]. The dynamics of information management have implications for the search for information and its treatment. Advise the student on the criteria required for this. It should not be forgotten that this information is what will be converted into knowledge. In this sense, it would be necessary to diagnose the information needs, define the purposes that are pursued with such information, and specify the parameters for obtaining it. Marcillo, [9].

For its part, the dynamics of active appropriation of content refers to the teacher promoting investigative actions in which the student's creative capacity is tested in terms of putting into practice different types of solutions to the problems being studied. The fundamental idea is to encourage critical reflection in the student, motivating him to develop in himself the capacity to create and construct new action procedures. In this sense, the teacher must try to evaluate the students' achievements with a constructive purpose, of progressive improvement of their skills, knowing and evaluating the strategies that they put into practice in the construction of their learning, and decisively influencing them so that they feel the taste for collaborative research.

2 Methodology

This is quantitative, descriptive, research with a non-experimental, cross-sectional field design. According to Sánchez [17], the essential thing in quantitative studies is the application of numerical variables in the collection, description, analysis, and explanation of the available data. Likewise, it is a study with a non-transsectional field design since the data collection was carried out directly from the subjects of interest; there was no manipulation of the data, and the collection was done at a specific time.

The survey was used as data collection technique, and the questionnaire was assigned five response alternatives: always (A); almost always (AA); sometimes (S); almost never (AN) and never (N). Each of them has a score or value, as follows: A = 5; AA = 4; S = 3; AN = 2 and N = 1. The issues or aspects to be analyzed are related to: didactic-reflective management of teaching-learning for problem solving; didactic management of methodological and contextual adaptation for research; didactic management of interactive-investigative strategic learning; and didactic-participative management of significant research tasks. Each of these indicators is broken down into three sub-indicators, which were analyzed.

The population is made up of all the teachers who work at the selected universities, reaching a number of 299, of which 274 (91.6%) answered the questionnaire, making this number the sample to be considered. For greater precision in the data analysis, a scale was developed with three attributes that measure the application of research to achieve an interweaving with teaching and community outreach. These are: low, moderate, and high. It is understood that, at the low level, the teacher does not value the use of research very much; at the moderate level, an improvement in its application is noted, but shortcomings persist; and at the high level, there is a significant appreciation in the use of research (Table 1).

For a better understanding of the tables, the following explanation of the abbreviations is offered: Abs. = absolute values; % = relative value; Options = response options A = always; AA = almost always; S = sometimes; AN = almost never.

Table 1. Scale

Attributes (level of application of the competence)	Range
Low	1.00–2.33
Moderate	2.34–3.68
High	3.69–5.00

3 Results and Discussion

In relation to the didactic-reflective management of teaching-learning for problem solving, the responses were clustered around the options sometimes and almost never with 56.8% and 16.1%, which makes the scale assume a value of 3.22, respectively (Table 2), representative of a moderate level of appreciation of research to achieve greater integration with teaching and connection with the community.

Table 2. Didactic-reflective management of teaching-learning for problem solving

Options	A		AA		S		AN		Total		Scale
Values	Abs.	%	Abs.	%	Abs.	%	Abs.	%			
Scientific problem solving Needs for	33	12.0	42	15.3	144	52.6	55	20.1	274	100	3.19
Self-forming	35	12.8	55	20.1	156	56.3	28	10.8	274	100	3.35
Error handling	24	8.8	34	12.4	167	60.9	49	17.9	274	100	2.76
Totals	92	11.2	131	15.9	467	56.8	132	16.1	822	100	3.22

This opinion leads to think that there is no positive consideration towards the reflective act on the part of the teacher that allows him to think critically about his educational practice, which could affect the students in a concurrent motivation that allows them to assume a commitment with themselves in the sense of preparing to assume the scientific resolution of the latent problems in their environment.

The results obtained correspond, to a certain extent, with what Marcillo [9] stated, who maintains that the teacher, through his research training, must develop a reflective action on his own practice. Likewise, he will influence his students to practice reflection on their own learning. In this sense, it is up to him to prepare, organize, and set up his class so that they can analyze and interpret their reality; in this way, they begin to learn how to learn.

Regarding the didactic management of methodological and contextual adaptation for research, the responses were sometimes and almost never, with 52.3% and 21.2%, respectively (Table 3). These results make the scale assume a ratio of 3.18, which corresponds to a moderate level of acceptance of research as an integrative function. Certainly, the opinion of the teachers leads to infer that there could be a relative disconnection of

the teacher-researcher with respect to confronting the student with his reality in which he can verify the problems that affect him

Table 3. Didactic management of methodological and contextual adaptation for research

Options	A		AA		S		AN		Total		Baremo
Values	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%	
Context Needs training process	45	16.4	36	13.1	162	59.1	31	11.4	274	100	3.34
Procedural Diversification of Learning	34	12.4	44	16.1	145	52.9	51	18.6	274	100	3.22
Treatment of professional problem	27	9.9	32	11.7	123	44.9	92	33.5	274	100	2.98
Totals	**106**	**12.9**	**112**	**13.6**	**430**	**52.3**	**174**	**21.2**	**822**	**100**	**3.18**

The opinion of teachers corresponds, to a certain extent, with what was stated by Marcillo [9] when he stated that the didactic management of methodological and contextual adaptation for research allows the teacher to, according to his perception of the surrounding reality and the programmatic contents, make readaptations in terms of the contextualization of the contents and the methods and procedures used, in such a way that they adapt to the labor demands of the market and to the needs that involve the community itself.

Regarding the didactic management of strategic interactive investigative learning, the responses were located around the alternatives sometimes and almost always, with 44.8% and 24.9%, respectively. (Table 4). These results make the scale assume a value of 3.69; as can be seen, this ratio corresponds to a high level of appreciation of research in favor of greater integration with teaching and connection with the community. Notwithstanding the above, it must be expressed that the mentioned value arises as a consequence of the scrutiny of the component of group and individual assessment and self-assessment, which takes an average of 3.93, as can be verified in the corresponding table.

The analysis of this management determines the possibility that teachers could give relative importance to the duties and dilemmas that usually arise in the investigative order. It is thought that there should be no equivocation in this sense, since a fundamental principle that all serious and responsible research must uphold is the one related to ethics. Research riddled with vices cannot be considered a contribution to knowledge. Likewise, a medium perception is verified about the importance of heuristics as a methodological criterion with creative qualities. The student's own experience, his previous knowledge, and adequate guidance from the teacher will awaken in him all that creative torrent that belongs to him and underlies him.

Regarding the didactic-participatory management of significant research tasks, the responses were located around the options sometimes and almost always with 57.4%

Table 4. Didactic management of interactive investigative strategic learning

Opciones	A		AA		S		AN		Total		Baremo
Valores	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%	
Ethical duties and dilemmas in the profession	72	26.3	75	27.4	127	46.3	–	–	274	100	3.34
Heuristics in Problem Solving	45	16.4	38	13.9	156	56.9	35	12.8	274	100	3.34
Assessment and auto-evaluation of group and individual work	87	31.8	92	33.6	85	31.0	10	3.6	274	100	3.93
Totales	**204**	**24.8**	**205**	**24.9**	**368**	**44.8**	**45**	**5.5**	**822**	**100**	**3.69**

and 19.1% (Table 5), in view of which the scale adopts a value of 3.51, distinctive of a moderate thought regarding the use of research as an integrative element with teaching and community outreach. Of course, this implies research skills that need to be improved.

Table 5. Educational-participatory management of significant research tasks

Options	A		AA		S		AN		Total		Scale
Values	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%	
Logical Problem-Solving Dynamics	54	19.7	59	21.5	161	58.8	–	–	274	100	3.61
Information Management	63	23.0	45	16.4	166	60.6	–	–	274	100	3.62
Dynamic Active Appropriation of Content	35	12.8	53	19.3	145	52.9	41	15.0	274	100	3.30
Totals	**152**	**18.5**	**157**	**19.1**	**472**	**57.4**	**41**	**5**	**822**	**100**	**3.51**

Certainly, it can be inferred from the responses obtained that there is a relative appreciation of the teacher in relation to establishing research tasks that are related to his field of study but that commit him to make use of the logical processes of thought such as analysis, metacognition, and reflection, among others. Likewise, moderate inadequacies are noted in terms of considering advice as an important strategy in the search and selection of information according to criteria of scientific rigor. Likewise, a moderate perception is verified in relation to scrutinizing the creative capacity of the student. All of this could have repercussions on the integration of research with teaching and the connection with society.

The opinion of the teachers is relatively consistent with that expressed by Marcillo, [9]; Acosta, [1]; and Martínez, [10] who maintain that the teacher must prepare and evaluate everything necessary so that students can engage in research that is closely linked to their field of study but with an interdisciplinary and transdisciplinary vision. Interdisciplinarity allows for a broader vision, observing and correcting errors arising from a science limited by its own knowledge. Transdisciplinarity implies creativity, criticality, transversality, and the exchange of methods, instruments, and procedures, which generates a dialectical management of global understanding of the processes.

4 Conclusions

Once the research was carried out and based on the contributions of the teachers, via an online questionnaire and interviewed principals, the following conclusions were determined:

Four (4) indicators were analyzed, which in turn were broken down into 12 sub-indicators. From this process, it was determined that eleven of the sub-indicators show a "moderate" appreciation in relation to the importance they give to the possession of research skills in favor of an integration with the functions of teaching and community outreach. Only the indicator assessment and self-assessment of group and individual work presents a high significance. On the other hand, from the interviews carried out with the directors of research, teaching, and community outreach, an opinion concordant with that indicated by the teachers themselves is perceived. According to this, each teacher works in his or her area independently in the substantive functions; only some teachers, the most experienced, manage to carry out an integrative work of the three functions. This situation could create negative repercussions in the formative process of the students.

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Pedagogical Innovation: Use of Business Information Technologies in the Training Process of Public Accountant and Auditor at Universidad Santo Tomás

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Abstract. This research proposes the integration of business technology tools into the Public Accounting and Auditing program at Universidad Santo Tomás to improve students' readiness for the digital transformation of the business world. The inclusion of tools such as SAP and BUK in the curriculum aims to ensure students acquire relevant and up-to-date competencies aligned with market demands. The proposal stands out for aligning the curriculum with the graduate profile and institutional objectives, allowing for a progressive development of technological skills through a structured approach at basic, intermediate, and advanced levels. It is also integrated across various accounting subjects, enabling students to acquire digital competencies applied to key areas like financial management, payroll, and decision-making. Continuous faculty training and the use of self-learning resources are essential for the success of the proposal, ensuring teachers can effectively guide students. However, challenges such as varying levels of technological familiarity among faculty and the time needed for students to adapt to these tools are identified. In conclusion, the integration of these technologies prepares graduates to face the challenges of the modern business world, and continuous support will be key to ensuring the initiative's success.

Keywords: Business technology tools · Digital transformation · Curriculum alignment · Faculty training · Competency development

1 Introduction

The constant evolution of technology has transformed all professional sectors, including accounting and auditing. Business technological tools are now an essential component in the management and analysis of financial, tax, and management information. In this context, the Universidad Santo Tomás (UST) has recognized the need to integrate these technologies into its academic training, especially in the field of Accounting and Auditing.

This paper proposes an educational innovation in the teaching and learning process, aiming to incorporate business technological tools into the accounting training track of

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 10–22, 2025.
https://doi.org/10.1007/978-3-032-09080-5_2

the Accounting and Auditing program. This innovation seeks to enhance students' digital skills, which are crucial for their professional development in an increasingly digitalized business environment. To achieve this, a gradual approach to integrating information technologies (IT) into the curriculum is proposed. This will allow students to familiarize themselves with technological tools from the early semesters and progressively develop more complex skills as they advance in their studies. This proposal is aligned with the program's graduate profile and UST's educational model, which emphasizes the holistic development of students and their ability to address the challenges of the current professional world.

The implementation of this proposal is based on a detailed analysis of the graduate profile of the Accounting and Auditing program and its current curriculum, with an emphasis on the subjects in the accounting training track. It details how these subjects can be enhanced through the use of information technologies, and how these changes will impact the development of specific and generic competencies, improving the preparation of future accountants and auditors for an increasingly technological workforce.

This proposal's development is organized into three parts: first, the graduate profile of the UST Accounting and Auditing program is analyzed; second, the current curriculum and its alignment with digital transformation is reviewed; and finally, the subjects that can be enhanced with the use of business technologies are identified, providing a clear vision of how this innovation will be implemented in practice.

2 State of Art

Technological disruption has significantly changed daily life, transforming communication, work, living, and learning. Educational institutions must adapt to meet the challenges and opportunities presented by these technologies. Higher education today faces new technologies, outdated knowledge and practices, and competition to maintain academic relevance (Hernández & Murillo, 2020; Hofer et al., 2021; Kolade et al., 2022; Miotto et al., 2020). In Latin American universities, accounting programs have incorporated technology to improve education. For Ecuadorian universities, aligning strategic vision with social commitment is key to enhancing outcomes and preparing students for global demands (Armijos & La Paz, 2022). These changes reflect the need for continuous adaptation to technological advancements and student needs.

Technologies positively impact education, but their implementation requires proper planning to avoid counterproductive results. Institutions sometimes focus on infrastructure while neglecting teacher training and curriculum updates (Frau et al., 2009). Successful integration of ICT into education depends on clear objectives and proper planning, ensuring meaningful educational experiences and continuous feedback (Almaiah et al., 2020). Villalonga Gómez & Lazo (2015) stress that ICT in education requires a methodological approach linking experimentation and simulation with learning.

Technologies have transformed various professional fields, particularly business. Studies show that technology improves education and learning outcomes in accounting (Danaei et al., 2020; Garzón et al., 2020). Accounting, with roots tracing back to 1494, has continually evolved (Rodríguez et al., 2012), and technology is accelerating this change, especially in education (Voshaar et al., 2022). However, while new generations

are tech-savvy, their skills may not be sufficient for the professional field (Cánovas, 2014). Universities and accounting programs face the challenge of integrating emerging technologies and ensuring graduates master them. Pedagogical mediation is essential, particularly for first-year students who may lack the necessary skills for university life (Valdivia Durán 2019). Faculty must adapt to technological changes and support students in their learning process (Brunner, 2015).

The proposed shift in teaching focuses on active learning, with technology serving as a central tool. Fernández and Aguado (2017) argue that modern education must engage students in alignment with contemporary realities, meaningfully integrating ICT to highlight technology's potential. An innovative educator can harness these tools effectively to enhance the learning experience. López Cruz and Heredia Escorza (2017) explore educational innovation through the integration of technology, pedagogy, and processes. Connecting theoretical concepts with real-world issues boosts student engagement and satisfaction (Hansen, 2006; Peréa et al., 2019). As facilitators of learning, teachers must guide students through technological and pedagogical transitions, which requires ongoing updates to their knowledge and teaching skills.

Resistance to change is a barrier in education, both for teachers and students, often due to uncertainty or attachment to traditional methods (Avendaño et al., 2016). Traditional methods, such as paper-based activities, hinder student motivation, making a shift toward tools like Excel and accounting software necessary (Cassiani & Zabaleta, 2017). Quality education is foundational for entrepreneurship and economic growth (Edward Ma, 2023). Accounting education directly impacts students' preparation for labor market challenges (Perdomo & Perdomo, 2012). The demand for accounting professionals with advanced technical skills is rising, and the use of accounting software is inevitable in professional practice (Ruiz Rojas, 2022; Villarreal & Córdoba Martínez, 2022). The impact of virtual learning environments during the COVID-19 pandemic has transformed the learning experience, affecting academic performance and social interaction (Armijos et al., 2022). Latin American universities have shifted toward strengthening virtual learning platforms (La Paz Lillo et al., 2023). Studies emphasize the need for institutions to adapt to technological changes and address the challenges faced during transitions (Armijos et al. 2023).

Curriculum design for accounting programs in Latin America has evolved to integrate technology (La Paz & Armijos, 2020). Ecuadorian universities focus on aligning strategic vision and social commitment to improve education (Armijos & La Paz, 2022). The continuous adaptation of educational approaches is essential, considering technological advancements and student needs (Libaque-Saenz & Armijos, 2025). Recent research highlights the importance of balancing regional and global perspectives in accounting education (Armijos et al. 2025).

3 Design and Methods

The proposed methodological design aims to facilitate the integration of business technology tools into the teaching-learning process of the accounting training track for students in the Public Accountant and Auditor program at the University of Santo Tomás. This process begins with a progressive analysis, moving from the general to the specific,

using the defined graduate profile of the program as the starting point. To achieve this graduate profile, the program takes responsibility for implementing a training proposal within its curriculum, which aims to develop both specific and generic competencies. The methodological design faces the challenge of incorporating these competencies into the course syllabi that make up the accounting training track, always considering the progression level of each competency. This approach allows the identification of teaching units where the integration of technological tools can enrich the formative process. Furthermore, it is essential to ensure the gradual integration of these tools, making sure their use is naturally embedded in the learning process, thus enabling students to adapt progressively and effectively. Within each teaching unit, specific learning objectives are identified, which will be mediated through the available business information technologies (IT). Additionally, the way these technologies will be incorporated into the development of practical activities is defined. Finally, the learning path and mediation of these technologies are also integrated into the course's teaching plan.

Along with the integration of business technology tools into the formative planning process, it is crucial to assess whether the teaching staff possesses the necessary competencies to use these tools effectively. To this end, minimum standards for handling these technologies should be established, ensuring that faculty members have the required competencies to integrate them into their pedagogical practice.

Simultaneously, the implementation of ongoing training programs for faculty members must be considered to update and strengthen their skills in using IT. These periodic training sessions not only ensure that faculty are equipped to meet technological demands but also contribute to the feasibility and effectiveness of the previously defined teaching plan. This guarantees that the planned technological tools can be optimally used in the teaching-learning process (Fig. 1).

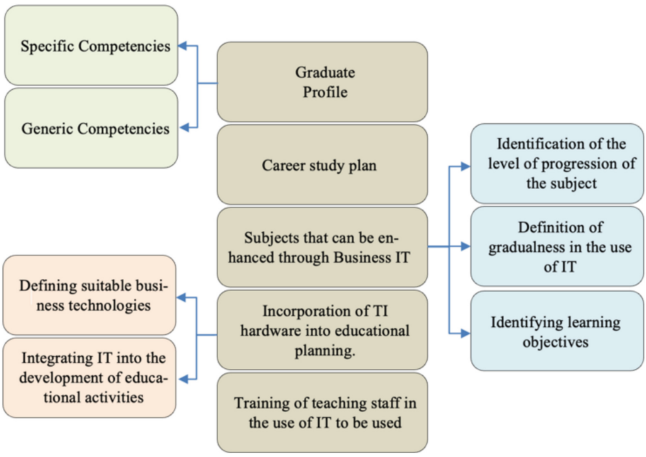

Fig. 1. Methodology used for the development of the proposal

4 Proposal Development

As previously mentioned, the academic innovation proposed in this paper aims to integrate the use of business technology tools into the training process of the Public Accounting and Auditing program at Santo Tomás University, specifically in the accounting training program. Each of the steps established in the proposed methodology is described in detail below:

4.1 Graduate Profile of the Public Accountant and Auditor at UST

The Formation Model of the Universidad Santo Tomás (UST) establishes the guidelines for designing careers, academic programs, curricula, and the teaching-learning process, while also defining the expected graduate profile. This model promotes the comprehensive development of students, encouraging the acquisition of knowledge, skills, and attitudes that enable them to address and solve complex, discipline-specific professional problems. The graduate profile at UST combines specific competencies related to the professional and disciplinary aspects of each program, as well as generic competencies shared across all programs and aligned with the institution's model.

To ensure the quality and relevance of the graduate profiles, the University has implemented procedures to align them with the institutional framework, current legal regulations, and the specific professional demands of each career.

The official graduate profile of the Public Accountant and Auditor program at UST states: "The Public Accountant and Auditor of Universidad Santo Tomás is a professional capable of preparing, interpreting, and validating financial, tax, and management information, as well as issuing an independent opinion on financial statements, control processes, risk management, and organizational governance, with an ethical and multidisciplinary approach. Due to the nature of their duties, they are able to work both dependently and independently." This graduate profile includes both specific and generic competencies, which are detailed below.

4.1.1 Specific Competencies:

- Manage an organization by analyzing all variables involved, both internal and external, to enable an efficient decision-making process.
- Implement information systems that address the needs of business processes within organizations.
- Generate information by analyzing data with technological tools to support organizational decision-making.
- Manage legal and tax compliance for individuals and legal entities.
- Issue a reasoned opinion regarding the reliability of information or processes under review, considering associated risks, with an ethical and multidisciplinary approach.

4.1.2 Generic Competencies:

- Ability to communicate orally and in writing in one's own language, expressing ideas clearly and coherently.

- Ability to work in complex environments, with interdisciplinary and multidisciplinary teams, with a proactive and quality-driven mindset to achieve objectives.
- Ability to use communication and information technologies as tools for autonomous learning and for improving personal and professional performance.
- Ability to generate processes of abstraction, analysis, and synthesis, using basic research tools that enhance professional performance.
- Ability to act with ethics and social responsibility, respecting human dignity in personal relationships and in various professional and work settings.
- Ability to use self-learning and continuous professional development as tools to improve professional growth and adapt to changes in the knowledge society.
- Ability to use basic English to comprehend simple texts and dialogues in personal and professional contexts.

The matrix showing how the courses in the curriculum align with these generic competencies can be seen in the following table.

4.2 Curriculum of the Bachelor's Degree in Public Accounting and Auditing at UST

The study programs are designed to ensure the achievement of objectives, competencies, and measurable learning outcomes, establishing milestones that allow for progressive and integrated evaluation of the fulfillment of the graduation profile. This ensures that graduates develop the competencies and achieve the learning outcomes required for the degree and professional title. The process maintains coherence across the different areas of the curriculum, ensuring consistency with the principles of the institution's training model.

The Bachelor's degree in Public Accounting and Auditing at Universidad Santo Tomás lasts 8 semesters and is offered in both daytime and evening formats. Its curriculum is aligned with the demands of digital transformation, incorporating over 35% of courses that integrate cutting-edge software for business management, ensuring updated and highly relevant training for today's professional context.

The curriculum follows a progressive model of training based on competency development. This approach includes periodic evaluations to measure students' progress in their competencies, using assessment milestones that provide feedback. These milestones evaluate competency development at three levels: basic, intermediate, and advanced, and are key components of the curriculum. This model ensures that students achieve the graduation profile gradually and consistently throughout their education process (Fig. 2).

4.3 Business Information Technology-Enhanced Subjects

Considering the objective of implementing a didactic innovation that incorporates the use of business information technologies (IT) in the accounting training pathway, the analysis will focus on the progression of the subjects that make up this educational pathway (Fig. 3).

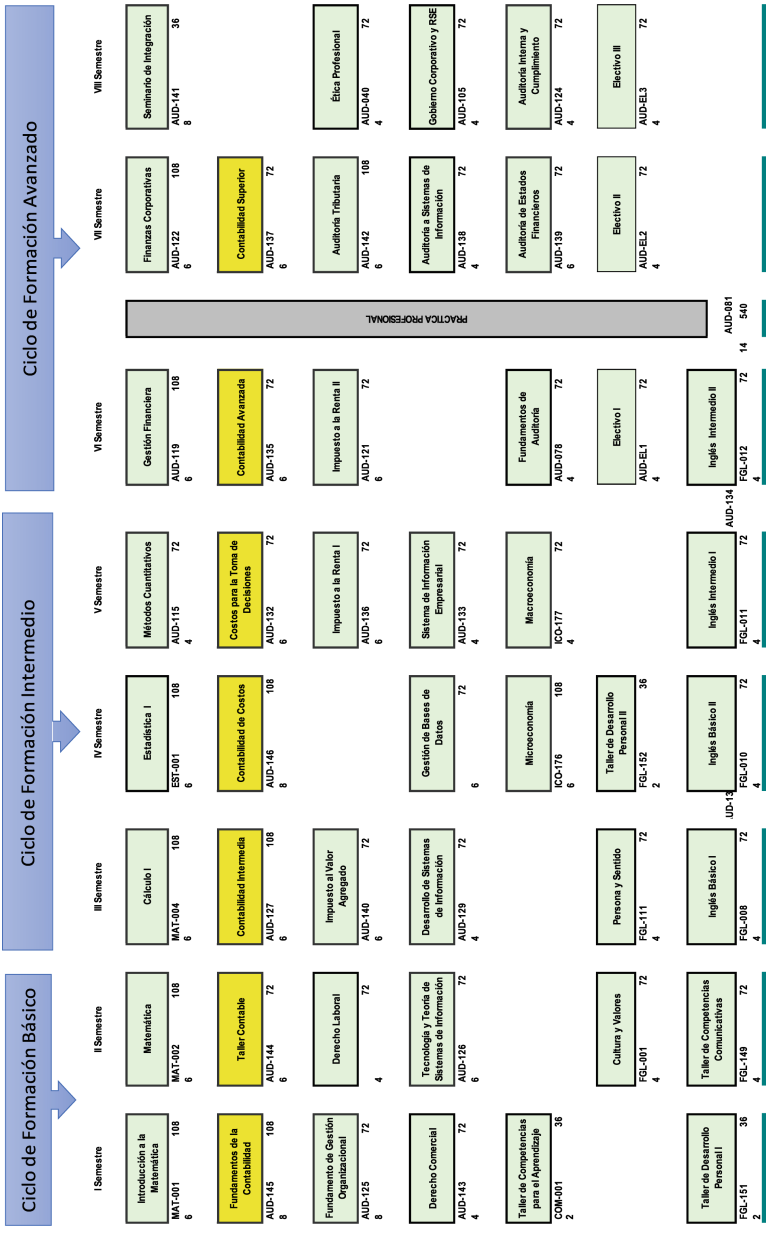

Fig. 2. Curriculum of the Public Accountant and Auditor degree and the accounting training pathway

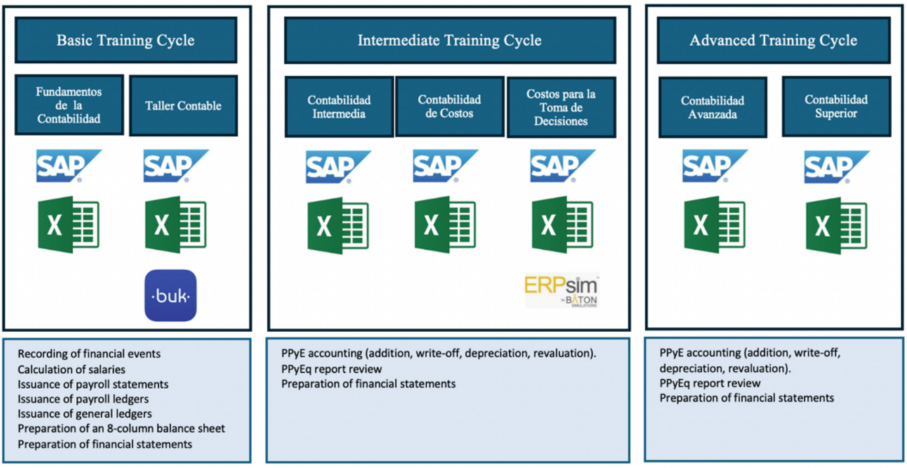

Fig. 3. Subjects associated with the accounting training pathway and the business IT tools to be used in the proposed pedagogical innovation are distributed across three levels of training: basic, intermediate, and advanced.

Based on this structure, a gradual approach will be adopted for the integration of business IT. In the basic level, simple interactions and introductory activities with these tools will be prioritized, while at the intermediate and advanced levels, the complexity of tasks and technological interaction will increase. This will allow students to progressively develop their digital competencies, aligning with their academic progress and the increasing depth of content.

Table 1 outlines how the subjects, their semester of delivery, units, learning objectives, selected business IT tools for intervention, and processes to be assisted by these technologies are related. This approach ensures that the integration of IT is carefully aligned with the pedagogical objectives and the planned learning sequence in the curriculum.

Table 1. Alignment of Subjects, Objectives, IT Tools, and Pedagogy.

No.*	TC**	Subjects	IT Tool	Unit	Capacity	Learning Outcome
1	Basic	Fundamentos de la Contabilidad	SAP: Finance Module - Basic Excel	3. Transaction Recording for the Preparation of Financial Statements	Record economic events in an organization's accounting system for the preparation of financial information.	Record accounting transactions and transfers in both the main and subsidiary ledgers.
						Prepare basic financial reports, identifying the main components of financial statements.
			SAP: Finance Module - BUK - Basic Excel	2. Compensation Process	Develop the process for calculating and accounting for compensation in an organization, considering compliance with tax and labor laws.	Develop the compensation calculation process in an organization for its recognition and valuation in accounting.
2	Basic	Taller Contable	SAP: Finance Module - Basic Excel	3. Preparation of Financial Statements	Prepare an organization's financial statements in accordance with international accounting standards.	Prepare the basic financial statements of an organization, applying international accounting standards.
3	Intermediate	Contabilidad Intermedia	SAP: Fixed Assets Module - Basic Excel	3. Accounting Treatment of Property, Plant, and Equipment	Apply current accounting standards for the recognition and valuation of transactions related to property, plant, and equipment assets and their presentation in an organization's financial statements.	Apply current regulations to property, plant, and equipment assets.
4	Intermediate	Contabilidad de Costos	SAP: Production Module - Intermediate Excel	3. Joint Costing, Process Costing, and Treatment of Defective Units	Use the process costing system in organizations with mass production methods	Apply the process costing method in a mass production system to determine costs.
5	Intermediate	Costos para la Toma de Decisiones	SAP: Fixed Assets Module - Basic Excel	1. Budgeting Process and Variance Analysis	Use the budget in an organization for planning and controlling operations	Prepare the master budget as a planning and control tool in an organization.
6	Advance	Contabilidad Avanzada	SAP: Finance Module - Advanced Excel	2. Intangible Assets	Apply current international accounting standards for the recognition and valuation of transactions related to intangible assets and their presentation in an organization's financial statements	Apply current international standards for the accounting treatment of intangible assets.
				3. Investments	Apply current international accounting standards for the accounting treatment of different types of investments, both in their initial recognition and in the effects these investments subsequently generate, for the correct presentation of an organization's financial information	Apply current international standards to consolidated and separate financial statements.
7	Advance	Contabilidad Superior	SAP: Finance Module - Advanced Excel	2. Cash Flow Statement	Apply current international accounting standards for the preparation and presentation of the Cash Flow Statement, identifying the different types of cash flows generated by an organization and classifying them appropriately according to their source.	Prepare a cash flow statement, in accordance with international accounting standards.

*** Number of Semesters, **Training Cycle.**

4.4 Incorporation of IT Tools in the Didactic Planning

Didactic planning organizes activities, objectives, and strategies for a specific period, aligning with content and learning goals. It is structured by training levels (basic, intermediate, advanced), enabling students to develop competencies progressively. Following Bloom's Taxonomy, objectives evolve from basic (identifying, recording) to complex (applying, proposing solutions). Technological tools like SAP and BUK software are integrated, bridging academia with industry needs and preparing students for professional challenges. The use of BUK for HR and payroll management is especially suitable for academic purposes. The impact on accounting courses is analyzed below.

- **Fundamentals of Accounting**: This introductory course uses SAP FIORI software to record economic transactions in organizations, allowing students to familiarize themselves with financial statements and the use of technological tools like SAP and Excel. The main objective is to provide basic knowledge so that students can understand and apply accounting in practical situations.
- **Accounting Workshop**: Students learn to prepare financial statements using SAP FIORI and BUK software for managing payroll, comparing manual calculations with those generated automatically by the systems. The course focuses on applying accounting standards and developing skills in specific technological tools for payroll management.

- **Intermediate Accounting**: Focusing on International Accounting Standards (IAS-IFRS), students delve into the management of Property, Plant, and Equipment (PP&E) assets using the SAP FI-AA module, which allows them to manage the asset lifecycle from acquisition to depreciation and other accounting adjustments. The integration of SAP in this process strengthens both theoretical and practical understanding.
- **Cost Accounting**: This course focuses on identifying and classifying costs for different production systems, using SAP S/4 HANA to simulate the process of planning, sourcing, production, and sales in a company. Students learn to generate cost reports and manage production, gaining real-time information about performance and associated costs.
- **Costs for Decision Making**: Students use SAP S/4 HANA and the ERPsim application to simulate cost planning and control in a competitive environment. Each team manages the business process of a company, calculating cost variations and evaluating performance to meet the budget and maximize profitability.
- **Advanced Accounting**: In this course, students work with SAP to record transactions related to biological assets, intangible assets, and investments, applying international standards for the correct presentation of financial statements. The focus is on consolidating financial statements and preparing detailed reports, developing advanced analytical skills.
- **Advanced Accounting**: Students prepare advanced financial statements, such as the statement of cash flows, using SAP and Excel to structure and present financial information clearly and precisely. The course focuses on integrating both tools to generate detailed and well-supported reports on an organization's liquidity.

4.5 Faculty Training

To successfully implement the proposal, it is essential to strengthen faculty capabilities. Although various business management tools may differ from those used in this initiative, most platforms operate on similar principles, facilitating a smooth adaptation for both faculty and students.

The training strategy consists of two complementary approaches:

- **Direct Faculty Training:** The program organizes workshops for professors in the accounting curriculum to familiarize them with the proposed technological tools, ensuring proficiency both technically and pedagogically.
- **Self-learning Support Materials:** Instructional videos have been developed to clearly explain the processes involved in using these business tools. These resources not only support faculty but also encourage students' autonomous learning and skill development.

Additionally, the University of Santo Tomás' participation in SAP University Alliances provides exclusive access to high-level training opportunities. This includes specialized courses and workshops led by SAP experts, along with a comprehensive online training portal, allowing participants to learn at their own pace based on their interests.

Together, these strategies ensure that faculty are well-equipped and foster a culture of continuous learning, bridging academic training with the demands of the professional business environment.

5 Conclusions and Discussion

This proposal aimed to integrate business technology tools into the Public Accounting and Auditing program at Santo Tomás University to enhance students' readiness for the digital transformation of the business world. The incorporation of tools such as SAP and BUK into the curriculum demonstrates the university's commitment to ensuring that students gain relevant and up-to-date competencies in line with industry standards.

One of the main strengths of the proposal lies in the alignment of the curriculum with both the graduate profile and the institutional objectives. The inclusion of business technology tools, tailored to different levels of competency (basic, intermediate, advanced), allows for a progressive development of skills. This structured approach ensures that students build their digital capabilities incrementally, preparing them for complex tasks in real-world business environments. By integrating these tools across a variety of accounting subjects, students are exposed to practical applications of technology in areas such as financial management, payroll, cost accounting, and decision-making.

The involvement of faculty through direct training and self-learning support is crucial for the success of this proposal. Workshops designed to familiarize professors with the technologies ensure that the teaching staff is adequately prepared to guide students through the learning process. The availability of instructional videos for self-study also promotes a culture of lifelong learning, encouraging both faculty and students to deepen their technical and pedagogical skills. Furthermore, the participation in SAP University Alliances provides valuable access to specialized training, enhancing the faculty's ability to deliver high-quality education.

Despite the promising outcomes, several challenges could arise during the implementation phase. One potential obstacle is the varying levels of familiarity with technology among faculty members. To mitigate this, continuous support and follow-up training may be necessary to ensure long-term success. Additionally, while the integration of business technology tools is undoubtedly beneficial, students may need time to adapt to these new systems, particularly if they have limited prior exposure to such tools.

In conclusion, the integration of business IT tools into the Public Accounting and Auditing curriculum at Santo Tomás University is a forward-thinking strategy that bridges the gap between academic training and industry needs. The progressive development of digital competencies ensures that graduates are well-prepared to meet the demands of the modern business world. Continued support for both faculty and students will be key to the long-term success of this initiative, creating a foundation for future innovations in teaching and learning.

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School Theater in the Oral Expression of the English Language in High School Students

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Abstract. The objective of this research was to diagnose the influence of School Theater on the level of learning of oral expression of the English language in fifth-year students of the secondary level of a public educational institution in the region of Tacna, 2023. The current investigation corresponds to an applied type of research using a pre-experimental design. An oral entry exam was carried out with the reading of a theatrical script, through an evaluation rubric considering the three performance levels of the competence Communicates orally in English, according to the National Curriculum. The results showed a significant improvement in students' oral expression. Before the intervention, 53.57% of students were at the initial level, 39.29% in progress, and only 7.14% had reached the expected level. After the implementation of the School Theater strategy, 60.71% reached the expected level, 14.29% reached an outstanding level, and only 3.57% remained at the initial level. The t-test for related samples yielded a significant difference ($t = -10.990$, $p < 0.001$), confirming the positive impact of the intervention. In conclusion, the application of School Theater significantly improved the oral expression in English of the students, demonstrating its effectiveness as a pedagogical strategy to enhance communicative competence in a foreign language.

Keywords: Oral expression · secondary level students · English language · school theater

1 Introduction

In the course of acquiring the English language, students cultivate four primary skills: reading, writing, listening, and speaking; nonetheless, advancement in each domain does not consistently transpire uniformly. During the secondary level, a period marked by substantial emotional and social transformations, insecurities frequently emerge that directly impact their communicative skills, especially in vocal expression. Although numerous students have satisfactory competence in reading comprehension, writing creation, and listening comprehension, they exhibit significant challenges in oral communication in English. These challenges are primarily linked to personal insecurity, anxiety, or the absence of suitable environments for authentic language practice.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 23–33, 2025.
https://doi.org/10.1007/978-3-032-09080-5_3

English teachers face the challenge of a dense array of competencies to be cultivated within a constrained instructional timeframe, hindering their ability to concentrate the teaching process on the core objective of foreign language acquisition: communication. In essence, regardless of the extent of vocabulary, grammatical structures, or idiomatic expressions imparted, if they are not actively exercised within context, the learning will lack practicality and devolve into mere transient memorization. This aligns with Jiménez's [1] assertion that English has emerged as a priority subject due to the numerous opportunities its proficiency affords. The Ministry of Education of Peru advocates for the adoption of the Communicative Language Teaching (CLT) approach, which posits that effective learning necessitates classroom activities where students articulate their ideas in authentic or significant contexts.

Despite the existence of methodological tools designed to enhance oral expression, their implementation frequently remains limited to the classroom environment, hindering students from internalizing the language as a means of communication in authentic circumstances. The Peruvian education system exacerbates this issue by failing to prioritize the cultivation of students' communication abilities, creativity, leadership, and critical thinking—competencies essential for the proficient use of the English language.

In this setting, school theatre serves as an invaluable teaching instrument that facilitates the transversal development of communicative abilities. Theatre, as a mode of artistic expression, necessitates the utilization of both the body and the voice to portray characters and communicate messages to an audience. This practice fosters the enhancement of confidence, spontaneity, articulation, and self-assurance. Vargas [2] asserts that school theatre emerges from the necessity to furnish pupils with pedagogical tools that enhance their spoken expression in the educational setting.

School theatre is regarded as a holistic pedagogical approach for enhancing oral expression, enabling students to confront communicative scenarios that promote successful engagement and the application of language in authentic contexts. This approach not only enhances verbal proficiency but also bolsters the socio-emotional skills that directly impact communication [3].

The Ministry of Education of Peru defines the skill "Communicates orally" as the capacity to engage actively with one or more interlocutors to convey ideas, emotions, and viewpoints. Nonetheless, the methodologies typically employed in English classrooms inside the country emphasize the cultivation of the competencies "reading" and "writing," concentrating on the acquisition of vocabulary and grammatical structures, while allowing minimal opportunity for vocal expression. Consequently, numerous students struggle to recognize or cultivate their communicative skills due to insufficient opportunities and secure environments for self-expression, a predicament further intensified by shyness or social anxiety.

The incorporation of theatre as an instructional tool addresses both methodological and emotional-social needs. The isolation resulting from the COVID-19 pandemic exacerbated communication issues among adolescents. A survey by UNICEF's U-Report indicated that over 25% of youth in Latin America and the Caribbean had symptoms of anxiety, while 15% displayed indicators of depression. This has led to a diminished inclination to communicate effectively, particularly on the return to in-person classes. Consequently, educators should encourage an increased variety of activities that enhance verbal

communication and genuine connection among students, with school theatre serving as an ideal option.

Moreover, the English Proficiency Index indicates the inadequate level of English proficiency in Latin America. In that assessment, Argentina achieved the highest score (556 out of 800), although Peru's performance is comparatively poor relative to other countries in the region [4]. This predicament is exacerbated by the limited integration of theatre inside the nation's educational institutions. Predominantly, private schools facilitate theatre activities, while public institutions frequently suffer from inadequate infrastructure and insufficient teacher training. English instruction in these institutions predominantly emphasizes written and grammatical exercises, resulting in insufficient development of oral abilities.

Jaramillo's study and his suggestion "Theatre Workshop Improves My Oral Communication" illustrate that the use of theatre in educational settings fosters a constructivist and social pedagogy. His research resulted in substantial enhancement of pupils' oral proficiency, alongside a more dynamic pedagogical approach for educators and more involvement from parents [5]. García also emphasizes that school theatre positively influences students' speech performance, serving as a crucial learning experience that improves both verbal abilities and interpersonal relationships [6].

Recent research seeks to investigate and evaluate the impact of school theatre on the development of the skill "Communicates orally in English." A study conducted in a public educational institution in the Tacna region revealed that fifth-year secondary students engaged in theatre activities had notable enhancements in their oral expression. The findings align with an assertion that theatre functions as a tool enabling youth to articulate and convey their particular beliefs to society, fostering discipline, commitment, and exceptional speech and physical skills [7].

In conclusion, the incorporation of school theatre as a pedagogical method in secondary English instruction is both pertinent and essential. This method enables pupils to surmount emotional obstacles, enhance their verbal proficiency, and cultivate genuine and significant communication in the foreign language. Moreover, it addresses contemporary contextual requirements and the necessity to cultivate well-rounded pupils adept at boldly navigating an increasingly globalized and challenging environment.

2 Methodology

Applied research is focused on utilizing scientific knowledge to solve practical problems. This body of work highlights the importance of practice-oriented studies and investigations. It stresses the need for applied research to develop concrete systems and solutions, such as technological advancements or inventions, aimed at addressing societal challenges [8]. The study design was employed to ascertain the influence of the first variable on the second by strategically and practically applying the provided knowledge. The fifth-year secondary pupils of a public educational institution studied School Theater and English oral expression.

Applied research, sometimes referred to as "practical or empirical research," seeks to utilize existing knowledge while fostering the acquisition of new insights through the implementation and systematization of research-based practices [8].

We employed a pre-experimental methodology with a singular cohort of fifth-year high school students at a public educational institution. The research exclusively employed the pre-experimental design.

The pre-experimental design included a singular pretest and posttest pair [9]. This design was used due to the impossibility of randomly assigning students to control and experimental groups. Consequently, the pre-experimental methodology facilitated the assessment of therapy effects within a singular cohort.

The research encompassed female fifth-year high school students from a public educational institution in the region. Fifth-year secondary school students at a public educational institution in the region comprised the cohort for the study.

This research employed both qualitative and quantitative methodologies to evaluate the impact of school theater on English oral expressiveness. The data for the independent variable was gathered utilizing an observation checklist aligned with the English segment of the national curriculum. Students engaged in a teacher-supervised oral discourse to assess the dependent variable. The oral examination was structured using a rubric and checklist to evaluate secondary students' communication abilities.

3 Results

Prior to the implementation of the school theater program, slightly over half of the students, specifically 53.57%, were at the beginning level in the dimension "Adapts, organizes, and develops the text in English in a coherent and cohesive manner," exhibiting challenges in diction, fluency, coherence, and rhythm. Additionally, a little more than one-third of the students, accounting for 39.29%, were categorized as in process, while 7.14% achieved the expected level of proficiency, with no students attaining the level of outstanding achievement (Table 1).

Table 1. Distribution of the dimension "Adapts, organizes, and develops the text in English in a coherent and cohesive manner" among fifth-year secondary level students at a Public Educational Institution in the Tacna region.

Level	Experimental group			
	Pre-test		Post-test	
	N°	%	N°	%
Beginning	15	53,57	1	3,57
In progress	11	39,29	6	21,43
Expected achievement	2	7,14	17	60,71
Outstanding achievement	0	0,00	4	14,29
Total	28	100,00	28	100,00

Subsequently, following the implementation of the school theater program, the majority of students attained the anticipated achievement level in the dimension "Adapts, organizes, and develops the text in English in a coherent and cohesive manner," specifically 60.71%. A minority of students, constituting 3.57%, were at the beginning level, while 21.43% were at the process level, and 14.29% achieved the outstanding level of accomplishment (Table 1).

Consequently, it can be asserted that the implementation of school theater has impacted the dimension "Adapts, organizes, and develops the text in English in a coherent and cohesive manner" among the pupils.

Table 2. Distribution of the dimension "Uses non-verbal and paraverbal resources strategically" among fifth-year secondary level students at a Public Educational Institution in the Tacna region.

Level	Experimental group			
	Pre-test		Pre-test	
	N°	%	N°	%
Beginning	21	75,00	2	7,14
In progress	6	21,43	8	28,57
Expected achievement	1	3,57	15	53,57
Outstanding achievement	0	0,00	3	10,71
Total	28	100,00	28	100,00

Prior to the implementation of the school theater program, nearly one-fifth of the students were at the beginning level in the dimension 'Uses non-verbal and para-verbal resources strategically', indicating that 75% struggled with the strategic use of body language. Just under one-third of the students were at the in-process level, comprising 21.43%, while 3.57% achieved the expected level of proficiency, and no students reached the outstanding achievement level (Table 2).

Subsequently, following the implementation of the school theater program, the majority of students attained the anticipated level of proficiency in the dimension 'Uses nonverbal and paraverbal resources strategically', specifically 53.57%. They no longer encountered challenges in the strategic use of body language, while a minority of 7.14% remained at the beginning level (Table 2).

Additionally, 28.57% of students were classified at the process level, and 10.71% achieved the level of outstanding accomplishment. Consequently, it can be asserted that the implementation of school theater has impacted the dimension 'Uses nonverbal and paraverbal resources strategically' among pupils (Table 2).

Table 3. Distribution of the dimension "Strategically interacts in English with different interlocutors" among fifth-year secondary level students at a Public Educational Institution in the Tacna region.

Level	Experimental group			
	Pre-test		Pre-test	
	N°	%	N°	%
Beginning	16	57,14	2	7,14
In progress	11	39,29	5	17,86
Expected achievement	1	3,57	17	60,71
Outstanding achievement	0	0,00	4	14,29
Total	28	100,00	28	100,00

Prior to the implementation of the school theater program, slightly over half of the students were at the introductory level in the dimension 'Interact strategically in English with various interlocutors'; specifically, 57.14% had difficulties in message clarity and vocal tone. Specifically, 57.14% exhibited deficiencies in message clarity, vocal tone, volume, and eye contact, while slightly over one-third of the students were categorized as being in the 'in process' stage, at 39.29%. Additionally, 3.57% of the students reached the expected level of achievement, with no students attaining the level of outstanding achievement (Table 3).

Subsequently, following the implementation of the school theater program, the majority of pupils attained the anticipated level of proficiency in the dimension 'Interact strategically in English with varied interlocutors', specifically 60.71%, and no longer had issues with message clarity. A minority of pupils, 7.14%, were at the beginning level, while 17.86% were at the process level, and 14.29% had remarkable success. Consequently, it can be asserted that the implementation of school theater has impacted the dimension 'Interact strategically in English with diverse interlocutors' among the pupils (Table 3).

Table 4. Distribution of the level of English Oral Expression among fifth-year secondary level students at a Public Educational Institution in the Tacna region.

Level	Experimental group			
	Pre-test		Pre-test	
	N°	%	N°	%
Beginning	20	71,43	2	7,14
In progress	7	25,00	4	14,29
Expected achievement	1	3,57	18	64,29
Outstanding achievement	0	0,00	4	14,29
Total	28	100,00	28	100,00

Before to the implementation of the school theater program, slightly over half of the students were at the beginning level in their Oral Expression of the English Language. Specifically, 71.43% exhibited difficulties in 'adapting, organizing, and developing text in English coherently and cohesively,' 'strategically utilizing non-verbal and paraverbal resources,' and 'interacting strategically in English with various interlocutors.' Additionally, a maximum of 25% of students were categorized as in process, while 3.57% achieved the expected level of proficiency, and no students reached the level of outstanding achievement (Table 4).

Subsequently, following the implementation of the school theater program, the majority of students achieved the anticipated proficiency in Oral Expression of the English Language, with 64.29% no longer encountering difficulties in 'adapting, organizing, and developing texts in English coherently and cohesively,' 'strategically utilizing non-verbal and paraverbal resources,' and 'interacting effectively in English with various interlocutors.' A minority of 7.14% remained at the beginning level, while 14.29% of students demonstrated processing and outstanding achievement levels. Consequently, it can be asserted that the implementation of school theater has impacted the Oral Expression of the English Language among the pupils (Table 4).

At the 5% significance level, it is found that school theater significantly influences the Oral Expression of the English Language among fifth-year high school students in section "C" of a public educational institution (Table 5).

Table 5. Test of the general hypothesis

	Mean	Deviation	Mean error	95% Confidence Interval of the Difference Lower	Upper	t	gl	Sig. (bilateral)
Pre test Post test	−5,821	2,803	0,530	−6,908	−4,735	−10,990	27	< 0,001

4 Discussion and Conclusions

This study analyzed the influence of school theater on oral English proficiency among fifth-year high school students in a public educational institution. The assessed students exhibited a beginner proficiency in English oral expression (71.43%) prior to implementing the school theater strategy, struggling with "adapting, organizing, and developing text in English coherently and cohesively," "strategically utilizing non-verbal and paraverbal resources," and "interacting strategically in English with various interlocutors." Students achieved expectations (64.29%) following the implementation of the school theater plan. The application of the school theater technique to enhance English oral expression significantly improved these results in comparison to the initial oral assessment.

The School Theater technique enhanced English oral expression in the studied cohort of youngsters, as indicated by the research. Navarro demonstrates that school theater transcends mere literary expression; it serves as a valuable educational instrument. According to Navarro, theater transcends mere literary material or audience performance. It integrates into the learning process and enhances the learner's communicative abilities, personal competencies, and interpersonal interactions. This validates the current study indicating that the School Theater technique influences pupils' English oral expression [10].

This study validates the hypothesis that school theater influences students' English voice expressiveness. The first aim assessed the influence of school theater on fifth-year high school students in a public educational institution on their ability to "adapt, organize, and develop text in English coherently and cohesively." Before the implementation of the School Theater approach, children exhibited a beginner proficiency level (53.57%) in diction, fluency, coherence, and rhythm. The School Theater technique enabled youngsters to attain the anticipated achievement level of 60.71%. The strategic implementation enhanced English oral expressiveness, as the outcomes markedly differed from the original oral assessment.

Following the implementation of the School Theater technique, the sample group enhanced their capacity to "adapt, organize, and develop English text coherently and cohesively." García asserts that school theater enhances students' verbal performance. She asserted that school theater should enhance students' communication skills in both academic and societal contexts. This research indicates that the School Theater technique

enhances students' ability to "adapt, organize, and develop text in English coherently and cohesively" in oral communication [6].

This study verifies that the school theater approach influences the ability to "adapt, organize, and develop the text in English coherently and cohesively."

The impact of theater on the ability of fifth-year high school students to strategically utilize non-verbal and paraverbal resources was investigated for the second indicated objective. Students were at the novice level (75%), experiencing difficulty in employing body language strategically prior to the School Theater technique. Utilizing the School Theater approach, students attained the anticipated performance level (53.57%). The preliminary oral assessment strongly indicates that the proficiently implemented school theater technique enhanced this aspect of English oral presenting.

The School Theater strategy enhanced skills in the strategic use of non-verbal and paraverbal resources. In her proposal "Theater Workshop Improves My Oral Communication," Jaramillo emphasized that theater facilitates a constructivist and social pedagogy that incorporates theatrical pedagogy into the enhancement of oral communication within the educational experience. Her research benefited all stakeholders: educators became more dynamic, students engaged actively and enhanced their verbal skills, and parents acquired theater-based communication techniques. The School Theater technique enhances students' ability to strategically utilize non-verbal and paraverbal resources in English speech expression [6].

This study verifies that the school theater approach influences the strategic use of non-verbal and paraverbal resources.

Findings demonstrate that school theater influences the capacity of fifth-year high school students to "Interact strategically in English with various interlocutors" about the third designated objective. Prior to the implementation of the school theater technique, students exhibited a beginner proficiency level (57.14%) in message clarity, vocal tone, loudness, and eye contact. Utilizing the school theater technique, students attained the anticipated achievement level of 60.71%. The significant enhancements in the preliminary oral assessment indicate that the school theater technique is effective.

Following the implementation of the school theater technique, the ability to "interact strategically in English with various interlocutors" improved markedly. In her research aimed at motivating youth to utilize theater for societal expression, [7] employed theater as a methodological approach. In her concluding presentation, the students excelled both physically and verbally, garnering substantial audience approval. Subsequent discussions revealed that theater fostered discipline, commitment, and remarkable physical and verbal abilities among the youth. This indicates that the School Theater strategy influences students' ability to "Interact strategically in English with various interlocutors" in oral expression at the institution [11].

The findings substantiate the assertion that the School Theater technique influences the ability to "interact strategically in English with various interlocutors." The execution of the "School Theater" strategy substantially influences oral English proficiency among fifth-year high school students in a public educational institution, with a significance level of 5%. This demonstrates the efficacy of the technique in enhancing English verbal expression.

The implementation of school theater has demonstrated an enhancement in students' proficiency in reading, organizing, and logically developing English material in the fifth

year of high school. Statistical analysis corroborates this conclusion. Prior to the school theater, a majority of pupils (53.57%) experienced challenges with diction, fluency, coherence, and rhythm in speaking English. Following the implementation of the theater, they attained the anticipated achievement level of 60.71%, demonstrating its efficacy

The implementation of school theater strongly impacted the competency 'Uses nonverbal and paraverbal resources strategically' among fifth-year high school students in a public educational institution. Prior to the school theater, 75% of students were at the foundational level in this skill, facing difficulties in employing body language effectively in English spoken communication. Following the implementation of the theater, they attained the anticipated achievement level of 53.57%, illustrating its effect on this capability.

The establishment of the school theater markedly enhances the capacity of fifth-year high school students to engage strategically in English with diverse interlocutors. Prior to the school theater, the majority of assessed children were at the introductory level (57.14%), struggling with message clarity, vocal tone, volume, and eye contact in oral English. Following the implementation of the theater, they attained the anticipated achievement level of 60.71%, demonstrating its efficacy.

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Mentoring in Higher Education: A Strategy for Academic Development

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Abstract. Mentoring has taken on an increasingly important role in the context of higher education and is recognized as an effective practice for promoting students' academic, personal and professional development. Several studies show that well-structured mentoring relationships increase motivation, persistence and integration into the university environment. This article briefly reviews the literature on the contributions of mentoring in higher education. Based on this theoretical foundation, the authors present the mentoring course developed at a Portuguese higher education institution. The course was developed as part of an Erasmus+ project (Difree). This project aims to fill the gap between academic knowledge and the current needs of recent university graduates. More concretely, this mentoring course aims to support students (or other interested parties) and teachers (or other parties interested in mentoring students) in the process of becoming freelancers. This work aims to contribute to the consolidation of mentoring as a strategic pedagogical tool while offering a concrete and replicable proposal for other institutions interested in implementing similar programs.

Keywords: Mentoring · Mentors · Mentees · Higher education · Academic development

1 Introduction

Mentoring has taken place throughout history, but it was in the 1970s that the concept came to be known as such [1]. Mentoring began as an informal relationship between mentors and mentees and is now present in structured programs in a wide variety of areas [2]. In general, the mentor is the entity that has the ability to prepare mentees to deal with various challenges and therefore, their role is to facilitate change and provide the tools that the mentee needs. In addition, the mentoring relationship is personal, emotional and subjective [3].

Mentoring in higher education has received more and more attention and has become a prominent educational practice within the last decade. Various factors, such as technological advances, have led to rapid changes in the labor market. This matters to all workers and higher education students preparing to enter the job market. Therefore, students must be lifelong learners and be able to assess the development of their skills, as these are essential for their employability. For this reason, mentoring is often used

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 34–41, 2025.
https://doi.org/10.1007/978-3-032-09080-5_4

as a pedagogical tool to encourage students to reflect on essential skills [4]. In higher education, mentoring is understood as a developmental relationship between two people, one of whom—the mentor—has more experience than the other—the mentee. The mentor provides various forms of support, such as professional guidance and emotional, psychological, academic, and psychosocial support, to help the student achieve success, develop skills, and progress in their educational and professional careers [5]. In addition, mentoring is seen as part of the educational process at universities and is a tool that helps student inclusion and success [6], helping to deal with some problems in these educational institutions [5].

This article aims to present one of the tools created as part of a European+ Project, Digital Freelancing for Higher Education Students and Recent Graduates (Difree). In general, the project aims to disseminate information about freelancing opportunities and develop tools to help university students, recent graduates, and young professionals take advantage of them. In addition, the DiFree project (https://www.difree-project.it/) aims to bridge the gap between the academic knowledge and training offered to higher education students and the current needs of a volatile and rapidly changing job market, where flexibility and digitalization are essential skills.

First, we will present a brief literature review to clarify some concepts and present the importance of implementing these courses in universities in order to achieve greater academic and professional success. Next, we will present in detail the course created in Moodle as part of the Difree project. The article ends with brief conclusions and suggestions for the future.

2 Literature Review

The concept and definition of mentoring have already been widely studied in the literature [7, 8] and in different areas, namely education, management, and psychology [8]. Considering previous studies, Jacobi [8] defined mentoring as a supportive relationship between a more experienced individual and a less experienced one: the mentor thus offers guidance, emotional support, feedback, and professional development to the mentee. Mullen and Klimaitis mentioned that the phases of mentoring relationships are four: initiation—which involves the interaction between the mentor and mentee and assesses the possibility of work between the two; cultivation—this is the most intense phase where the mentoring functions are carried out and the relationship reaches its peak; separation—as the mentee's autonomy increases, the interactions between mentor and mentee decrease; redefinition—this is the last phase and is when the relationship has ended or has become only informal and mutually supportive [9].

There are many studies on the role of mentoring in education. Nowadays, the job market is constantly changing, and there is an increasingly diverse network of students. For this reason, higher education has been forced to adopt a form of education based on skills and personalized learning [5]. In higher education, mentoring can be defined as a formal process based on a developmental relationship between two people: the mentor and the mentee. The mentor—the more experienced person—is expected to provide career, emotional, psychosocial, psychological, and academic support to promote and facilitate the success of the student—the less experienced person [5].

In their study, Nuis et al. [5] mentioned the main characteristics of mentoring in higher education, as shown in Fig. 1. Through their study, the authors noted that mentoring, firstly, has specific purposes, such as students' academic success, skills development, and career preparation. Secondly, the authors point out that mentors can take on different profiles, such as university professors or professionals from the business sector, and that the choice of mentor is often related to the objective of the program. Thirdly, most programs are formalized, with components such as specific training for mentors and, in some cases, compensation for their work. Fourthly, the importance of the relationship between mentor and mentee is highlighted, which is usually established through individual or group sessions. Finally, mentors, as already mentioned, play a predominantly supportive role, offering guidance of an emotional, academic, psychosocial, and professional nature, through behaviors such as sharing information, feedback, role-modelling, encouraging reflection, and setting goals. Figure 1 reflects the authors' study, mentioning the main characteristics of mentoring in higher education institutions.

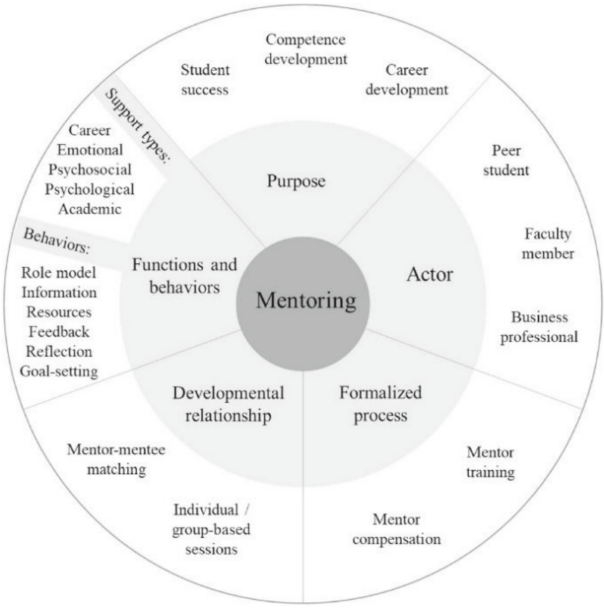

Fig. 1. An overview of mentoring characteristics in higher education based on [5].

In fact, mentoring programs have many advantages. In Foutain and Newcomer's study, the authors mention that mentoring programmes facilitate the recruitment and retention of teaching staff and mentors, promote the socialization of all groups belonging to academic teaching institutions, increase the productivity, professional growth and career development of both mentors and mentees [10]. Table 1 shows some of the benefits of mentoring programs for mentors, mentees and companies.

Table 1. Benefits for mentorship stakeholders according to [11].

Mentees	Mentors	Organizations
Increased job satisfaction	Personal fulfilment ("giving back")	Increased work performance
Feeling of empowerment	Assistance on projects	Enhanced strategic planning
Increased research grant opportunities	Development of leadership and coaching skills	Improved communication and organisational culture
Enhanced productivity	Increased recognition	Professional development of employees
Increased protected time for scholarly activities, e.g. publications	Renewed interest in personal career	Retention and distribution of organisational knowledge
Improved academic 'self-efficacy'	Potential financial reward	Reduced turnover
Greater networking opportunities	Career advancement	Accelerated training
Career advancement		Cost-effectiveness

In the same article, the authors highlighted the main characteristics of an effective mentor. Mentors are expected to look for opportunities for mentees in order for the mentoring to be successful. Mentors, in general, have personal characteristics and behaviors that support and encourage mentees along their path. They must therefore have certain personal characteristics such as enthusiasm, generosity, patience, a sense of humour, knowledge and competence. With regard to professional characteristics, you need to be able to share past experiences, pass on knowledge and values, and promote work opportunities for the mentee, among others [11]. An effective mentee, on the other hand, is someone who is committed to the relationship and is an active voice in shaping the relationship. The mentee must show a willingness to learn, be open to the mentor's suggestions, be enthusiastic and also ask questions [11].

3 Methodology

The main goal of the Mentoring Program is to foster a culture of mentoring in higher education and to prepare both mentors and mentees for meaningful engagement in the digital freelance economy. By presenting clear and practical guidance for structuring and managing mentoring relationships, the course empowers young professionals to navigate their career paths more effectively and equips educators and experienced professionals with the tools needed to become impactful mentors. Mentoring is presented not only as a means of personal and professional development but also as a mutually enriching exchange that fosters skill-sharing, resilience, and confidence in navigating today's dynamic labor market.

The DiFree Mentoring Program is structured into eight thematic sections, each consisting of 1–3 video lessons (for a total of 15 videos), accompanied by downloadable slide presentations and short quizzes to reinforce learning. All video content is recorded in English and supported by full transcripts translated into the languages of the project partners: Greek, Italian, Portuguese, and Spanish. While the course encourages linear progression to support deeper learning, users are free to navigate the modules at their own pace, allowing for a flexible and personalized learning experience.

A summary video introduces the program and objectives, while a final reflection video and post-course questionnaire help learners consolidate the experience. Real-life interviews embedded in the video lessons offer authentic, experience-based insights that complement theoretical content and provide practical illustrations of effective mentoring. Table 2 shows the theme of each of the sections.

Table 2. Difree mentoring program sections.

Overview of the Mentoring Course Sections and Content		
1	Introduction	Introductory video—outlines the goals and methodology of the course.
2	Main concepts	Explores the differences between mentoring, coaching, and tutoring. Defines key mentoring principles and values. Quiz and slides included.
3	The relevance of mentoring	Discusses mentoring as a career development tool. Examines the different types of mentoring relationships (peer, reverse, group mentoring, etc.). Includes materials on motivation and benefits for both parties.
4	Mentoring for development	Focuses on the business and organizational value of mentoring. Defines clear objectives for structured mentorship programs. Provides answers to frequently asked questions, especially by mentors.
5	Mentor-Mentee relationship	Offers operational guidance for handling requests for mentorship. Describes the process for forming mentoring pairs. Clarifies the roles and responsibilities of both mentor and mentee.
6	Meetings between mentor and mentee	Focuses on how to prepare for and conduct effective mentoring sessions. Covers the first meeting, development meetings, and the final meeting. Offers best practices for evaluation and closure.

(*continued*)

Table 2. (*continued*)

Overview of the Mentoring Course Sections and Content		
7	Key mentoring skills	Emphasizes communication, empathy, leadership, and emotional intelligence. Encourages reflective practice and adaptation to mentees' evolving needs.
8	Conclusion and testimonial videos	Recap key takeaways. Ends with a self-reflection questionnaire.

4 Results and Discussion

The development of the program was not accomplished without overcoming challenges. Designing and implementing the mentoring program within this international project presented a series of difficulties that demanded strategic thinking, intercultural awareness, and close cooperation among partners. However, from the outset, the goal was clear: to develop a program that supports both mentees and mentors, not only by offering structured knowledge but also by nurturing meaningful mentoring relationships grounded in reciprocity and reflection.

The process began with a thorough search and analysis of existing mentoring and freelancing courses. One key observation stood out: while many resources focused on preparing mentees, very few offered guidance for mentors or recognized the importance of preparing both roles for a productive and mutually beneficial relationship. This insight became the foundation for a program that embraces both perspectives and positions the mentoring dynamic as a two-way process of learning and development.

A central difficulty was the design of a pedagogically sound and modular structure that could be relevant across diverse cultural, linguistic, and professional contexts. The result was a program divided into six thematic sections, supported by 15 instructional videos, each accompanied by a slide presentation and a full script. Every video explores essential dimensions of mentoring and digital freelancing, blending theory with practice in a way that is accessible and adaptable.

Recognizing the importance of multilingual accessibility, all video scripts were translated into five languages, a process that required more than linguistic accuracy—it demanded cultural sensitivity. To reinforce understanding and engagement, each video is followed by a quiz containing ten multiple-choice questions. Developing these assessments required careful attention to fairness, clarity, and consistency. The quizzes are not only tools for validation but also opportunities for learners to consolidate key messages and reflect on their learning.

Another crucial element in the program's implementation is the use of an initial Moodle forum designed to welcome participants and foster a sense of community from the very beginning. In this space, participants are invited to introduce themselves—sharing their name, location, and professional or academic background. They are encouraged to state whether they are joining as a mentor, mentee, or both and to express what they hope

to gain from the experience. A light-hearted prompt also invites participants to share a fun fact, hobby, or interesting story, helping to create a warm and engaging atmosphere. This forum plays a vital role in breaking the ice, encouraging early interaction, and laying the groundwork for trust and openness throughout the program.

Finally, the program includes a feedback questionnaire at the end of the course. This instrument is key to understanding participants' experiences, gathering insights for improvement, and ensuring that the course evolves in response to real needs and expectations. The feedback process reinforces the reflective dimension of the mentoring journey and supports the continuous enhancement of the project's quality.

5 Conclusions

The DiFree Mentoring Program plays a transformative role by creating a dynamic and supportive environment for emerging digital freelancers, helping to develop learners' professional identity and readiness for the freelance labor market. Educators and institutions can reuse or adapt the course's practical templates and scripts to suit their own mentoring initiatives.

The course is explicitly designed not only to guide and empower mentees but also to prepare and strengthen mentors: the program ensures that both sides of the mentoring relationship benefit from structured, reflective, and well-supported interactions. This dual focus enhances the overall quality and sustainability of the mentoring process. The program is framed as a catalyst for personal and professional development. For mentees, it offers guidance, confidence-building, and contextualized learning opportunities. For mentors, it provides a framework for sharing expertise effectively, developing leadership and communication skills, and gaining insights from new perspectives.

The program promotes reciprocity, emphasizing that mentoring is not a one-way transfer of knowledge but a collaborative relationship that evolves through trust, empathy, and shared learning. By fostering this two-way growth, the mentoring program contributes meaningfully to the international project's aim of equipping digital freelancers with both the technical tools and human support systems they need to thrive.

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Creation of Seedbeds as a Space for Educational Alliances Between University-Schools to Develop Research Skills

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Abstract. Education, seeks to develop in students skills that promote analytical, critical and reflective thinking, where the creation of research seedbeds as an inter-institutional space University-School can contribute to an alliance of educational type in the formation of scientific groups in the management of knowledge to propose alternative solutions. Therefore, the methodological process was addressed in the quantitative approach through a descriptive research with a field and documentary design from the systematic review of some authors such as Vidal (2018), importance of alliances of school centers and socio-educational support organizations to school support; Garza (2021), knowledge management model as an academic and research requirement; Artigas (2017), determines the number, category and gender of researchers in Ecuador. This review allowed the content analysis. Likewise, surveys were applied to a sample of teachers and students in the statistical analysis. The results support the need for a training plan to promote research skills.

Keywords: Research seminars · Inter-institutional alliances · Use and good practices of information · Critical thinking · Research skills

1 Introduction

Today's society is moving towards an era characterized by the accelerated advance of technology and great challenges linked to the globalized context that requires a quality education in the creation of different and disruptive spaces where students can develop diverse skills for problem solving; the proper use of information, computational thinking, and analytical-reflective thinking.

It should be noted that the teacher becomes a fundamental pillar as a mediator in the teaching-learning process for a practice in constant search of strategies in relation to the construction of scientific knowledge that allows the reflection-action of the daily problems of the communities [1].

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 42–51, 2025.
https://doi.org/10.1007/978-3-032-09080-5_5

Therefore, the importance of promoting students' research skills. Consequently, education in the 21st century must leave behind the traditional models of memorization and repetition of information without real application of what has been learned. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), it emphasizes the research skills that are essential in modern education, which must include information literacy to analyze problems from multiple perspectives [2].

However, science teaching in schools is developed by teachers who are not involved in research and with little knowledge production; the contents transmitted coincide with those that appear in texts and research manuals, but they still lack the conditions for scientific thinking [1]. Therefore, it is necessary to provide literacy training to these professionals in order to increase their research skills.

On the other hand, public and private universities currently have a greater production of scientific knowledge in the world, however, there are universities that are dedicated exclusively to teaching, especially in Latin America [1]. The relevance of the creation of seedbeds as an inter-institutional space for the development of university-school research activities is highlighted, particularly in the case of an educational unit in Ecuador.

However, agents from both public and private institutions interact and are linked in knowledge management; thus, in programs, science and scientific development activities for its transfer [3]. Hence, the importance in the use and good practices of information based on academic honesty avoiding plagiarism in this systematic review of the state of the art.

In Ecuador, the number of researchers has increased in recent years, but the difference with the number of researchers in developed countries, either per capita or absolute, is alarming [3]. There are 2554 active accredited researchers and 789 inactive researchers registered in SENESCYT, Ecuador [3].

The largest number of active accredited researchers are in the areas of Life Sciences and Engineering, with 696 and 595; followed by Social Sciences, Education and Medicine with 308, 231 and 212; Business and Mathematical-Physical Sciences, between 179 and 159; while active accredited researchers are not evenly distributed in 71 higher education and research centers in Ecuador [4].

The importance of the creation of research seedbeds for a pedagogical and investigative practice that should be strengthened in public institutions of basic and secondary education is highlighted, providing students with experiences in the approach of integrative projects [5].

Consequently, the research seedbeds appear as a propitious space where students assume the role of researchers under the tutelage of the teacher, creating together learning communities around a line of research [6]. These skills can be developed in a transversal axis that includes the writing of scientific text, the ethical handling of information and the correct use of technological tools.

In derivation, this research seeks in the general objective to highlight the importance of the creation of seedbeds as an inter-institutional space University-School to develop research skills in students and teachers. Thus, inter-institutional alliances encourage educational participation and cooperation between the different academic actors, dynamizing networks that transfer learning opportunities to promote research culture [7].

Inter-institutional alliances help to share knowledge, increase production in knowledge management, lead research projects, develop research activities, and produce strategies contextualized to social needs in the resolution of problems [7].

Therefore, the initiative to carry out this research leads to the application of a diagnosis to know the interest and research skills developed by the teachers of the Sublevel of Basic Education of the Eugenio Espejo School, with the possibility of creating an educational alliance to exchange experiences, which makes necessary a recapitulation and analysis of what has been done in recent years to improve the teaching of science [8].

2 Theoretical Foundation

2.1 Research Seminars

Education requires active methodologies to achieve significant learning of students, where the formation of research groups could be a pedagogical alternative to increase investigative thinking through activities in real problems where information is consulted for reflection and learning in real contexts. It is there where the teacher acquires the responsibility to create participative and binding spaces [4].

Therefore, research seedbeds help active and constructivist teaching in order to disseminate knowledge [4]. Different methods can be used, for example, project-based learning to delimit a real audience topic where students analyze the information and work collaboratively.

As a derivation, the seedbeds represent a space for the exchange of ideas among students and with the participation of the teacher in the role of tutor for the management of knowledge that allows the activation of metacognitive processes. In addition to generating other teaching methods [6].

However, achieving the "articulation between teaching and research has been a complex task due to the demanding administrative and academic load in which teachers are immersed" [6]. In addition to the absence of research skills that hinders the writing of texts and the ability to frame the theory with the research problem.

2.2 Scientific Research Groups

The current scenario of school institutions requires the teaching profession to manage knowledge, giving way to research as one of the substantive activities for scientific research and recognition in the role of researcher [9].

A research group represents professionals and students who are interested in producing knowledge in specific areas to develop lines of research [9]. This favors cooperative work to unite efforts in joint goals that foster shared responsibility in ethical and academic principles.

In order to form a sustainable and productive research seedbed in knowledge management, it is necessary to convene the interested parties; establish written agreements in the constitution of the seedbed; carry out a research project with its respective operative actions, taking into account the objectives pursued [10].

Likewise, to evaluate the structural and operational conditions of the institution, subject to authorization by the respective authorities. The sponsorship of an organization

is encouraged. Remembering that the creation of seedbeds promotes the research culture between novice and expert researchers to strengthen research lines and generate new knowledge.

Consequently, to program participatory and pedagogical activities in interdisciplinary cooperation [10]. Also, to guarantee the tutored accompaniment in the development of research projects, which requires spaces with optimal physical infrastructures that guarantee the logistical process for the execution of the proposed activities and in the school or social intervention [6].

2.3 Research Skills of Teachers and Students

Students need to learn to do research in order to develop the capacity for analysis, synthesis and reflection in the writing of scientific texts. Therefore, this learning begins in basic education and should continue throughout the school career [11].

In this sense, research capabilities are developed by K. Lewin's theory (1944), which proposes to understand the problem but also to establish the purposes or scope to be sought in the different solutions [11]. Highlighting the importance of developing research skills to promote critical thinking in the creation of research groups as an educational alliance.

However, the promotion of research competencies among elementary and middle school students is a fundamental aspect of the [12]. In addition, a "compulsory scientific activity where the whole complex system of interpretations and propositions proper to the cognitive independence required by a creative, reflective and enterprising person is being built" [13].

Hence, the importance of creating research seedbeds to strengthen inter-institutional educational alliances between universities and schools around the world in order to break down barriers and geographical separations towards a model of a committed society. However, the majority of teachers lack initial training in scientific research, which requires ongoing training and the use of technological tools [14].

2.4 Information Literacy in the use and Good Practices of Information

School activities carried out inside and outside the classroom facilitate the search, selection, and organization of information in databases. In addition to the digital culture in constant growth, it is important to consider the use and good practices to avoid plagiarism of the information consulted.

Hence, the relevance of using the citation system through short or block quotations; parenthetical or narrative quotations according to the writing rules in the language being written to maintain authorship rights; in addition to learning how to deal with so much information [15].

Thus, information literacy seeks to develop skills in the search for and evaluation of information obtained from different primary or secondary sources. It allows to cope in an informational context where information is produced rapidly in different formats [15], for content analysis in the argumentation of ideas.

2.5 Critical Thinking

Current education must develop higher order thinking in which students can process new information with the information already stored in memory, allowing meta-cognition. Therefore, the formation of critical thinking is a requirement in education. In fact, promoting this type of thinking is still a pending task of the Ecuadorian education system [16].

Critical thinking favors the construction of analytical reasoning based on evidence from a reflective act to produce judgments on a particular fact which invites to deepen the state of the art of the issue [16]. Therefore, one must learn how to research and write correctly in order to avoid wasting efforts and avoid the blank page syndrome, and the anything but thesis syndrome.

2.6 University-School Educational Alliances

It requires the active and binding participation of citizens in the improvement of current problems, one of them being the lack of planetary awareness in the knowledge of how to live well; where educational systems can emerge as alliances between universities and schools to create relational spaces that facilitate the reflection of the school community and its participation [17].

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Consistent with the above, Huberman & Levinson, 1988; Marcelo & Este-baranz, 1998, as cited in [17], propose the theory of knowledge transfer and inter-institutional theory, used to analyze university-school relationships that benefit both institutions in teaching practice, institutional management, conditions and opportunities for those who participate.

This process requires an institutional policy for planning, implementation, and joint evaluation among institutions [17]. The importance of the creation of seedbeds is emphasized as an educational alliance to develop research skills in both teachers and students in order to favor the research culture towards the resolution of problems in the most vulnerable communities.

3 Methodological Process

The general objective of this research is to highlight the importance of the creation of seedbeds as an inter-institutional paradigm of educational type between University-School, in the development of research skills for the realization of joint projects to solve the problems of the communities.

Consequently, the quantitative approach was used through descriptive research with a field and documentary design for the systematic review of the state of the art. A survey was applied to a sample of 21 teachers from the Eugenio Espejo School of Basic

Education in Ecuador, which allowed the situational diagnosis. This survey was taken from Cuevas and adapted by Alejo, et al.; it was applied in the Google Froms form, with Likert-type multiple response options [8].

The results of the survey were analyzed and tabulated using the statistical analysis route of the quantitative method [18]. It led to the programming and development of a training plan, which was submitted to the evaluation criteria of functional, novel and pertinent specialists, with the purpose of promoting research skills in teachers through reflective and didactic activities

3.1 Results and Discussion

The data obtained were organized by sections in tables and figures, and were divided into five parts for statistical analysis and interpretation (Table 1).

Table 1. Section results

Sections	Indicators	Scale
Science as a cross-cutting theme in the development of re-search skills	Interest in learning	3
	To teach related subjects	2.75
	Use of learning methods	3
	Contents and practical activities.	2.85
	Consideration in the development of critical thinking	3
	Science in problem solvin.	2.8
	How to teach science	2
Planning of classroom activities	Extra-curricular activities	2.8
	Techno-pedagogical resources	2.9
	Use of didactic resources	3
Teaching-learning methods	Application of methods for the development of classes	3
	Subjects that teach research	2.85
	Learning to do research in any subject.	2.75
Research skills in the teaching profession	Attendance at international and national congresses	1.75
	Information technology tolos	2.85
	Development of surveys or interviews as part of an investigation	1.75
	How to systematize the information of the teaching-learning process	3
Training plan	Feasibility.	3

Note: Classification criteria (Scale: low 1, medium 2, high 3. Alejo, et al., 2025)

Consequently, in the section: science as a transversal axis in the development of research skills, it is pointed out that a high percentage show interest in learning new teaching-learning methods in subjects related to natural science and exact sciences such as mathematics.

In addition, to use techno-pedagogical resources in the development of the theoretical-practical activities planned to encourage the active and reflective participation of students in the realization of projects in collaborative learning.

In relation to the sections on planning class activities and teaching methods, a large majority of teachers pointed out that it requires in-depth knowledge of science and the application of different resources and ways of teaching.

However, they use a variety of practical resources such as posters, clippings, magazines, newspapers, at the same time they include the methodology of collaborative work, and guided tasks that strengthen joint actions to learn from each other. However, they continue in the traditional teaching practice, since they can use active methodologies such as: visits to museums in virtual projections, interactive games, use of Padlet tools, Canvas or Geniall Templates, among others.

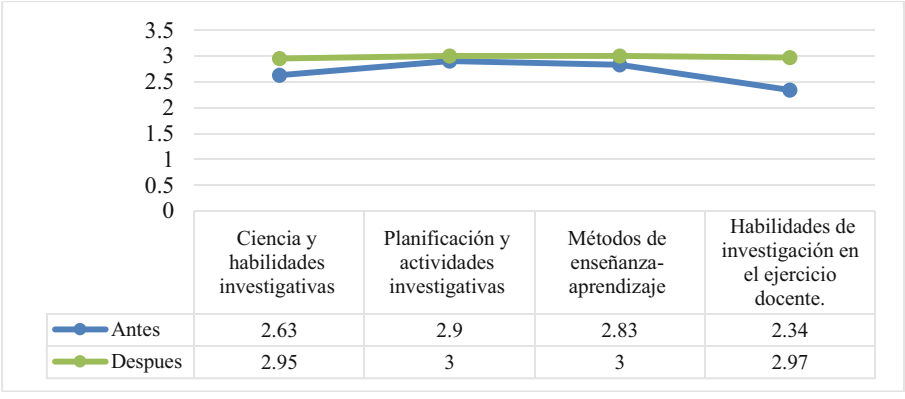
In the research skills section, the professionals indicated that they infrequently attend congresses as opportunities for updating and research experiences; however, a large majority use Google Scholar to consult information. Likewise, they use diaries, logs and posters to systematize ideas and to support the activities carried out.

Faced with this situation arises the need to propose a training plan for teachers and managers with the possibility of creating research groups in the implementation of inter-institutional projects. Thus, comprehensive actions are required to strengthen pedagogical and research skills and how the university offers the opportunity for ongoing training to generate an educational alliance towards an inclusive and participatory school that benefits not only teachers but also in the union of collaborative networks as a triad: school systems-communities-governments [17].

For the proposal of a training plan that seeks to promote university-school links based on a pedagogical, participatory and innovative approach in the creation of research seedbeds, four phases were established:

1. Planning of the activities at the beginning, development and closing of the programmed contents. Therefore, each workshop is organized in a three-week chronogram socialized with the teachers.
2. Design of techno-pedagogical materials. This section aims to create a virtual learning environment where teachers can interact with multimedia resources as one of the substantive activities in scientific research and recognition in the role of researcher [9].
3. Preparation and execution of the workshops in the training of teachers, detailing each meeting step by step, with the respective schedule, modality and the learning to be achieved.
4. The evaluation of the training plan through consultation with experts from the research area, the institution's directors and teachers, which was 100% approved.

With respect to Fig. 1, indicators of change before and after were evidenced, which range between 2.95 and 3, where the interest of teachers in developing research skills and managing other strategies to address the contents related to science, including active methodologies in this teaching practice, is demonstrated.



	Ciencia y habilidades investigativas	Planificación y actividades investigativas	Métodos de enseñanza-aprendizaje	Habilidades de investigación en el ejercicio docente.
Antes	2.63	2.9	2.83	2.34
Despues	2.95	3	3	2.97

Fig. 1. Main indicators of change**.** *Note:* Classification criteria (Scale: low 1, medium 2, high 3. Alejo, et al., 2025)

4 Conclusions

The formation of seedbeds in an educational alliance constitutes an opportunity for the exchange of interdisciplinary knowledge, in that experience that each professional has in the teaching practice. In addition to promoting spaces in the classroom in the execution of research projects for problem solving, critical thinking and meaningful learning of students.

Concomitantly, it favors the progress of science, which is constantly advancing. In addition, it helps scientific dissemination in the training of new researchers.

This exchange for knowledge management can also be socialized in congresses or international events in the updating of the area of research interest.

Therefore, it is recommended the implementation of workshops in the permanent training of basic and secondary education teachers, in which universities contribute to the formation of research skills for information literacy in the use and good practices of information, time management and scientific text writing.

It is pointed out that, in the scope of this research, the scope was established up to the feasibility of the training plan to know the interest and commitment of the authorities and teachers of the selected school institution, leaving the possibility of creating a research seedbed to promote the research culture of both teachers and students.

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Design of a Comprehensive Job Performance Evaluation Model Based on the 360° Method for a Telecommunications Company

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Summary. The 360° performance evaluation is a comprehensive method that allows evaluation of the work performance of employees from multiple perspectives within the organizational environment, including supervisors, peers, employees and self-evaluation. This study was applied in a telecommunications-related company in the city of Quito, Ecuador, specialized in the survey, design, planning, construction and maintenance of fiber optic networks, using a mixed methodological approach that combined structured surveys, semi-structured interviews and documentary analysis. This model seeks to diagnose the current performance situation in three main departments of the company: Engineering, Accounting and Technical Area. Based on these results, which show deficiencies in formal feedback and communication, an integral evaluation model adapted to the organizational structure is designed, which will contribute to strengthening the corporate culture, fostering professional development and aligning human talent with the company's strategic objectives.

Keywords: Performance evaluation · 360 model · Telecommunications · Human talent management · Employees

1 Introduction

In a challenging business environment with constant changes, human talent management has become a great support for the success of companies. In recent years, the implementation of formal performance evaluation methods has reached a great step in the evolutionary scale that allows companies to enhance the productivity and motivation of their employees [1]. The concept of performance appraisal has changed throughout history [2]. A performance appraisal is

An evaluative process that organizations use to learn about the behavior of their workers, analyze the work they perform and their consequent contribution. It is a complete

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 52–58, 2025.
https://doi.org/10.1007/978-3-032-09080-5_6

and integral evaluation of the employee's performance of his or her work, facilitating the identification of his or her strengths, weaknesses and potential for development.

This indicates that performance appraisal is a procedure that allows an organization to evaluate and persuade people about the characteristics and behaviors related to the work activity, with the objective of measuring the employee's productivity in terms of different components, identifying whether the employee will be able to improve his or her performance in the future [3].

One of the most widely used performance evaluation models in recent decades is the 360° model, which has as its central objective the feedback of the group, of all the people who have direct and frequent contact with the employee. It provides a broad knowledge and participation of the actors involved in the performance evaluation and more precise information on the performance of the person being evaluated.

This is how the 360° evaluation proposes the measurement of employees' work performance from all possible perspectives to obtain qualitative and quantitative result, the feedback provided by this tool comes from employees, subordinates, colleagues and customers, thus avoiding biases as it is a multi-source process, ensuring its objectivity [4].

Adopting a well-structured performance evaluation is crucial to align the daily actions of those who collaborate with the organization's vision. This type of system not only measures results, but also reinforces competencies, corrects deviations and supports professional improvement. When feedback is constructive, it promotes an environment in which people understand expectations and receive support to improve their competencies.

Currently, the company has implemented quality control mechanisms; however, the opportunity to formalize a structured system will optimize the feedback and professional development of its team. Performance appraisal is a strategic tool for analyzing the competencies, skills and achievements of employees, which facilitates decision-making in training, professional development and talent recognition.

The implementation of an evaluation model based on updated methodologies will contribute to strengthening the organizational culture, promoting continuous improvement and the strategic alignment of human talent with the company's goals. The purpose of this study is to design an integral model that guarantees a clear and effective performance evaluation, which will allow the company to continue its growth and become a reference company in the telecommunications sector.

This study seeks to promote an inspiring and egalitarian work environment that may be suitable for other companies in the telecommunications sector. The proposed design proposes the use of digital tools for data analysis, which will help the community. The direct beneficiaries are the employees who, by accessing a performance evaluation and receiving feedback, can enhance their professional development [5].

Likewise, the human talent management team will be privileged to have a unique tool that facilitates decision making in terms of census, training and permanence policies. Leaders and supervisors will have objective information on the work of their teams, which will help them to promote leadership and more effective management. Likewise, the company will obtain privileges related to increased productivity and reduced staff turnover.

2 Theoretical Foundation

Performance appraisal is a key process to determine more precisely how much and how each person contributes to the company's objectives. This approach is not only based on the analysis of results, but also on the observation of skills and attitudes of each professional [6]. Authors such as Chiavennite argue that performance evaluation makes it possible to identify strengths and areas for improvement and is fundamental for managing human talent strategically. Thus, an adequate evaluation promotes individual and collective evolution, and provides relevant information for decisions related to training, promotions and compensation [7]. This feedback generates useful feedback, increasing motivation and fostering more transparent labor relations, contributing to the alignment between personal and organizational objectives [8]. In this sense, it becomes an essential tool to achieve efficient competency-based management.

When we speak of an integral evaluation model, we are referring to a method that is not limited to a single metric, but considers multiple dimensions of work performance, from the quality and speed with which problems are solved, to the collaboration capacity of the entire team. This integrated approach first requires clarity on the goals and responsibilities of each position.

A comprehensive evaluation model is not limited to a single metric, but considers multiple dimensions of job performance, both quantitative and qualitative. These may include quality of problem solving, productivity, collaborative work, effective communication and customer orientation. For this model to be effective, it is necessary to have clear goals, well-defined job responsibilities and measurement tools adapted to the organizational reality. In the telecommunications sector, where immediacy is predominant and technology is constantly changing, an integrated approach is valuable, as it aligns individual performance with the company's business objectives with the institution's objectives and customer satisfaction [9].

One of the most widespread methodologies for evaluating performance is the 360° evaluation, which involves gathering perceptions from different hierarchical levels: superiors, peers, subordinates and customers [10]. This approach makes it possible to identify whether there is any gap between the individual's own perception of his or her work and what others think. According to Robbins and Judge, this technique favors more objective and richer feedback, which can significantly improve cooperation, work climate and service quality.

However, good planning is required so that people feel safe to provide feedback, and that feedback is used to build, not to punish. In this way, 360° evaluation can become a powerful resource for raising the level of cooperation and the quality of service.

Another fundamental aspect is the definition of evaluation criteria consistent with the organizational culture and strategic objectives. In telecommunications, it is usual to combine technical indicators such as speed in solving telecommunications problems with technical indicators such as speed in solving telecommunications problems.

network or accuracy in the installation of equipment with soft skills such as entrepreneurship, leadership or communication skills [11]. It is recommended to establish easy-to-understand evaluation scales, with a specific weighting according to the importance of each aspect for the position. In this way, the person receiving the evaluation will know in a transparent way what is expected of him or her, and the evaluator

will have a frame of reference to be more objective. In the end, the idea is to make the whole process not only fair, but also an incentive for people seeking to improve and reach higher standards.

For a telecommunications company, evaluating performance has an additional value, not only to measure individual efficiency, but also to ensure that the team operates in a synchronized manner to provide a stable and reliable service. It also has an impact on various talent management processes such as recruitment, professional development plans and compensation policies [12].

3 Methodological Process

The study was developed under a mixed approach, integrating quantitative and qualitative methodologies to achieve a complete understanding of the company's work performance. In the quantitative area, structured surveys with a Likert-type scale and 360° evaluations directed to managers, employees and subordinates were used. The results were analyzed by means of frequencies, averages and percentages, in order to identify predominant trends. This information was complemented from a qualitative perspective by means of semi-structured interviews and direct observation, instruments that allowed an in-depth understanding of the latent motivations and the organizational context that give meaning to the patterns recorded in the quantitative stage, thus providing an integral and total analysis of the company's reality [13].

The methodological process was structured in four phases [14] In the first phase, an initial survey was conducted among the 35 employees of the company to find out their doubts and opinions about the performance evaluation process [15]. The instrument used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

The questionnaire (Table 1) was validated through expert judgment (three specialists in human talent management) who reviewed the consistency, clarity and coherence of the items. The questionnaire was validated by the judgment of experts (three specialists in human talent management) who reviewed the consistency, clarity and coherence of the items.

During the second stage, specific surveys were used in each of the engineering, accounting and technical departments, where competencies were accurately measured to gauge both technical and cross-functional competencies. This provided an initial self-assessment in each area, laying the groundwork for the subsequent implementation of the 360° comprehensive assessment.

The third phase refers to the execution of the 360° evaluation, including different points of view on performance: self-evaluations, evaluations by managers, peers and, if applicable, subordinates. This approach minimized bias and encouraged objectivity in the analysis. The repetition of the evaluation process at different levels made it possible to validate recurrent perceptions and establish more accurate patterns of professional behavior.

In the fourth stage, a non-probabilistic purposive sample of between 8 and 10 key collaborators was selected, including department heads, outstanding or recently incorporated personnel. Semi-structured interviews were conducted with this group, focusing on their experience with the evaluation process and their perception of the organizational

Table 1. General Questionnaire. Sect. 1: Likert Scale (1 to 5). (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree/Neither Agree/Nor Disagree, 4 = Agree, 5 = Strongly Agree)

Ask	1	2	3	4	5
I know what the performance evaluation in a company consists of.					
I am open to having my performance evaluated periodically.					
I believe that receiving feedback from different areas (not only from my boss) could improve my performance.					
I currently receive sufficient feedback on my work.					
I think that performance evaluation is necessary for professional growth.					
I would feel comfortable giving evaluations to my peers and/or bosses.					
I perceive that the company promotes internal communication on the performance of its employees.					
I believe that performance evaluation should be linked to training opportunities.					

Note: This questionnaire allows us to know the overall perception of the collaborators regarding performance evaluation, their previous knowledge and their attitude towards 360° feedback.

climate. At the same time, direct observation was carried out in operational meetings and daily work contexts. This qualitative information allowed us to go deeper into the quantitative results, explaining causes, perceptions and attitudes behind the observed performance.

4 Results and Discussion

The initial diagnosis revealed significant gaps in the feedback received by employees, mainly in the technical and accounting departments, where more than 60% of the employees indicated that they do not receive frequent comments on their performance. In addition, 74% stated that there is no formal follow-up of the professional training received, which affects the continuous development of their competencies. These results suggest a disconnect between operational activities and institutional evaluation mechanisms [16]. On the other hand, more than 80% of the respondents positively assessed the inclusion of multiple perspectives (chiefs, directors, managers, etc.) in the evaluation process The company's management is aware of the importance of the evaluation process, stressing that this would allow fairer development, a more complete vision of their performance and better alignment with organizational objectives.

Based on these findings, the following key components of the proposed performance evaluation method were designed:

- Planning of the evaluation process: Definition of objectives, criteria, periodicity and responsible parties.
- Socialization and training: Training collaborators to ensure understanding of the process, build confidence and guarantee correct interpretation of the instruments.

- Application of evaluation instruments: Implementation of structured questionnaires and surveys with a Likert-type scale, applied in 360° mode.
- Analysis of results and feedback: Data processing through descriptive analysis, review of patterns and identification of strengths and areas for improvement.
- Individual improvement plan and follow-up: Preparation of action plans for each employee, continuous support and monitoring of results.

5 Conclusions

The integral performance evaluation model based on the 360° method proves to be viable for implementation in the company analyzed, as it allows aligning individual actions with organizational objectives, encouraging continuous improvement and providing a more complete view of employee performance.

The literature review supports the effectiveness of competency-based and multi-source feedback systems as they make it possible to identify and identify with

more accurately, both strengths and areas for improvement, contributing to a more focused and fair professional development process [17].

The results of the diagnosis show that, although employees are aware of the evaluative concept, there are gaps in formal feedback and inter-departmental communication, reflecting the need for improvement in them.

The system designed, which includes specific surveys, 360° evaluations and interviews, allows a complete picture of the performance of the Technical, Accounting and Engineering departments, facilitating the creation of specific action plans for each sector [18].

Although the study was conducted with a limited sample ($n = 35$) and without a detailed sociodemographic characterization, the methodology employed proved to be useful for the organizational context of a telecommunications company. It is recommended that future research includes more robust statistical analyses and larger samples in order to generalize the results more reliably.

Finally, it is concluded that the model developed has a high potential to be applied in similar organizations in the sector, if it is accompanied by an internal training process, adequate change management and an organizational culture that values feedback and continuous learning. This type of system not only improves individual performance but also becomes a strategic tool for decision making in human talent management.

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Bridges Between Margins and Knowledge: Scientific Tourism Along the Porto-Gaia Axis

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Abstract. This article examines how the bridges linking Porto and Vila Nova de Gaia can serve as valuable assets in fostering Scientific Tourism. Through an exploratory and qualitative approach, based on a literature review and technical visits carried out between October 17 and 19, 2024, seven bridges over the Douro River with historical, architectural and engineering value were analyzed.

The study demonstrates that these infrastructures, in addition to their functional role, represent important milestones in the technical-scientific and identity evolution of the region. Each bridge reveals constructive particularities and distinct historical contexts that can be integrated into educational and scientific dissemination programs. The application of Scientific Tourism in these contexts promotes the connection between science, heritage and community, contributing to the enhancement of the territory, public education and local sustainable development.

The analysed bridges— including the D. Maria Pia Bridge, D. Luís I Bridge, Arrábida Bridge and São João Bridge — were studied with a focus on their structural and historical aspects and their potential to enrich immersive tourist experiences of a scientific nature.

Keywords: Science Tourism · Bridges · Douro River · Heritage Interpretation and Experiential Education

1 Introduction

Tourism is a multi-billion dollar global industry that creates jobs and supports a healthy environment locally and globally [1]. Scientific Tourism (ST), as a process of elaboration of scientific knowledge based on travel experiences with the objective of making observations, collecting data and information for scientific use [2], is an expanding tourism segment, with potential for growth and to create new identities of supply, and consequently generation of jobs and wealth creation for resident populations [3]. According to the International Scientific Tourism Network [4], Scientific Tourism is positioned as a bridge between the world of science and tourism, bringing together inhabitants

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 59–68, 2025.
https://doi.org/10.1007/978-3-032-09080-5_7

of the territories and their visitors, motivated by the search for scientific knowledge. In this way, Scientific Tourism values the scientific heritage of the territories, bringing together researchers and local actors in the creation of new dynamics relevant to local development, and can contribute to the understanding and resolution of environmental challenges [4]. Thus, for Bourlon and Mao [5] there are four forms of Scientific Tourism, namely: exploration or adventure tourism with a scientific dimension, cultural tourism with scientific content, scientific eco-volunteering and scientific research tourism. In this research, cultural tourism with scientific content will be considered, since the focus will be on the bridges of the Douro River, which are the object of visitation, constituting a cultural heritage that has scientific content.

Bridges are, due to their unique characteristics, elements that allow roads to cross rivers, estuaries, canals, roads, valleys and other obstacles, both natural and man-made, allowing the flow of traffic at intersections and access to communities with difficult access. Most of the time, bridges make it possible to connect the two banks of a river, shortening distances and facilitating accessibility, both in terms of costs and time. Over time, and given that their expected lifetime is long, many of them become an excellent way to characterize a city, a region or a territory, showing its traditions through local architecture. For this reason, it is not surprising that these can be architectural landmarks and symbols of tourist attraction for the regions where they may be implemented. The most recent case in Portugal is the 516 Arouca Bridge, a suspended pedestrian point over the Paiva River that has attracted thousands of visitors to the region, which is in an area of low population density and has been the engine of development for the region.

Thus, the objective of this research is to survey the existing bridges along the Douro River, identifying those that can be visited and how they contribute to the growth of Scientific Tourism.

This exploratory and qualitative work will rely on a review of the literature on Scientific Tourism and the analysis of existing cases along the Douro River.

2 Scientific Tourism

Scientific Tourism is a type of tourism that is beginning to be the target of scientific research. This type of tourism combines leisure, education and scientific research. For Conti *et al*. [3], Scientific Tourism is a process of generating scientific knowledge from travel experiences with the objective of making observations, collecting data and information for scientific use [2]. Basically, it is a kind of tourism in which participants can learn, observe and, in some situations, contribute to projects that are being carried out in other areas of research. This approach arouses curiosity and understanding of natural, cultural, technological, and engineering phenomena, promoting the preservation of heritage and the sustainable development of the population/region, where they are located [6].

Unlike many other forms of tourism, Science Tourism seeks much deeper engagement with the destinations where these experiences take place, providing immersive and at the same time educational experiences. Next will be presented some areas where Scientific Tourism is applied, namely geology, archaeology, astronomy, biology and engineering, which can be applied in urban, rural or natural contexts.

2.1 Scientific Tourism Applied to Bridges

Bridges, as engineering structures and historical landmarks that define the economic, social and environmental evolution of a given place/region, represent an excellent opportunity for the application of Scientific Tourism. These, some of them authentic works of art, are the reflection of scientific and technological advancement, construction practices and cultural and social evolution over time. In this way, the study and visitation of the bridges can be organized around 3 thematic axes, namely historical, architectural and environmental.

From a historical point of view, bridges often carry a rich historical context, representing important periods in the evolution of engineering and society. One of the examples, and which is a historical landmark in the city of Porto and Vila Nova de Gaia, is the das Barcas Bridge, which is one of the first connections between the two cities, as will be presented. In addition, the Roman bridges can also be mentioned, which illustrate the mastery of arch architecture. Thus, a Scientific Tourism program could include guided tours of the bridge sites, lectures and workshops on the history of bridge engineering and its economic and social importance in the development of the region where it is located.

The bridges are also remarkable, given their architectural and structural features. In this way, some emblematic bridges stand out, such as: Charles Bridge, in the Czech Republic, one of the best-preserved medieval bridges in Europe, the year of its inauguration being 1937. The Vasco da Gama Bridge in Lisbon, the longest bridge in Europe with about 17.2 km and which was inaugurated in 1998, at the time of Expo 98. Bridge 516 in Arouca is one of the largest pedestrian suspension bridges in the world, with 516 m in length, having been inaugurated in 2021. All these bridges offer a unique opportunity to understand concepts such as structural design, typology of materials used, as well as construction techniques. In this way, interactive activities, such as construction simulations, stability analysis and workshops on innovation in civil engineering, can enrich the visitors' experience and be another opportunity for Scientific Tourism.

Another important and relevant pillar is the environmental impact that results from bridge construction. That is why it is important to analyze its integration with local ecosystems. In this way, Scientific Tourism programs can and should address how bridges affect rivers, the natural landscapes surrounding the river, minimizing the impact that they may have on ecosystems and their territory. The discussion about sustainable bridges and the use of eco-efficient materials can foster environmental awareness among tourists and can therefore be part of Scientific Tourism.

Scientific Tourism related to bridges offers numerous benefits. It contributes to public education in science and engineering, encourages interest in technical careers, and promotes the preservation of historical heritage. On the other hand, it can generate additional revenues for the maintenance of infrastructure and for local development by creating new jobs and settling people in the territories. However, there is a need to create specialized guides, who master the theme of tourism and engineering. It is also important to control the risks that the impacts of the visit may have on the territory and on the different equipment. Finally, it would be important to develop marketing strategies that encourage the demand for this type of tourism, which is generally attractive and sustainable.

3 Methodology

This study, which is exploratory and qualitative, was based on a review of the literature on Scientific Tourism. Next, a survey of the existing bridges in the city of Porto and their connection to the city of Vila Nova Gaia was carried out. To prove their existence and their characteristics, a technical visit to the different bridges was carried out on October 17, 18 and 19, 2024 to obtain elements that will support the study.

4 Technical/Historical Description of Bridges

Bridges are fundamental structures that play a central role in the socio-economic development of the regions. These structures make it possible to overcome natural obstacles such as rivers and valleys. They allow the connection between communities, enabling the transport of people and goods, facilitating communication between banks. In addition to their practical function, these, due to their scope, have a strong impact on urban aesthetics and the development of the communities they serve. These structures often become iconic landmarks, becoming part of the identity of the cities, as happens, in Gaia and Porto, with the bridges that bond the two banks of the Douro River. These engineering works for their constructive audacity and beauty are recognized worldwide as poles of tourist attraction, boosting the local and regional economy.

The history of Porto's bridges is intertwined with the history of the city itself, as the need for communication with the south bank has always been a reality. If in the early days the crossing was carried out using boats and rafts, the increase in communication between the two banks made it necessary to build a permanent crossing between the two banks. The first bridge of permanent nature, the das Barcas Bridge, was built in 1806, which was only dismantled in the flood season. However, the fragility of these structures, consisting of boats anchored at the bottom of the river, led to the construction of the first permanent fixed bridge, although it was the most ephemeral of all.

This bridge, D. Maria Pia II Bridge or Suspension Bridge, as can be observed in Fig. 1, of which only the two obelisks on the north bank remain, was inaugurated in 1843.

The suspension bridge project was prepared by the French engineer Stanislas Bigot, with the collaboration of the Portuguese engineer José Vitorino Damásio. The construction was carried out by the French corporation Claranges Lucotte & Cie [7].

The deck of this bridge, built of wood, had a total length and 170.14 m and 6.00 m wide. This was suspended by eight cables and iron hangs, four on each side, supported by columns, or obelisks, of masonry with a trunk-pyramidal shape and 18.00 m high and tied to the rocky massifs of the banks. This structure rose 10.00 m above the average water level of the Douro River, thus allowing its navigability.

The Suspension Bridge, vital for the cities of Porto and Vila Nova de Gaia, was in operation for four decades, until 1887, when it was dismantled after the inauguration of the D. Luís I bridge, which was built next to it.

The second built bridge, the D. Maria Pia bridge, was a railway bridge. This bridge is shown in Fig. 2.

This bridge, a unique work of iron engineering and architecture, at the time of its inauguration was the bridge with the largest iron arch in the world. It can be considered

Fig. 1. D. Maria Pia II Bridge (Suspension Bridge)

Fig. 2. D. Maria Pia Bridge

the first important work of the French engineer Gustave Eiffel and the Belgian Théophile Seyrig. The structure is made of iron and has a main arch with a span of 160.00 m and a height of 42.60 m. The total length of the bridge is 352.88 m, of which 192.88 m corresponds to the side viaducts and 160.00 m to the main arch. The deck is located about 61.00 m above the average water level of the Douro River. Recognizing its historical and architectural importance, this bridge was classified in 1982 as a National Monument (Diário da República No. 47/1982, Series I of 1982-02-26). The structure remained in use until 1991, when it was replaced by the São João Bridge.

The D. Luís I Bridge, represented in Fig. 3, designed by Belgian engineer Théophile Seyrig, was inaugurated on October 31, 1886 (upper deck) and 1888 (lower deck), replacing the old suspension bridge that existed on the same site.

Fig. 3. D. Luís I Bridge

The main arch has 172.00 m width and 45.00 m height, supporting the two boards that are at different levels. The total length of this bridge is 385.25 m. The upper deck, which rises 62.00 m above the average water level of the Douro River, has a length of 391.25 m and a width of 8.00 m. The lower deck, located 10.00 m above the river level, has a length of 174.00 m and a width of 6.00 m. The main arch consists of two parallel ribs, connected by horizontal and diagonal crossbars that guarantee the stability of the structure. The support columns were built in masonry and iron, which are anchored to the banks of the river [8]. This structure has been classified as a world heritage site since 1996 [9].

The first concrete bridge to be built was the Arrábida Bridge in 1963. It was designed by the Engineer Edgar Cardoso as well as the S. João Bridge. The construction was awarded to the company Eng. José Pereira Zagalo. This structure, due to the solution and the construction method used, was considered, and continues to be, a landmark of structural engineering [10].

As can be observed in Fig. 4, it is a bridge with reinforced concrete arch structure with its parallel hollow ribs, creating an elegant and imposing structure that integrates harmoniously with the surrounding landscape. This bridge, at the time of its construction, was a world record [11], as it has a span of 270.00 m and a height of 52.00 m. The arch consists of two parallel hollow ribs, each with 8.00 m wide, connected by longitudinal and transverse bracing. The bridge has a total length of 493.20 m and a width of 26.50 m.

Upstream of the D. Maria Pia bridge and to replace it, since it could no longer meet the growing demand for rail traffic, the S. João Bridge was built in 1991. This bridge, represented in Fig. 5, was also designed by Engineer Edgar Cardoso. The construction oversaw by the consortium comprising Sociedade de Construções Soares da Costa, SA and Teixeira Duarte Engenharia e Construções.

The total length of the bridge is 1140.00 m, including the access viaducts. The central span is 250.00 m long, while the two side spans are 125.00 m each [12]. The support columns are made of reinforced concrete and are fixed to the riverbed. Each main column is reinforced with 130 reinforced concrete micropiles, consisting of five steel rods, 50.00 mm in diameter and 12.00 m long, driven into the rocky bottom of

Fig. 4. Arrábida Bridge

Fig. 5. São João Bridge

the river. The bridge's superstructure consists of a trapezoidal cross-section box girder, which directly supports the railway tracks.

To relieve the pressure of traffic, in 1995 the Freixo Bridge and the D. Luís I Bridge were built on the Arrábida Bridge and the D. Luís I Bridge (Fig. 6). This prestressed reinforced concrete bridge was co-designed by engineers António Reis and Daniel Sousa.

The bridge, which consists of two independent parallel structures 0.10 m apart, has a total length of 705.00 m, with a main span of 150.00 m. The total width of the bridge is 27.50 m, divided into two parallel structures of 13.75 m each [13]. The superstructure, which supports the deck, consists of prestressed concrete beams. The columns are in reinforced concrete which are founded on direct foundations (with immersed footings that reach 7.00 m in thickness), indirect foundations with tip piles and indirect foundations with lateral friction piles in the sandy soil.

The most recent bridge, the Infante D. Henrique Bridge, built in 2003, was designed by Engineer Adão da Fonseca with the collaboration of Spanish engineer Francisco

Fig. 6. Freixo Bridge

Millanes Mato and engineer Fernandez Ordoñez. This bridge, in prestressed reinforced concrete, consisting of a rigid deck supported by a main arch is represented in Fig. 7.

Fig. 7. Infante D. Henrique Bridge

This bridge, with a total length of 371.00 m, has a "Maillart" type arch, which has a span of 280.00 m and a height of 25.00 m, resulting in a span/height ratio of 11.2, a world record for this type of structure [14]. The bridge has a width of 20.00 m. The deck consists of a 4.50 m thick box beam. The columns, founded on the riverbank, are also in reinforced concrete.

5 Conclusions

The application of Scientific Tourism to bridges is an innovative way of connecting people with science, history and engineering.

By exploring the educational and cultural value of these structures, it is possible to create enriching experiences that combine knowledge with leisure. Thus, the present

research demonstrated that the bridges that connect Porto to Vila Nova de Gaia represent a heritage of high historical, architectural and scientific value, with strong potential to be integrated into Scientific Tourism initiatives. The technical visits made it possible to confirm the richness and diversity of these structures, highlighting them not only as functional infrastructures, but also as testimonies of the evolution of engineering and the urban identity of the territory.

By valuing these elements in the context of Scientific Tourism, new opportunities are created for non-formal education, the involvement of local communities and the promotion of more sustainable and qualified tourism. This approach also strengthens the connection between visitors and the territory, while promoting technical knowledge in an accessible and attractive way.

However, for the full realization of this potential, it will be essential to invest in the creation of interpretative content, training of specialized guides and development of promotion strategies appropriate to the specificity of this segment.

5.1 Study Limitations

Some limitations of the present work are the fact that this analysis focuses exclusively on the bridges between Porto and Gaia and, in addition, the study only had a qualitative approach and an exploratory nature, which did not involve the collection of data from visitors, or other stakeholders.

5.2 Future Research Avenues

Extend to other bridges in the Douro and other regions of Portugal with tourist and heritage relevance, as well as carry out perception studies among tourists, students and residents on the interest and impact of Scientific Tourism associated with bridges.

Acknowledgements. This work is supported by National Funds through FCT – Fundação para a Ciência e a

Tecnologia, I.P., under the projects Ref. UIDB/04470/2020, with DOI identifier https://doi.org/10.54499/UIDB/04470/2020 and project reference UIDP/04131/2020, with DOI identifier https://doi.org/10.54499/UIDP/04131/2020.

We would also like to thank the Center for Research, Development and Innovation in Tourism (CiTUR), Electromechatronic Systems Research Centre (CISE) and (BRIGGES)

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The Mediterranean Dietary Pattern in Higher Education: From Perception to Reality

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Abstract. The aim of this study was to assess the influence of some sociodemographic factors on the adherence of students at the Polytechnic Institute of Guarda to the Mediterranean Dietary Pattern (MDP), using the PREDIMED scale. The sample consisted of 316 students, mostly female and with an average age of 20.6 years.

Although 84.8% of respondents said they knew about the MDP and 86.1% said they adopted it, only 15.8% actually demonstrated behaviours compatible with this pattern according to the PREDIMED scale. This mismatch suggests an incorrect perception or lack of knowledge of the specific MDP criteria.

A summary analysis of the results of the PREDIMED scale revealed low adherence to the consumption of wine, oleaginous fruits and fish, essential components of the MDP, although olive oil as the main fat and the consumption of vegetables and cereals were prevalent.

With regard to sociodemographic factors per se, the study did not show a close relationship between greater adherence to the MDP in relation to age, gender, geographical location of origin, type of course and parents' schooling, which may suggest that there are other factors, such as lifestyle in an academic context, group influences and day-to-day management, which may have a greater impact on students' eating habits.

Keywords: Mediterranean diet · Sociodemographic factors · Higher education · PREDIMED and University Student

1 Introduction

Dietary habits are a determining factor in the state of health of individuals, particularly in preventing the incidence of chronic non-communicable diseases, such as cardiovascular diseases, which continue to be the leading cause of death in Portugal [1].

A food choice, more or less conscious, is made at the moment a certain food is bought and/or consumed, and this choice is determined by various factors: physiological, psychological, social, economic and cultural [2].

At the same time, dietary patterns represent a general picture of food and nutrient consumption and are characterised on the basis of usual eating habits, as revealed in [3].

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 69–77, 2025.
https://doi.org/10.1007/978-3-032-09080-5_8

According to [4], parents play a fundamental role in informal learning processes, namely by modelling eating habits.

Several studies show consistent associations between dietary patterns and social, economic and lifestyle characteristics, and other factors that can also interfere with food consumption patterns, such as household size, marital status and skin colour [5–8].

As shown in [9, 10], the main determinants of the food choices made by young university students are the lack of time available, convenience, cost, flavour, state of health and the social and physical environment, as well as concerns about controlling body weight.

Thus, food choices are influenced by multiple factors, including age, gender, genetic factors, lifestyle, family, surroundings, cultural and religious traditions, availability, advertising, peer groups, preferences, costs and sensory properties of food [9].

The study presented here, using the PREDIMED scale [11], aims to contribute to understanding how food choices in a sample of public higher education students are related to sociodemographic factors, namely gender, age, parents' schooling, place of birth and course attended.

2 Methodology

The methodology used was based on a literature review on the concepts of the MDP and the assessment of adherence using the PREDIMED scale. An online survey was carried out at the different schools of the Polytechnic Institute of Guarda from 21 November to 7 January 2025.

A total of 316 surveys were collected and processed using SPSS, version 29.0.

Taking into account the number of students at the institution at the time, which is 2933 (see electoral roll, 2024), and considering a 95% confidence level, the margin of error for this study is ±5.2% [12].

The questionnaire was divided into two parts: a first part relating to the respondents' socio-demographic variables, and a second part with data relating to the PREDIMED scale. In order to avoid response bias, five items on the scale were inverted.

The questionnaires were administered with the help of several teachers, who asked the students to fill them in before the start of the lesson. These questionnaires were made available to students via a QR Code.

3 Result

The analysis of the results (Table 1) begins with a description of the sample in terms of socio-demographic variables. In terms of gender, there was a predominance of females, with 75% of respondents. As far as age is concerned, the most common age is 19, which is higher than the average age of 20.63.

With regard to educational qualifications, those of the father and mother were identified. In general, the mother's educational qualifications are higher, although in the case of both the father and the mother, the majority do not have higher education qualifications.

Table 1. Socio-demographic characterisation of the sample

Variables		N	%
Gender	Male	80	74,7
	Female	236	25,3
	Total	316	100
Education Father	Basic Education	154	48,8
	Secondary Education	97	30,6
	Bachelor's Degree	42	13,3
	Master's degree	8	2,5
	Doctoral degree	2	0,6
	DK/NA	13	4,1
	Total	316	100
Education Mother	Basic Education	108	34,2
	Secondary Education	128	40,5
	Bachelor's Degree	56	17,7
	Master's degree	16	5,1
	Doctoral degree	2	0,6
	DK/NA	6	1,9
	Total	316	100
Residence district	Guarda	94	29,7
	Aveiro	39	12,3
	Castelo Branco	19	6,0
	Coimbra	33	10,4
	Lisboa	13	4,1
	Porto	21	6,6
	Viseu	39	12,3

(*continued*)

Table 1. (*continued*)

Variables		N	%
	Others	58	18,4
	Total	316	100
Nationality	Portugal	278	88
	Others	38	12
	Total	316	100

In terms of districts of residence, most people live in the district of Guarda (94), followed by the districts of Aveiro and Viseu (39), Coimbra (33), Porto (21) Castelo Branco (19), Leiria (18) and Lisboa (13).

Finally, with regard to country of origin, the vast majority are from Portugal, with around 88%.

When asked what dietary pattern they adopt, the vast majority say that they adopt a MDP (272), which corresponds to around 86.1% of respondents.

On the other hand, when asked if they were aware of the MDP, the vast majority of respondents said yes (268), corresponding to 84.8%. This seems to indicate that people know what the MDP consists of and that they adopt this dietary pattern.

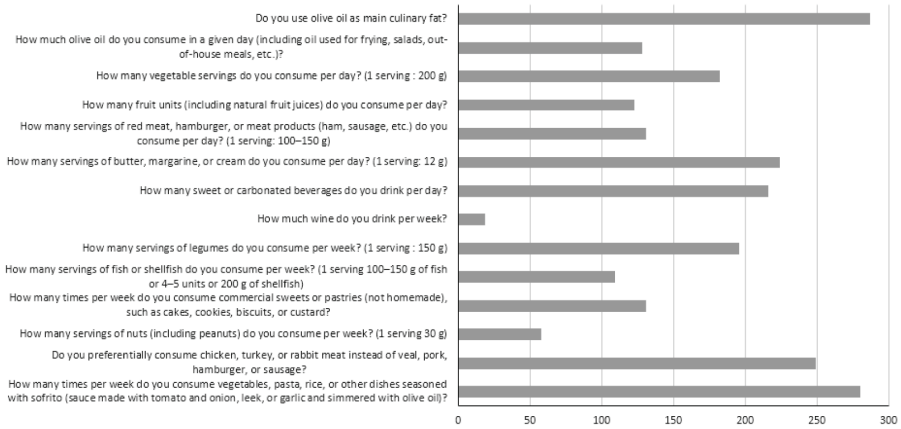
The results obtained regarding the adoption of a MDP are therefore surprising. When the PREDIMED test was applied, only 15.8% (50) of respondents obtained a score indicating that they adopt the MDP, which contradicts what was initially said.

Analysing each of the items that make up the PREDIMED scale (Graph 1), we see that the items with the lowest scores are wine consumption, with only 19 responses, followed by oilseed consumption, with 58 responses, and fish and seafood consumption, with 109 responses.

On the other hand, the use of olive oil as the main fat is the most popular, with 287 responses, followed by the consumption of vegetables, pasta, rice and stir-fries, with 280 responses.

Another aspect to note is that respondents say that their main cooking fat is olive oil, but then they consume some quantities of butter, margarine and cream, which is not in line with the adoption of a Mediterranean dietary pattern.

Graph 1. PREDIMED Scale score



In order to understand the influence of the district of residence on membership of the MDP, the country was divided into coastal and inland, with the following districts considered on the coast: Viana do Castelo, Braga, Porto, Aveiro, Coimbra, Leiria, Lisbon, Setúbal and Faro. As for the interior, the following districts were considered: Bragança, Vila Real, Viseu, Guarda, Castelo Branco, Portalegre, Évora and Beja.

The analysis carried out (see Table 2) showed that 46.6% belonged to the coast and 53.4% to the interior.

Table 2. Residence

		Frequency	Percentage	Valid percentage	Accumulated percentage
Valid	Coast	145	45,9	46,6	46,6
	Interior	166	52,5	53,4	100,0
	Total	311	98,4	100,0	
Omitted	System	5	1,6		
Total		316	100,0		

In order to find out whether there were significant differences between this division and the level of adherence of the MDP, the variables that characterise it and the place of residence were crossed. Table 3 shows that of the 261 respondents who don't adopt a MDP, 120 (46%) are from the coast and 141 (54%) are from the interior. Of those who say they do adopt an MDP, there is equality, i.e. 25 (50%) for those from the interior and the coast.

Analysing Table 4 below, we can say that there are no statistically significant differences between adherence to the MDP and whether students live inland or on the coast (Pearson's chi-square test with a significance greater than 0.05).

Table 3. Crosstabulation mediterranean dietary pattern*Place of residence

			Place of residence		Total
			Coast	Interior	
Mediterranean Dietary Pattern	NMDP	Count	120	141	261
		% Mediterranean Dietary Pattern	46,0%	54,0%	100,0%
		% Place of Residence	82,8%	84,9%	83,9%
		% Total	38,6%	45,3%	83,9%
	SMDP	Count	25	25	50
		% Mediterranean Dietary Pattern	50,0%	50,0%	100,0%
		% Place of Residence	17,2%	15,1%	16,1%
		% Total	8,0%	8,0%	16,1%
Total		Count	145	166	311
		% Mediterranean Dietary Pattern	46,6%	53,4%	100,0%
		% Place of Residence	100,0%	100,0%	100,0%
		% Total	46,6%	53,4%	100,0%

Table 4. Chi-Square Tests

	Value	df	Asymptotic Significance (2 sided)	Exact Sig (2 sided)	Exact Sig (1 sided)
Pearson Chi-Square	,273a	1	,601		
Continuity Correctionb	,135	1	,713		
N of Valid Cases	311				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 23,31.
b. Computed only for a 2 × 2 table.

In order to understand the relationship between adherence to the MDP and the course attended by students at the Higher Education Institution, these parameters were analysed, taking into account that there are courses related to the health area, namely nursing, pharmacy, medicinal biotechnology, and the other courses include Hotel Management, Restaurants and Catering, Sports, Marketing, Marketing and Communication.

The analysis showed that 68.4% of the students who responded to the survey were from health courses and 31.6% from other areas (see Table 5).

Table 5. Type of course attended

		Frequency	Percentage	Valid percentage	Accumulated percentage
Valid	Health courses	216	68,4	68,4	68,4
	Others courses	100	31,6	31,6	100,0
	Total	316	100,0	100,0	

Given that in other studies there is a positive relationship between people belonging to the health sector and the adoption of an MDP, in this case we wanted to find out if there were significant differences between their level of adherence and the type of course attended by the students. Thus, analysing Table 6, we can conclude that there are no statistically significant differences between adherence to the MDP and the type of course.

Table 6. Chi-Square Tests

	Value	df	Asymptotic Significance (2 sided)	Exact Sig (2 sided)	Exact Sig (1 sided)
Pearson Chi-Square	,074a	1	,785		
Continuity Correctionb	,011	1	,915		
N of Valid Cases	316				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 15,82.
b. Computed only for a 2 × 2 table.

4 Conclusion

The aim of this study was to assess the adherence of students at the Polytechnic Institute of Guarda to the Mediterranean Dietary Pattern (MDP), based on the application of the PREDIMED scale.

The sample consisted of 316 students, predominantly female and with an average age of around 20.6 years. The vast majority of respondents said they were aware of MDP (84.8%) and adopted this eating pattern (86.1%). However, when objectively assessed using the PREDIMED scale, only 15.8% actually demonstrated behaviours compatible with adherence to the MDP.

This contrast between the subjective perception of adherence and the observed reality shows a significant discrepancy, suggesting a possible overestimation of food quality on the part of those surveyed or partial ignorance of the specific criteria that make up the Mediterranean pattern.

Detailed analysis of the PREDIMED scale revealed that the least frequent dietary behaviours among students are the consumption of wine, oilseeds (nuts) and fish or shellfish - central components of the MAP. On the other hand, the use of olive oil as the main cooking fat and the regular consumption of vegetables and cereals (pasta and rice) are highly prevalent.

Geographical location (coast or interior) does not significantly influence adherence to the MDP.

On the other hand, the type of course (health area or not) also does not positively influence adherence to the MDP.

At a stage when non-parental social interactions are intensifying, the construction of choice becomes more complex, which may suggest that there are other psychosocial, cultural and economic factors, such as the students' lifestyle, living outside the family context and the availability of food, that lead them not to adopt the PDM.

In this context, it would be important to organise training sessions for these students at the higher education institution on the MDP and the benefits of adopting this dietary pattern.

5 Limitations and Future Perspectives

A limitation is the way in which the sample was obtained, given that the sampling process was non-probabilistic.

In the future, we recommend improving the sociodemographic characterisation by including other family factors and extending the study to other higher education institutions.

Acknowledgements. This work is supported by National Funds through FCT – Fundação para a Ciência e a.

Tecnologia, I.P., under the projects Ref. UIDB/04470/2020, with DOI identifier https://doi.org/https://doi.org/10.54499/UIDB/04470/2020.

We would also like to thank the Center for Research, Development and Innovation in.

Tourism (CiTUR) and Biotechnology Research, Innovation and Design for Health Products (BRIGGES).

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Science Fiction in Science Education: A Systemic Review

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Abstract. This study reviews the use of science fiction as a pedagogical tool in science education, highlighting its role as a motivational, inspirational and instructive resource. Science fiction can facilitate the teaching of complex scientific concepts, encourage critical thinking, and enhance creativity in students. Through a systemic review of the literature in databases such as Scopus, Web of Science, ERIC, EBSCO, SciELO and Google Scholar. The findings are grouped into four categories: films, interdisciplinary approaches, narratives and audiovisual resources. The results show that science fiction increases students' motivation, scientific understanding, and critical thinking, offering a holistic and contextualized learning experience.

Keywords: Education · Science Fiction · Pedagogy · Science Education

1 Introduction

Science fiction is a literary and audiovisual genre that explores the impact of science and technology on society and individuals through speculative narratives [1]. This genre is characterized by its ability to imagine alternative futures, advanced technologies, and unconventional scenarios [1, 2]. Throughout history, science fiction has served as a space for the exploration of philosophical, ethical, and social ideas, offering a critical view of the present and the future [3, 4].

Menadue and Cheer [5] conduct a study on science fiction and human culture and conclude that the results show that science fiction literature has been used in research within disciplines such as theology, semantics, natural sciences, and education. Science fiction narratives offer a historical record of transformations in social and cultural values over time, allowing them to be related to their original contexts [5].

The purpose of this study is to provide an overview of research linking science fiction and science education.

The present study aims to answer the following question: What is the impact of the use of science fiction and audiovisual literature as a didactic tool in science teaching?

The objective is to conduct a review of the existing literature on how science fiction can be used as a pedagogical tool for science teaching and learning.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 78–87, 2025.
https://doi.org/10.1007/978-3-032-09080-5_9

The methodology is a systemic review that combines the PRISMA method and content analysis. The PRISMA methodology ensures that systematic reviews and meta-analyses are carried out with a high level of quality, reducing bias and errors, and reinforcing the reliability of the results obtained.

1.1 Science Fiction

Asimov, one of the most influential authors of the genre, defined science fiction as the narrative that addresses the human response to changes in the level of science and technology [2]. According to Asimov, science fiction not only imagines technological futures, but also explores how these advances impact society and the human condition [2].

Suvin [6] describes science fiction as a type of art that is based on the introduction of a novelty or innovation, which generates an alteration in observable reality. For their part, Kulart and De Rosso [7] mention that science fiction consists of texts that articulate scientific or technological knowledge in each future.

Science fiction stands out for its ability to act as a reflective and critical tool [8, 9], since it is a literature of ideas that uses the counterfactual conditional to formulate extraordinary hypotheses about the world and its social organization [10]. This speculative dimension makes it possible to anticipate and analyze the possible social, economic and cultural effects of scientific and technological advances before they materialize in reality [3, 4, 8]. Science fiction stands out as one of the most versatile and imaginative genres in various artistic expressions, from literature to cinema and comics.

Science fiction is not only useful as a mirror to reflect on the present and the future, but it also inspires technological innovations and stimulates the scientific imagination [11].

Carl Freedman [12], from a literary and critical approach, valued science fiction as the most suitable genre for academic study, highlighting it above other literary genres due to its considerable analytical potential [12]. Suvin [6] elevates science fiction to an area conducive to academic research.

Within the genre of science fiction, there are two main types that differ in their approach and level of scientific rigor: hard science fiction and soft science fiction [11].

Hard science fiction is characterized by its meticulous attention to technical and scientific details, presenting scenarios that are plausible within known scientific laws [1]. Authors such as Arthur C. Clarke and Larry Niven are famous for their works of hard science fiction, where scientific accuracy is paramount [13]. This type explores how technological advances can alter our understanding of the universe and our technical capabilities [1].

On the other hand, soft science fiction focuses more on the social, psychological, and humanistic aspects of stories [1, 11]. This type allows for greater creative freedom in terms of scientific concepts and is more interested in how these advances impact human relationships and social structures [11]. Authors such as Frank Herbert, and Ursula K. Le Guin, are prominent examples of soft science fiction, where the sociocultural and ethical implications of technology are the focus [3].

2 Methodology

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2.1 Inclusion and Exclusion Criteria

Empirical studies, systematic and qualitative reviews on the use of science fiction in science teaching, published in English or Spanish, with full text available, were included. The studies had to be published in high-impact academic journals, understood as those indexed in databases such as: Scopus, Web of Science, ERIC, EBSCO, SciELO and Google Scholar, and located in the Q1 or Q2 quartiles according to metrics such as the impact factor, SJR or CiteScore in the areas of education or social sciences. This criterion ensures the quality, relevance and scientific validity of the sources. We excluded works that were not peer-reviewed, not indexed, or that addressed science fiction only tangentially or without a clear relationship to science teaching.

2.2 Literature Search

The bibliographic search was carried out in recognized academic databases. Keyword combinations in English and Spanish were used using Boolean operators, such as:

- “Science fiction” AND (“science education” OR “education”)
- “Science fiction” AND (“science education” OR “education”)
- “Fiction-based learning” AND “STEM education”

Filters were applied by document type (peer-reviewed articles), language (English and Spanish), and date of publication (last 10 years). This strategy sought to guarantee the exhaustiveness and replicability of the process, prioritizing current studies with direct relevance in the educational field and published in indexed journals.

2.3 Study Selection

The selection of studies was carried out in two phases. In the first phase, 50 relevant articles were identified from titles and abstracts. These studies underwent a first screening, reducing the set to 25 articles that met the inclusion criteria. In the second phase, a detailed evaluation of these 25 studies was carried out, considering the methodology, the quality of the research and the relevance to the topic under study. Finally, 13 key articles were selected for the final analysis. Empirical studies and systematic reviews that provided solid evidence [14, 15] on the use of science fiction in science teaching were prioritized.

2.4 Analysis and Synthesis

The information was organized according to the objective of the study, following an inductive thematic analysis approach [16]. The full texts of the 12 selected studies were reviewed, and emerging themes related to the use of science fiction in educational contexts were manually coded. Based on this open coding, the studies were grouped into four thematic categories, determined by the frequency and relevance of the identified approaches:

1. Movies: Studies that look at the use of science fiction movies in the classroom.
2. Interdisciplinarity: research that integrates science fiction to connect different disciplines, especially in STEM contexts.
3. Narratives: works focused on science fiction literature as an educational resource.
4. Audiovisual resources: studies that address the use of digital or multimedia materials inspired by science fiction.

Within each category, a detailed thematic analysis of methodological approaches, main findings and pedagogical recommendations was carried out. The narrative synthesis allowed the results to be integrated, identifying recurring patterns, divergences and gaps in the literature. This strategy contributes to a coherent and comparative interpretation of the studies, while maintaining the traceability of the analysis process.

2.5 Limitations

Limitations of this study include exclusion of studies in languages other than those included and potential publication bias, where studies with positive results are more likely to be published. The inherent limitations of literature reviews, such as reliance on published studies and the possible lack of unpublished or hard-to-access data, are also recognized.

2.6 Implementation of PRISMA

To ensure transparency and reproducibility of the review, the PRISMA checklist was used, verifying that all required elements were present and well documented. Figure 1 shows a flowchart that visually represents each stage of the selection process, from the initial identification of articles to the final inclusion of studies.

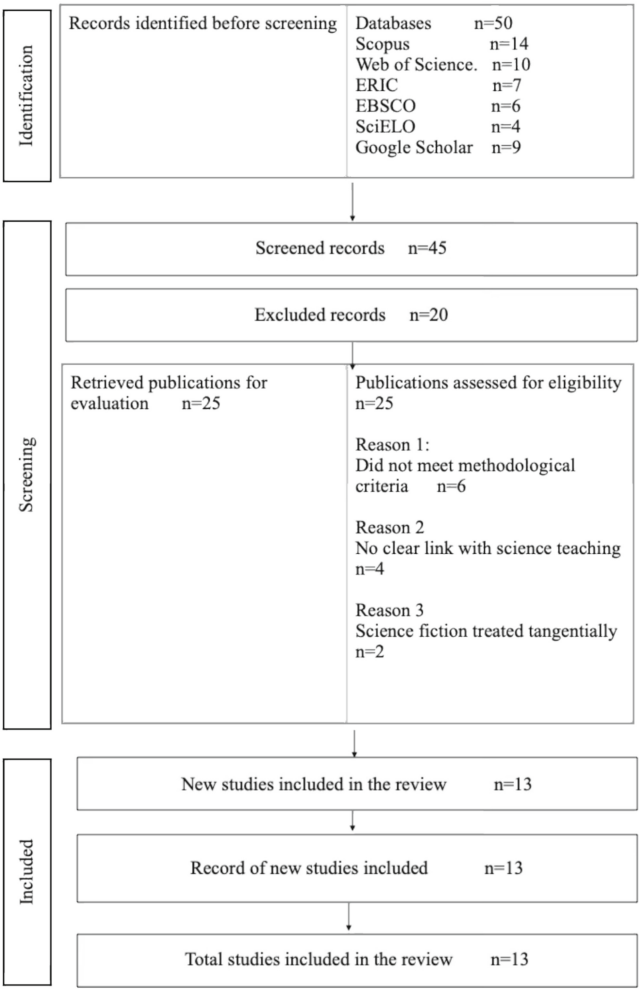

Fig. 1. Flowchart of the PRISMA process.

3 Analysis

Below is a comparative table (Table 1) of the research found and selected in the bibliographic search in scientific databases that review the use of science fiction in science learning.

Table 1. Comparative table of research.

Category	Author	Main result
Films	Petit Pérez & Solbes Matarredona [17]	Students improved their understanding of scientific concepts and their positive perception of science and scientists.
	Abello [18]	Science fiction is a versatile and effective resource for science teaching, especially for motivating students.
Interdisciplinarity	De Oliveira Moraes et al. [19]	Students were able to explore scientific concepts to discuss social problems and developed critical reasoning skills.
Narratives	Vesga Vinchira [20]	Science fiction helped students better understand STS concepts (Science, Technology and Society) and fostered critical thinking.
	Vrasidas et al. [21]	Students showed a greater interest in and understanding of science by connecting with real-life problems and developed critical skills.
	Chapela [22]	Science fiction narrative illustrates abstract concepts and generates interest in science.
	Callejas Arévalo [23]	Students recognized physics and science as engaging career activities and developed a more positive perception of scientists.
	Lindgren Leavenworth y Manni [24]	Speculative climate fiction offers young people a safe space to imagine alternative futures, promoting sustainability, problem-solving and collective action.
	Summet y Bates [25]	The article suggests that science fiction-based modules can be a useful tool for continuing education in professional ethics and provides resources and strategies for assessing students' ethical development in an engineering and computer science context.

(*continued*)

Table 1. (*continued*)

Category	Author	Main result
	Londoño-Proaño [4]	The article proposes a methodology for using a digital narrative to teach science and technology.
	Montes et al. [26]	The article highlights the importance of the use of science fiction stories in architecture students to motivate the study of science.
Audiovisual resources	Pérez & Matarredona [27]	Students showed increased motivation and understanding of scientific concepts after the activities.
	Noor & Manturuk [28]	Respondents reported increases in knowledge, interest, and engagement with Star Trek-related scientific content.

The results are presented below in a detailed and grouped manner:

Films
Petit Pérez and Solbes Matarredona [17] conclude that the use of science fiction films in secondary school science classes significantly improves the understanding of scientific concepts such as light, sound, and gravity. In addition, a more positive perception of science and scientists is observed among students. This approach allows students to connect more deeply with scientific concepts through visual narratives. In the same way, Abello [18] reviews several articles and concludes that science fiction is a versatile and effective resource for science teaching. This approach not only motivates students but also makes it easier to understand complex concepts. Abello [18] argues that science fiction should be more integrated into educational methodologies due to its multiple didactic benefits.

Interdisciplinarity
De Oliveira Moraes et al. [19] investigate the use of the dystopian novel 1984 in an interdisciplinary didactic program to discuss socio-scientific issues. The results show that students develop critical and creative skills when exploring scientific concepts in a socio-political context. Dystopian works combined with socio-scientific debates can stimulate students' creativity and research skills.

Narratives
Various studies agree that science fiction is an effective educational tool to promote critical understanding of science and its social implications. Vesga Vinchira [20] and

Vrasidas et al. [21] show that, when integrated into academic contexts, speculative narratives favor the understanding of complex concepts, develop critical skills, and connect theory with real situations.

Lindgren Leavenworth and Manni [24] highlight its usefulness in sensitizing students to environmental and social justice issues, while Summet and Bates [25] use it to introduce ethical dilemmas into technical careers. Both approaches show that science fiction not only captures interest but also stimulates ethical thinking and social responsibility.

In short, science fiction is presented as a valuable pedagogical resource, capable of integrating science, ethics and society in more reflective, interdisciplinary and contextualized training processes.

Audiovisual Resources

Pérez and Matarredona [27] analyze classroom activities using science fiction films to improve scientific concepts. The results reveal that students show greater motivation and understanding of scientific concepts after participating in activities based on science fiction movies. This approach has been shown to be an effective teaching resource for improving both motivation and scientific understanding.

Finally, Noor and Manturuk [28] investigate the impact of educational videos related to science fiction, specifically Star Trek, in an online survey. Respondents report increases in knowledge, interest, and engagement with Star Trek-related scientific content. The results suggest that the use of science fiction narratives is effective in attracting and teaching science to audiences who would otherwise not be interested in scientific content.

4 Conclusions

The literature reviewed allows us to conclude that science fiction represents an effective and adaptable pedagogical tool, especially useful in science teaching. Authors such as Petit Pérez and Solbes Matarredonaa [17], as well as Abello [18], have shown that the use of science fiction films in the classroom not only improves the understanding of scientific concepts, but also motivates students and promotes a positive perception of science.

Various studies also highlight the value of science fiction as a means for the development of interdisciplinary approaches. Research such as that of De Oliveira Moraes et al. [19] shows that the integration of scientific elements with socio-political and cultural contexts favors critical thinking, creativity, and ethical reflection. In this sense, science fiction makes it possible to address not only technical knowledge, but also its social, environmental and cultural implications [19].

On the other hand, it has been proven that speculative narratives, when incorporated into the educational curriculum, facilitate the connection between scientific theory and everyday reality. Vesga Vinchira [20] and Vrasidas et al. [21] stress that this approach fosters cognitive skills such as problem-solving, argumentation, and creativity, while maintaining students' interest in the learning process. Likewise, audiovisual resources such as those used by Pérez and Matarredona [27] and Noor and Manturuk [28] enhance the understanding of complex content thanks to their ability to represent abstract ideas in a clear and visually attractive way.

Finally, authors such as Callejas Arévalo [23], Chapela [22] and Summet and Bates [25] agree that science fiction can contribute to transforming the perception of science, breaking stereotypes and expanding access to a more inclusive and ethical vision of scientific knowledge.

The present study allows us to conclude that the use of science fiction is an innovative pedagogical strategy, capable of enriching the teaching of science with a critical, creative and socially committed perspective.

Future research on the use of science fiction as a pedagogical tool in science teaching should focus on empirical studies that examine the long-term effects of science fiction use on students' critical thinking development and creativity. The integration of science fiction into interdisciplinary curricula and its impact on students' perceptions and attitudes towards STEM careers can also be explored. It would be interesting to consider longitudinal studies on the impact of science fiction on the acquisition of scientific and socio-emotional skills or the impact of different types of science fiction on learning.

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Community-Based Motricity: Methodological Approaches from Initial Teacher Education in Physical Education Pedagogy

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Abstract. This article analyzes Community-Based Motricity as an emerging field in initial teacher education in Physical Education, highlighting its transformative potential from a critical and situated perspective. Grounded in a theoretical-methodological framework that integrates the ontological, epistemological, and methodological dimensions of motricity, the study reflects on its understanding as a complex, embodied, and relational phenomenon. It explores its connection to community, territory, and motor expressions as forms of identity, cultural, and political construction. Furthermore, it examines the pedagogical application of methodologies such as Participatory Action Research (PAR) and Service-Learning (SL), which enable formative processes with ethical and social meaning. A specific training experience within a university course is presented, where students design and implement intervention projects in real communities, fostering meaningful learning, active participation, and civic engagement. The findings highlight the educational value of Community-Based Motricity for rethinking Physical Education from an emancipatory perspective, one that is sensitive to territorial contexts and committed to social justice. The study concludes that integrating this approach into teacher education strengthens the link between theory and practice, promoting a contextualized and transformative education oriented toward the common good .

Keywords: community · motricity · community-based motricity · initial teacher education · physical education

1 Introduction

Community-Based Motricity is understood as an approach that recognizes the link between human motricity and the community. According to Ochoa and Arias [1], it is a formative model that seeks to promote well-being and social participation through

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 88–99, 2025.
https://doi.org/10.1007/978-3-032-09080-5_10

physical and sports practices adapted to the needs of local territories. Community-Based Motricity incorporates elements of the educational territory, critical reflection on teaching practice, and the prevailing educational model [2].

As Calvo [3] states, the educational territory is a space for identity construction that articulates relational forms within communities. In this framework, Community-Based Motricity is positioned from a critical and decolonial perspective of Physical Education in Latin America [4, 5], and is linked to the planning and evaluation of community social interventions [6].

Authors such as Molina et al. [7] have defined Community-Based Motricity as an intervention proposal with playful, formative, and aesthetic intentions, with a strong presence of sport. However, its scope is broader, as Rannau [8] points out, by including diverse motor expressions involving children, the elderly, women, migrants, and other groups.

This theoretical proposal aligns with the Sustainable Development Goals of the 2030 Agenda [9] and with the proposals of the Chilean Ministry of Education [10], which promote comprehensive education from early childhood, where Physical Education and Community-Based Motricity are articulated to foster critical and participatory citizenship. This becomes particularly relevant in a global context where UNESCO advocates for holistic and contextualized educational approaches that integrate citizenship, social justice, and community participation [11].

For all these reasons, we refer to a process and progress: we start from a point and project ourselves toward advancement. In this regard, participation is the primary criterion for valuing motor expressions, rather than performance, results, or products. Therefore, it plays a social role by enabling access for all members of the community and the need to adapt to the specific characteristics of each group. As such, it has a purpose in the coexistence between cultures and in the development of civic virtues.

Thus, defining Community-Based Motricity involves evoking a complex network of elements that make up this construct. From this complexity, we propose to clarify essential ideas and questions regarding its constitution and expression, such as the ontological, epistemological, and methodological dimensions [12], as reflective pillars for a theoretical approach.

From this perspective, we propose a reflection on the ontological, epistemological, and methodological dimensions of Community-Based Motricity, as well as its possible pedagogical implementation in Initial Teacher Education, through approaches such as Participatory Action Research and Service-Learning.

2 Foundations of Community-Based Motricity

Community-Based Motricity is a complex construct that requires a critical approach. Its nature is grounded in two main dimensions:

i) A sociomotor dimension, which considers movement as a form of encounter and intersubjective expression, where symbolic and affective exchange occurs between corporalities [13].

ii) A community dimension, which situates motor activity as a culturally and territorially grounded practice. This dimension is based on the concept of *comunalidad* [14], understood as a form of collective existence and solidaristic interdependence, where the territory acts as a pedagogical agent and the practice is oriented toward social transformation [15].

Participation constitutes the central criterion for pedagogical validation, over technical results or performance. Community-Based Motricity is projected as a space for intercultural coexistence, civic formation, and identity construction, rather than as an instrumental discipline.

2.1 Ontological Dimension

To approach the reality that constitutes Community-Based Motricity, a complex perspective is required, given the very nature of the construct. In this regard, answers are sought and proposed to the essential questions of science: What is the nature of the knowable? What is the possible relationship between the knowable and the knowing subject?

Its character is assumed to be that of a complex reality, situated in living, changing, and intersubjective communities. It is not a fixed structure, but rather a network of relationships, affections, symbols, and practices expressed through motricity.

In this sense, the ontological dimension makes it possible to question the definition of the nature of Community-Based Motricity as a knowable phenomenon. This involves addressing not only its nature but also asking: What can be known about Community-Based Motricity? This is proposed from the understanding that it is not possible to fully know the reality of this phenomenon, given its complex nature, which is considered through two core ideas.

On the one hand, the social dynamism [16] inherent to human collectives, where the social being unfolds in its communal expression within civil society; and on the other hand, intersubjectivity as a constitutive factor of the essence of communities and their expressions, among which those of a motor nature are included. In this regard, Husserl [17] refers to reciprocity in human interactions, in which all the elements that are part of the self are summoned.

This perspective is deepened by Levinas, who not only legitimizes the necessity of otherness but also places the face of the other as the starting point of ethical subjectivity, arguing that it is in responsibility toward the other that the subject is constituted [18].

This metaphor of the face, as the original manifestation of the other, intertwines with what Merleau-Ponty [19] describes as the interweaving of corporealities in the lived world, where the experience of the other becomes present through the embodiment of consciousness. In this sense, relationships between corporealities are not merely visual or conceptual, but expressive encounters between motricities that mutually signify each other, configuring an intercorporeal space in which openness to the other occurs.

The above responds to a conflict in which "lived experience" and "rationality" converge in processes of change and transformation in society. Therefore, reality is not constituted solely by structures, as the unfolding of these structures is made possible by

those who recreate and intertwine them through their intersubjectivities, with their specificities and contradictions. As a consequence, this space would constitute the community itself [6, 14].

2.2 Epistemological Dimension

The epistemological dimension, for its part, raises questions such as: What is the nature of the relationship between the knowing subject and the knowable? And how does this type of relationship influence the cognitive process? From this dimension, the relationship between the knowing subject and the object of knowledge is reconsidered. Community-Based Motricity cannot be known from an external position, but rather through participation, dialogue, and reciprocity.

Community-Based Motricity, as a knowable phenomenon, is closely related to motor expressions, which, according to Arboleda [20], represent the social, the communal, in an exercise of "re-thinking knowledge, re-drawing it, and re-conceptualizing it; they are, therefore, a re-presentation" (p. 33). Thus, motor expressions, within the framework of Community-Based Motricity, would constitute the social representations [21] that emerge from the imaginaries constructed through intersubjective relationships occurring in the everyday life of the community. These expressions provide a sense of belonging and identity to the social fabric constructed in the dialogical space of the community.

Therefore, motor expressions are mediated by the social representations of each territory, which are deployed throughout the evolution of the social fabric [22]. This implies the need to consider various types of motor expressions: sporting, artistic, playful, and ecological.

In this reflection, it is pertinent to consider the social fabric, as Habermas [23] states, as a network constituted and constructed by the entire community. It is based on the interactions and communications of its members, who share life, time, and space. This becomes the basis of the nature of Community-Based Motricity, as it is a territory where social construction is developed and expressed—and therefore, so are motor expressions.

In this sense, it can be affirmed that communicative action [23], understood as all social action aimed at transmitting messages through various means—such as written, verbal, paraverbal, visual communication, among others—is a constituent element of Community-Based Motricity. It resides at the core of the relationship between the one who knows and what can be known, since it is the foundation of what is possible to know about Community-Based Motricity.

Therefore, it transcends a merely instrumental reasoning with predetermined ends [24]. Rather, it implies a comprehension of the world and the lifeworld that surrounds each community. It also becomes a necessary condition for a society that is emancipated according to its intersubjective needs, territorial particularities, and legitimate autonomy.

In this effort, as Blumer [25] points out, the interpretation that emerges in the community regarding intersubjectivity and the symbols that arise in its interactive becoming are both constitutive and open to study. In this sense, the communicative exchange of a communal nature gives meaning to the nature and content of the relationship between the one seeking to know Community-Based Motricity and Community-Based Motricity itself, in its complexity as a phenomenon—both in itself and in relation to subjects—through communication and the attribution of symbolic meaning.

Community-Based Motricity demands overcoming the subject–object paradigm in favor of a subject–subject logic, characteristic of a participatory and emancipatory society. This shift aligns with the proposals of Guba and Lincoln [12], who advocate for a constructivist epistemology grounded in the co-creation of meaning among the actors involved.

This entails a redefinition of the subject–object relationship and, beyond that, a saturation of all types of social relationships within a specific social formation. Breaking the traditional domination–dependency relationship implied in the subject–object binary would lead to a new type of society—a participatory society—where the fundamental relationship would be subject–subject. Thus arises the aim of making critical use of accumulated theory, preventing the closure of complex social reality within the limits of any single epistemological lens.

2.3 Methodological Dimension: A Proposal within the Field of Study

Finally, an attempt is made to respond to the methodological dimension of Community-Based Motricity, which problematizes the question: how can the knowing subject come to know or access reality or the phenomenon?

Orlando Fals [26] calls for mutual learning and problem-solving through joint work among communities, their members, and researchers by means of Participatory Action Research. In this regard, Participatory Action Research has an emancipatory or liberating interest [27], as a form of knowledge production from a socio-critical and transformative sphere [28].

It transcends the technical and practical with other paradigmatic and methodological nuances it proposes [29]. It is based on anthropological techniques from the classical academic tradition, particularly those of participant observation [30]. In this regard, Fals [31] systematizes this aspect into six methodological foundations: authenticity and commitment; anti-dogmatism; systematic feedback; recourse to organic intellectuals; rhythm of reflection-action; and modest science and dialogical technique. By its very nature, it corresponds to a cyclical, recursive, participatory, and qualitative methodology [32, 33].

Kemmis [34], for his part, organizes the Participatory Action Research process into two axes that are in constant interaction and articulation. One of them encompasses action and reflection; the other is organizational, involving planning and observation. Both are included in four interrelated phases or moments identified as planning, action, observation, and reflection. This investigative process aims to improve the quality of educational practice, and in this sense, provides tools to strengthen Initial Teacher Education through the analysis and application of this methodology.

In a Latin American context and as an example of implementation in education, Ortiz and Borjas [35] propose a Participatory Action Research cycle in three phases: first, the observation of reality to generate reflection on educational practice; second, the planning and development of actions to improve practice; and finally, the systematization of the experience and reflection in and on action to produce knowledge.

This coincides with Colmenares [36], who argues that Participatory Action Research always begins with an initial diagnosis, consulting various community actors in search of assessments, points of view, and opinions on issues and/or problems that may be subject

to intervention in order to transform them and improve the well-being of the community through good social practices.

Once such thematic concern and/or problem has been revealed [37], this leads to the construction of an action plan, the implementation of said plan and its corresponding observation, the reflection and interpretation of results, and, if necessary, the re-planning phase, in a spiral of continuous improvement.

Therefore, Colmenares [36] assumes that this multidimensionality "guides the researcher on how to approach their object of study—the reality; how they will relate to knowledge, the ways of knowing that reality, and even how they will present the findings that emerge from their research" (p. 103). According to this, the author states that, according to Participatory Action Research, this responds to a realist or critical realist ontology, to a subjectivist epistemology that includes values, and finally, to a dialogical and transformative methodology. It is therefore in intimate, pertinent, and coherent connection with what we have understood as Community-Based Motricity.

3 Community-Based Motricity and Initial Teacher Education

Community-Based Motricity is a construct in which subjects are situated in their individual complexity, and from there, spaces of interaction are built. These are subjective constructions of existence in and with others, within a specific social sphere where all of this occurs, and which determines its very essence. Thus, it emerges as a scientific field of study, becoming a central element of Initial Teacher Education in the area of Physical Education. For this purpose, it is necessary to make decisions about how it will be addressed and with which teaching methodology the didactic knowledge will be constructed.

On the one hand, it is proposed that Participatory Action Research is the methodology that best responds to the specificities of Community-Based Motricity, as it understands the community as a living and unique organism, in its composition and structure. Therefore, the investigative process includes a territorial component.

On the other hand, since it is a methodology aimed at an emancipatory process whose purpose is the production of knowledge from a socio-critical and transformative sphere, it urges the development of collaborative work between academia and the territories themselves. This gives rise to the development and study of diverse social practices which, according to Ochoa and Arias [1], have two complementary aspects: practices linked to physical activity and health, and those related to the process of training for the socio-political participation of communities and their members.

The above is articulated with the objective of Participatory Action Research, which—like Community-Based Motricity—has as its focus the unique and unrepeatable character of each community, and within them, undoubtedly, motor expressions, each oriented toward social transformation [38].

3.1 Formative Dimension: A Proposal for Physical Education Teachers

Service-Learning represents a significant opportunity for methodological experimentation in Initial Teacher Education in Physical Education, integrating academic learning

with the acquisition of values [39], by providing a service to the community through a dynamic of mutual benefit [40]. Thus, Service-Learning is presented as a pedagogical instrumentalization technique that enables the integration of curricular content with community service, through a bidirectional logic of benefit and transformation. This logic has already been documented in previous experiences within critical physical education [40, 43], reinforcing the value of Service-Learning in community-based contexts.

On one hand, academic learning is established by the training institution, which defines learning outcomes for the content addressed; and on the other, the same institution proposes values to be learned and the levels at which they are expected to be developed during the intervention carried out.

One of the main characteristics for achieving these objectives is the reciprocity or bidirectionality of benefits, since all the actors involved gain something as a result of the intervention. Among other areas made concrete in these proposals, there is an intention to improve the promotion of health, well-being, and quality of life from a perspective of solidarity and reciprocity. Furthermore, Service-Learning promotes critical thinking rather than a merely assistentialist approach [41], both in students and in community partners, fostering personal, social, and cultural commitment.

According to Martín-García et al. [39], this methodology develops values linked to three major axiological dimensions: civic participation, altruism and cooperation, and transformative learning—each of which leads to the promotion of specific values and social practices, including self-awareness, empowerment, regulation, moral sensitivity, commitment, rigor, among others, which are in turn aligned with the expectations placed on those applying Participatory Action Research.

The critical component of Service-Learning can be aligned with a cultural perspective, allowing for a better understanding of the social and heritage environment of the participants [42–44]. In the context of Physical Education, Service-Learning not only contributes to individual development within Initial Teacher Education, but also acts as a space for relationships and a proposal for social transformation, with clearly defined and aligned actions and values.

To meet the applicability requirements of Service-Learning in Initial Teacher Education, a paradigmatic perspective is needed—one that aims toward transformation from the phenomenon in question, aligned with an appropriate methodological technique, which we find in Participatory Action Research.

Thus, once it is established that Community-Based Motricity is a socio-pedagogical practice carried out within society—particularly in communities—through the field of physical activity, and that it also impacts sociopolitical levels, its main aspiration is social transformation through interventions that call for coordinated work between academia and the territories.

3.2 Formative Experience: Implementation of Community Intervention Projects

The course Community-Based Motricity, corresponding to the fifth semester of the Physical Education Pedagogy program at Universidad Santo Tomás, proposes a formative experience that critically integrates disciplinary knowledge, situated pedagogical intervention, and ethical commitment to the territories.

The pedagogical intent can be expressed through the following learning outcome:

To distinguish pedagogical intervention strategies based on the theory and methodology of Human Motricity and the community approach, in order to respond coherently and appropriately to the needs and interests that emerge from the socio-community context.

This process unfolds through a plan that articulates theoretical classes, practical workshops, individual student work, and the implementation of community projects in real-world settings. From its foundations, the didactic proposal emphasizes the collective construction of knowledge, the identification of relevant sociomotor issues, and the transformation of pedagogical practices through participation.

The experience begins with a formative diagnosis in the classroom, where students reflect on the meanings of community, notions of human motricity, and paradigms of community action. Through cooperative learning communities, the group organizes itself to problematize its own understandings of the territory and intervention, establishing a first approach to the school or social contexts in which their actions will be projected: within the community. In this initial phase, emphasis is placed on building critical and contextualized thinking, recognizing the inherent tensions in educational and community environments, as well as the need for a situated approach that is sensitive to cultural, generational, and socioeconomic diversity.

Subsequently, students develop a participatory diagnosis process in real educational communities. This phase seeks to gather relevant information about the motor, cultural, and organizational conditions of the communities, as well as to generate horizontal relationships that legitimize local knowledge as a source of understanding. This dialogical and reflective dimension allows for the identification of shared needs and the projection of appropriate interventions that consider both motor expressions and the collective meanings that sustain them. In this sense, a situated epistemology is put into practice, in which subjective corporealities, motor expressions, territorial memories, and forms of coexistence become central elements of analysis.

The intervention project design is based on a situational planning model that includes explanatory, normative, strategic, and tactical-operational moments, as proposed by the methodology addressed in the course. This structure allows for the organization of objectives, experiences, and resources for the intervention, considering not only technical feasibility, but also its ethical, political, and educational coherence. The planned actions are implemented over several weeks, with continuous support from faculty who play a facilitating role and generate opportunities for feedback from the community actors themselves. The interventions encompass motor experiences in their various manifestations, cooperative dynamics, intergenerational dialogue spaces, among other strategies that integrate corporeality as a vehicle of expression, communication, and social transformation.

One of the most significant elements of this experience is the redefinition of Physical Education from a Community-Based Motricity perspective, shifting the focus from performance and technique toward participation, well-being, and identity construction. Within this framework, motor expressions are conceived as embodied languages that mediate relationships, knowledge, and emotions in public space—not as instrumental or standardized practices. Thus, the formative process challenges traditional forms of

teaching, promoting a teaching role committed to social justice, active citizenship, and the recognition of diversity.

Finally, the projects culminate in the systematization of the experience through collective reports that recover both the learning achieved and the tensions, challenges, and projections of the work carried out. This stage allows for the consolidation of a reflective closing process, in which the contributions of the intervention to professional training, the strengthening of the social fabric, and the democratization of pedagogical knowledge are acknowledged. At the same time, this exercise contributes to the development of critical awareness regarding the transformative role of Physical Education teachers, especially in contexts of vulnerability, exclusion, or community fragmentation.

This formative experience is configured as a situated practice that interweaves the principles of Human Motricity, community intervention approaches, and a critical pedagogy oriented toward emancipation. More than a course, it is conceived as a collaboratory of democratic and community education [45], where interacting corporealities, territory, and education intersect to open.

4 Conclusions

Community-Based Motricity constitutes an emerging field of study and pedagogical action that articulates theoretical and methodological foundations with situated intervention practices in real contexts. Its integration into Initial Teacher Education in Physical Education makes it possible to develop professional competencies oriented toward critical understanding of the territory, active participation in communities, and the construction of educational proposals that are coherent with specific sociocultural needs.

This theoretical-methodological-practical association has an influence across multiple domains, one of the most relevant being its capacity to strengthen sites of resistance against the hegemonization of motor and cultural expressions.

The implementation of methodologies such as Participatory Action Research and Service-Learning has proven to be an effective avenue for the formative approach to Community-Based Motricity, as it facilitates processes of diagnosis, planning, implementation, and systematization of community projects with pedagogical intent. These methodologies support the development of professional skills in future teachers and strengthen ties with local territories, promoting educational experiences with social relevance and community meaning.

Likewise, the Community-Based Motricity approach allows for an expanded understanding of motor expressions beyond physical performance, incorporating cultural, social, and political dimensions that directly impact civic education and the strengthening of the community fabric. From this perspective, it is configured as a formative alternative that promotes critical reflection on pedagogical practice and the social role of teachers.

Therefore, advancing the consolidation of Community-Based Motricity as a field of knowledge requires not only its curricular recognition, but also its deepening as a space for applied research. This entails strengthening formative experiences in which the link between theory, practice, and community becomes the articulating axis of teacher

education committed to educational and social transformation. Future research could explore the longitudinal relevance of Community-Based Motricity in teacher education trajectories, as well as conduct comparative analyses of its implementation across diverse sociocultural and curricular contexts.

To this end, it will be necessary to initiate a process of resignifying Community-Based Motricity not merely as a fragmented form of knowledge, but as a field of knowledge that gains strength through the practical exercise of investigative work with and within communities, as well as through the learning processes experienced by students themselves. In such a process, the methodological demands—both investigative and didactic—encourage the constant questioning and interrogation of reality and of pedagogical action itself, within a continuous cycle of improvement not only of pedagogy but also of human life in its wholeness.

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Impact of the Information Consumption Culture on Public Perception of Artificial Intelligence

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Abstract. The advent of generative artificial intelligence technologies has reignited fears of human replacement by machines: four in ten Brazilians are afraid of losing their jobs to AI. The following article revisits discussions from the Frankfurt School — specifically the concept of semi-formation (Halbbildung) by Adorno and Horkheimer, and technological rationality by Marcuse — along with a 25-year analysis of Public Understanding of Science (PUS) surveys, concepts of scientific literacy, and the trend of social media algorithms favoring the distribution of more sensationalist/negative content, to raise hypotheses about the root causes of this phenomenon. The results of an exploratory analysis indicate that the way individuals stay informed on the topic — whether proactively or passively — impacts their perceptions and feelings toward it. Those who consume algorithm-driven content via digital media platforms like YouTube, TikTok, and Instagram are more likely to perceive AI as a highly dangerous technology. In contrast, individuals who adopt a more active approach to seeking information, turning to potentially less sensationalist content produced by experts, tend to hold a less alarmist view.

Keywords: Chat GPT · scientific literacy · technological rationality

1 Introduction

Since IBM's supercomputer Deep Blue defeated Russian chess grandmaster Garry Kasparov between 1996 and 1997 [1], and its younger sibling, Watson, beat human competitors live on national television in the quiz show Jeopardy Go1 in 2011, the threat portrayed in scripts such as the film *2001: A Space Odyssey* — in which artificial intelligences overpower and exterminate humans — has seemed closer to reality. But instead of life being taken from us by the most primitive and definitive means — death — the threat has shifted to a form more in tune with the capitalist society in which we live: the means of living, or simply, work.

Panic was renewed in November 2022, when OpenAI introduced ChatGPT to the world [2] a generative artificial intelligence based on natural language capable of simulating the production of original content.

Four in ten Brazilians fear losing their jobs to artificial intelligence [3]. The most affected are young people aged 18 to 26, with 52% expressing concern, especially those

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 100–109, 2025.
https://doi.org/10.1007/978-3-032-09080-5_11

working in technology, programming, and internet-related roles. Generation X follows (45%), then Generation Y/Millennials (43%). Baby Boomers, in contrast, feel less threatened (33%). Fear of technology also shows patterns across education and income levels, being highest among those with only elementary education (49%) and incomes of up to two minimum wages (48%). Those with high school education rank second (43%), followed by those with a university degree (30%). The numbers are similar for people with a monthly household income between two and five minimum wages (43%) and above five minimum wages (31%).

The following article revisits discussions from the Frankfurt School—specifically the concept of semi-formation by Adorno and Horkheimer, and technological rationality by Marcuse; a 25-year analysis of Public Understanding of Science (PUS) surveys; concepts of scientific literacy; and the tendency of social media algorithms—which are, after all, a form of artificial intelligence—to favor the distribution of more sensationalist or negative content, in order to raise hypotheses about the roots of the widespread fear surrounding AI.

The initial hypothesis was that individuals with a minimally inquisitive profile — those who actively seek information about artificial intelligence on their own — would be less vulnerable to the negative and sensationalist tone of content spread through digital channels, particularly social media. On the other hand, those who remain at the mercy of what algorithms choose to present to them would be more susceptible to being influenced by negative content, which in turn would foster a stronger sense of fear toward AI.

The exploratory analysis, based on a quantitative online survey, indicated that passive individuals (*Group 1*) — those who do not take an active role in understanding the concept and consume information without questioning it — perceive AI as a more dangerous technology (52.8%) than those who seek information proactively (37.1%). The fear of losing one's job to AI is also higher among *Group 1* (17.3%) compared to *Group 2* (11.5%), although this is not the primary concern for either profile. When it comes to perceiving AI as a threat to society, again, *Group 1* (56.2%) expresses more fear than *Group 2* (38.3%).

This behavior can be partially explained by the type of content consumed by each profile. While *Group 1* primarily relies on information served by social media algorithms — which tend to prioritize negative content due to its viral and engagement potential — *Group 2* mostly turns to "dedicated channels/blogs by experts in science, technology, and artificial intelligence".

2 Background

Automation technologies and innovations in general are the foundation of economic development in capitalist societies [4, 5]. Based on empirical observation, one can infer that, until recently, major technological transformation processes predominantly — or even exclusively — replaced or threatened operational tasks. With the advent of generative artificial intelligence, the game has changed. Two-thirds of occupations in the United States are exposed at some level to automation by AI [6]. On average, 25% of the tasks performed by professionals can be automated. Among the 15 occupations with the highest level of AI exposure, only two — Farming, Fishing & Forestry and

Protective Services, both at 28% — are not exclusively intellectual. The most exposed fields are Administration (46%) and Legal (44%). The least exposed are those related to Construction (6%) and Maintenance (4%).

These data are striking — but are they alone enough to justify the fear that 40% of the population has of losing their jobs to AI [3]? Or could the way this information is distributed — and to whom it is distributed — affect public perception of artificial intelligence? To infer such a complex question, given the heterogeneity of society, a multidisciplinary approach was necessary, drawing from the fields of science and technology, education, philosophy, and sociology. Insights gathered from these diverse sources help shape an understanding of the intricate social fabric that receives artificial intelligence. Discussions from the Frankfurt School pave a primary road on which the subsequent lines of thought analyzed here follow. The most fundamental among them may be the Marcuse's notion of technological rationality [7], through which individuals adapt, unquestioningly, to the conveniences promoted by technology. Comparing technological society to a road — with signs indicating routes, stops, and tourist spots — this comfortable social environment indoctrinates the individual, who finds no reason to resist the mechanization and standardization of the world, which, after all, saves time and energy and provides security, among other benefits. "By manipulating the machine, man learns that obedience to instructions is the only way to achieve the desired results" [7].

It is worth noting that when Marcuse wrote the essay — in 1941 — many forms of human interaction, work, leisure, and entertainment had already been intercepted by technology, but the environment was certainly not comparable to today, where smartphones and social media not only mediate social interactions but often replace them altogether.

It becomes even more complex to break through mental boundaries when considering how the individual has been shaped in modern society — according to Adorno and Horkheimer — through the concept of "semi-formation." The current landscape undermines true autonomy and the development of critical thinking, as the individual's primary function is to reproduce a world to which they are already subjugated, and in which limited knowledge is falsely perceived as absolute truth. Through the mass culture industry, ideology—which becomes indistinguishable from society itself—is constantly affirmed and reinforced, and thus, strengthened [8]. As the individual does not resist technologies that facilitate social interaction, nor questions the structures that uphold their known world, any critique of these structures requires an uncommon degree of drive and proactivity.

In this environment, which is not conducive to counterpoints, a structural gap has developed in the exchange between the scientific community and ordinary citizens. One root cause lies in how science investigates and responds to the population's knowledge needs. "As long as science and society are not entirely overlapping spheres, issues regarding the public understanding of science and scientists' understanding of the public will persist" [9]. Bauer, Allum and Miller examined 25 years of data from the Public Understanding of Science (PUS) Survey to understand the shortcomings in the transfer of scientific knowledge and the necessary ways to overcome them. According to the authors, the surveys were based on a flawed premise of public déficit — in knowledge, attitudes, or trust toward science. With this flawed starting point, the investigations served to reinforce a particular view and justify corrective methods. The authors argue

for breaking away from this "deficit" notion — seen as a prejudice held by the scientific community — when designing research, in order to prevent models and protocols from limiting the scope of inquiry. They suggest that a public understanding of science agenda should:

> "Contextualize survey results through a new approach to the knowledge and attitude problem, within a framework of scientific indicators; analyze data for cultural indicators; integrate and globally analyze longitudinal datasets; and mobilize additional data flows, preferably qualitative, with a long-term perspective."(Bauer, Allum & Miller, 2007, p.90)

2.1 An Inevitable Consequence

One likely consequence of this combination of factors — a lack of questioning regarding technology in society, limited knowledge mistaken for absolute truth, a structural failure in dialogue between the scientific community and the public, and finally, scientific illiteracy—is the manipulation of individuals facilitated by the widespread use of algorithmic content distribution on digital platforms.

Durant sets up three definitions of scientific literacy [10], two of which the author himself considers unsatisfactory. The first — scientific literacy as "knowing a lot of science" — e mphasizes content without aiming for a broader understanding of the topic. The next — scientific literacy as "knowing how science works"— goes a step further, requiring experimental teaching that allows citizens to distinguish science from pseudoscience. Durant critiques this definition by pointing out that pseudoscientists are often skilled at mimicking the "standard description of the nature of Science [9]. The third and final definition — scientific literacy as "knowing how science really works"— is the one the author finds most comprehensive. It shifts scientific authority from individuals to a broad, self-regulating community, organized as a social practice. Understanding that science is subject to peer review, critique, and scrutiny allows one to see the scientific community as highly self-regulated and self-monitoring.

Negative stories are more likely to go viral on social media [11], and biased media — whether leaning left or right on the political spectrum — publish 12% more negative content than more balanced outlets. A Stanford University (California, USA) study conducted by Knutson et al. analyzed over 30 million posts from approximately 180 news organizations on X (formerly Twitter) between 2011 and 2020 and revealed that, over time, the appeal of negative news grew and shifted the editorial lines of even the more neutral outlets.

If the context presented through these references holds true, it can be inferred that individuals with even a mildly inquisitive mindset—those who, on their own initiative, seek information about artificial intelligence—tend to be less manipulated by the negative and sensationalist tone of content distributed through digital channels, especially social media. On the other hand, those who rely solely on algorithm-driven content are more likely to be exposed to negative messaging, which could result in a more acute sense of fear regarding AI.

3 Methodology

The research proposed in this article involves the exclusion and selection of methodological approaches aligned with the theoretical frameworks presented herein.

AI Literacy. Investigating the level of artificial intelligence literacy in a population based on the concept of "knowing how science really works" (Durant, 1994) would be a complex task, requiring more time and resources than the scope of this study allows. As such, this approach was excluded.

Mass Manipulation. Given that (a) negative content is more likely to go viral than neutral or positive content on social media platforms (Knutson, 2004); (b) the concept of semi-formation suggests that the individual's function is to reproduce a world to which they are already subjugated, where limited knowledge is falsely perceived as absolute truth, and where the mass culture industry reinforces the prevailing ideology/society and the individual's role within it (Adorno & Horkheimer, 1944); (d) technological rationality leads individuals to accept, without questioning, the structures imposed by the system, given the way society is organized (Marcuse, 1941), the chosen direction was to investigate whether the user's profile of information consumption— proactive or passive — regarding content related to artificial intelligence influences their perception of the technology (positive, neutral, or negative). This was explored through a quantitative survey distributed online.

The survey was conducted online between December 14 and 15, 2024, and received 319 valid responses from users across all five regions of Brazil. Respondents were reached through WhatsApp groups and the authors' direct contacts via various digital channels (Instagram, LinkedIn, etc.). It is important to note that the sample was collected by convenience, which may introduce selection bias. Precisely because of the lack of methodological rigor, this research should be considered merely exploratory and does not confirm any trends. The findings can serve as a starting point for further, more rigorous investigations.

3.1 Questionnaire Structure

The questionnaire was organized into three sections. The first collected basic demographic information (generation group, education level, and region of residence) from all respondents. Its final question asked: "Do you proactively seek information about artificial intelligence?" Based on the respondent's answer—yes or no—the second section was split accordingly. The questionnaires for the "yes" and "no" responses each contained four questions with nearly identical structures, allowing for comparative analysis.

Three identical questions assessed the respondent's perception regarding: (a) artificial intelligence technology itself; (b) the potential threat to their professional occupation; and (c) the potential threat to society as a whole.

The fourth question, which differed between the two groups, asked about their primary sources of information. This divergence was based on the assumption that information consumption behavior varies depending on whether the individual is proactive or passive. The questionnaire served as an exploratory study and did not follow a formal scientific research methodology. Its purpose was to indicate the potential for more in-depth future investigation.

Hypotheses. The initial hypothesis posited that passive individuals—those who do not actively seek to understand the concept and consume, without critical thinking, the negative content delivered to them by algorithmic mechanisms—are more likely to fear the technology. In this study, they are referred to as *Group 1*.

In contrast, those who take initiative in studying and researching the subject are expected to express more neutral or even positive opinions, as their interest in the topic likely stems from a prior favorable view of the technology. They are also presumed to seek out sources that confirm this perspective. In this study, they are referred to as *Group 2*.

4 Results

The survey was conducted online between December 14 and 15, 2024, and received 319 valid responses from users across all five regions of Brazil (Table 1). Respondents were reached through WhatsApp groups and the authors' direct contacts via various digital channels (Instagram, LinkedIn, etc.).

Table 1. Respondent's region of residence

Region	%
North Region	04.10
Central-West Region	04.70
Northest Region	05.60
South Region	15.70
Southeast Region	69.90

The proportion of respondents who proactively seek information about AI was slightly higher (54.9%) than those who receive content passively (45.1%).

4.1 Group 1 – Passive Content Consumption

Among those who passively consume information about AI (*Group 1)*, 52.8% consider the technology to be "quite dangerous and should be adopted with caution," while 23.9% describe it as "very positive, with the potential to significantly improve human life." Meanwhile, 9% view it as "a technology like any other." The remaining 14.3% provided open-ended responses in the "Other" field, emphasizing that the technology's impact — positive or negative — depends on human decision-making. These responses can be grouped with the intermediate opinion, resulting in a total of 23.3% (Table 2).

The investigation revealed that the most common sources of information for this group are automatically suggested content on digital media platforms (which themselves rely on algorithms—a form of artificial intelligence), such as YouTube, Instagram, TikTok, and similar services (63.9%). This is followed by newsletters from news outlets (40.3%) and information shared by friends and family (39.5%).

When asked to rate, on a scale from 1 to 5 (with 1 indicating the lowest threat and 5 the highest), the extent to which AI poses a threat to their jobs, the majority of respondents felt minimally threatened: over half (approximately 54%) selected either 1 or 2 (Table 3).

Table 2. On a scale from 1 to 5, how threatened do you feel by AI in your job, with 1 being very little and 5 being very much?

Response	%
1	34.70
2	19.40
3	28.50
4	10.40
5	06.90

Table 3. On a scale from 1 to 5, how much do you think AI threatens other areas of society (excluding jobs)?

Response	%
1	04.00
2	08.00
3	31.00
4	32.00
5	24.00

Once the question shifts to society at large, excluding the topic of employment, the scenario changes, with 56.2% selecting the highest levels (4 and 5) on the scale.

4.2 Group 2 – Proactive Content Consumption

The audience that proactively seeks information about AI (*Group 2*) holds, for the most part, a positive view of the technology: 51.4% describe it as "a very positive technology that can significantly improve human life." A more distant second group (37.1%) considers it "a rather dangerous technology that should be adopted with caution," while 11.4% classify it as "a technology like any other." This question did not include an open-ended "Other" option. However, since the question was phrased as "Which of the following statements best reflects your perception of artificial intelligence?" and the open-ended answers in the corresponding question for the passive consumption group aligned with the neutral option ("a technology like any other"), a significant analytical deviation is unlikely.

The primary source of information for *Group 2* is "Specialists' own channels/blogs on science, technology, and artificial intelligence," cited by 60% of respondents. This is followed by "General content on YouTube, Instagram, TikTok, and other social media platforms" (54.9%), and "Print or online news outlets, general or specialized" (53.1%).

This group also reports feeling minimally threatened by AI in the workplace, with 56.5% selecting options 1 or 2 on a 5-point scale assessing perceived threat (Table 4).

Table 4. On a scale from 1 to 5, how threatened do you feel by AI in your job, with 1 being very little and 5 being very much?

Response	%
1	35.40
2	21.10
3	32.00
4	08.60
5	02.90

As with the passive content consumption group, the perceived threat regarding society in general is greater, though at a less pronounced level; those who selected 4 and 5 on the scale account for just over 38% (Table 5).

Table 5. On a scale from 1 to 5, how much do you think AI threatens other areas of society (excluding jobs)?

Response	%
1	12.00
2	14.90
3	34.90
4	20.60
5	17.70

5 Conclusion

The research confirmed the initial hypothesis that passive individuals (*Group 1*) — those who do not seek to take an active role in understanding the concept and consume, without questioning, the negative content pushed by algorithms — tend to view AI as a more dangerous technology (52.8%) compared to those who proactively seek information (37.1%).

The fear of heaving their jobs affected is also greater among *Group 1* (17.3%) than in *Group 2* (11.5%), although this is not the main concern for either profile. When it comes

to AI as a threat to society, Group 1 (56.2%) is once again more fearful than *Group 2* (38.3%).

This behavior can be partially explained by the type of content consumed by each profile. While *Group 1* primarily receives information through content suggested by social media algorithms — which tend to highlight negative narratives due to their viral and engagement potential — *Group 2* mostly turns to "dedicated channels/blogs by experts in science, technology, and artificial intelligence." (Table 6)

Table 6. Three main sources of information about Artificial Intelligence

Group 1 (Passive)	Group 2 (Active)
Suggested content on YouTube, Instagram, TikTok, and other social media platforms; Movies/TV shows/series (63.9%)	Personal channels/blogs by experts in science, technology, and artificial intelligence (60%)
Newsletters from news outlets (40.3%)	General content on YouTube, Instagram, TikTok, and other social media platforms (54.9%)
Friends/family (39.6%)	General or specialized print/online news outlets (53.1%)

Since this is an initial exploratory study, it is necessary to conduct more in-depth research with scientific rigor to confirm the hypothesis. Once the hypothesis is confirmed, considering the theoretical references presented here, the challenge of moving individuals out of their comfortable ignorance and guiding them toward critical thinking about science and technology — so that fear surrounding AI evolution is kept in realistic proportions — becomes even more significant.

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An Intelligent Ecosystem for Teaching Mathematics: The SMART Education Ecosystem framework

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Abstract. The integration of digital technologies into education has significantly transformed the teaching and learning landscape, particularly in mathematics education. However, veteran teachers often face challenges in adapting to these technological shifts, leading to a gap in effective implementation. This study explores the "Smart Education" concept and its potential to build a framework to support a professional development of mathematics veteran teachers. The research introduces the *SMART Education Ecosystem*, a framework structured around four key pillars: Space, Technology, Pedagogy, and Teaching. Thematic analysis was used to review literature on Smart Education and mathematics instruction, identifying key trends and challenges. The findings suggest that targeted professional development initiatives and structured integration of Smart Education principles can bridge generational and technological gaps in teaching. This research contributes to the ongoing discourse on educational innovation, advocating for technology-driven strategies that enhance mathematics instruction and support educators in adapting to the digital era.

Keywords: Smart Education · Ecosystem · Mathematics · Veteran Teachers

1 Introduction

The nature of mathematical concepts and their complexity are commonly used to justify the poor results obtained by students in the class [1, 2]. The poor results have an impact on the teacher, even more so when it is known that the teaching staff is ageing and that 'veteran teachers' [3, 4], who are over 50 years old and the majority in Portuguese schools, suffer from the gap between the time of their initial training and the present day [6]. Nowadays, with the digitalisation of the educational environment, when students' competence in handling digital technologies is often greater than the teacher's, it is essential to define the principles of learning when the student is at the centre of this process. All of this creates an enormous pressure on the veteran teacher which, compounded by the increase in retirement age, triggers burnout processes.

However, digital technologies can make an essential contribution to the understanding of mathematical concepts [7] and teachers in the digital age are receptive to their

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 110–121, 2025.
https://doi.org/10.1007/978-3-032-09080-5_12

use [8]. Technological innovation and its significant representations in the educational context present a new learning and training context that needs to adjust to the demands impose by today's society [9, 10]. Portugal has an ageing teaching staff, which results in a generational gap with its students, accentuated by the digital familiarity that characterises today's students. At the same time, teachers are being asked to take on more responsibilities and are expected to improve the quality of their educational activities using digital technologies.

Smart education represents a paradigm shift in the educational landscape, taking advantage of technology to promote personalised and interactive learning environments that respond to the diverse needs of each student. Teachers need to review their teaching strategies, taking up the challenge posed by this new generation of students. As Jonassen [10] points out, technology should not be viewed merely as a supplementary tool, but as an integral component of the learning process. Continuous training is a way to help teachers overcome these challenges and gain knowledge that enables them to deal with the current reality of the educational context [11]. In this way, teachers can expand their own knowledge and use it in the classroom [12, 13].

Smart Education incorporates a holistic approach that promotes a synergy between pedagogy, technology and learning spaces, fostering an environment conducive to professional development and innovative teaching practices [14, 15]. This paradigm shift towards Smart Education requires a re-evaluation of pedagogical practices to bring them into line with the digital age, advocating a transformation of physical and virtual learning environments. It means a shift towards an educational model in which the emphasis is on improving learning outcomes through the strategic use of technology, adapted to individual learning needs and preferences. Consequently, Smart Education not only revolutionises the way in which educational content is provided and consumed but also redefines the roles of teachers and students in the learning process, placing technology at the heart of educational innovation and personal growth.

The increasing complexity of mathematical concepts and the evolving digital landscape present significant challenges for educators, particularly veteran teachers. Portugal's ageing teaching workforce, combined with the rapid advancement of educational technologies, has created a generational gap that affects instructional methods and student engagement. Smart Education represents a paradigm shift by integrating digital tools into teaching, promoting personalized and interactive learning experiences. However, veteran teachers require structured support to leverage these technologies effectively. The primary aim of this study is to explore the concept of "Smart Education" and its potential to build a framework to support the professional development of veteran mathematics teachers. To address this need, the study introduces the SMART Education Ecosystem, a framework designed to enhance professional growth and improve mathematics instruction. The following sections present the foundation of this framework, preliminary data results, and its potential impacts.

2 Methodology

2.1 Creation of the Framework

For this study, thematic analysis was conducted to identify, evaluate and synthesize evidence from the literature on the correlation between Intelligent Education and mathematics teaching [16, 17]. As a qualitative analytical technique, thematic analysis provides

a flexible and accessible approach to examining qualitative data [16]. It plays a crucial role in constructing scientific knowledge by enabling a comprehensive understanding of a subject [16]. Additionally, it facilitates the integration of diverse research findings while ensuring analytical consistency [18]. In this method, the corpus encompasses all collected data, the dataset refers to the portion analysed, an item represents individual data components, and an extract is a coded segment of an item [16].

Braun and Clarke's [16] thematic analysis framework was followed, using the keywords Smart Education and Mathematics to search the SCOPUS and ScienceDirect databases. These terms were combined with the Boolean operator AND to ensure that all retrieved documents included both concepts. The search was restricted to English language documents, freely available in the social sciences, and published between 2015 and 2024. The systematic review followed a five-stage process, eliminating documents based on predefined criteria.

Thematic analysis follows a structured process similar to other literature reviews. According to Anzul et al. [19], it involves: (i) familiarizing oneself with the data through initial readings and note-taking, (ii) coding the data and grouping relevant information under each code, (iii) identifying and organizing themes, (iv) reviewing and refining themes, incorporating elements of content analysis, (v) further refining themes through detailed examination, and (vi) producing the final analysis report by selecting and analysing data examples relevant to the research question.

Papers published before 2015 were excluded from the search to ensure a focus on recent studies. The retrieved articles were organized on an Excel file using Mendeley. Filtering in Excel removed entries lacking abstracts or keywords. Titles were reviewed to exclude unrelated documents, while abstracts were analysed based on specific criteria to assess credibility and relevance. The remaining articles underwent a thorough review, leading to the identification of four subcategories: space, pedagogy, teaching, and technology.

3 Results

3.1 Creation of the Framework

The thematic analysis resulted in 197 documents from SCOPUS (164) and ScienceDirect (33). In the next stage, duplicates, papers lacking abstracts, keywords and/or literature reviews were eliminated, reducing the count to 192 articles. The third stage involved reviewing paper titles, excluding those unrelated to Intelligent Education and Mathematics Education. Those that caused uncertainty were retained for further evaluation. Next, the abstracts of the remaining articles were analysed, leading to the exclusion of unrelated documents and narrowing the selection to 44 articles. In the final phase, all documents were thoroughly reviewed, and those misaligned with the study's aim were excluded, leaving ten scientific articles that met the criteria. The following table presents key information from these selected papers.

Table 1. Summary of key findings from the ten selected articles [15, 20–28] based on the thematic analysis.

Year	Country	Authors	Title	Main aim
2024	Spain	Palomés, X. P. I., Verdaguer-Codina, J., Casas, P. F. I., & Rubiés-Viera, J. L.	Physical and Digital Twin with Computational Thinking to Foster STEM Vocations in Primary Education	It explores the use of digital twins and computational thinking to encourage STEM careers in primary education.
2021	China	Wilson, J. C. M., Kandege, P., Edjoukou, A. J. R., & Teklu, M. T.	Unpacking smart education's soft smartness variables: Leadership and human resources capacities as key participatory actors	It analyses leadership factors and human resources as key elements in the effective management of Smart Education.
2021	Malaysia	Benita, F., Virupaksha, D., Wilhelm, E., & Tunçer, B.	A smart learning ecosystem design for delivering Data-driven Thinking in STEM Education	It proposes a learning ecosystem built on the Internet of Things to foster data-driven thinking in STEM education.
2020	China	Han, Z., & Xu, A.	Ecological evolution path of smart education platforms based on deep learning and image detection	It examines the challenges of developing an intelligent education ecosystem using deep learning and image detection, emphasizing personalization and ecological support.
2020	Singapore	Ilkou, E., & Signer, B.	A Technology-enhanced Smart Learning Environment based on the Combination of Knowledge Graphs and Learning Paths	It presents an intelligent learning environment that integrates knowledge graphs and personalized learning paths to identify gaps in students' knowledge.
2019	Russia	Galimullina, E., Ljubimova, E., & Ibatullin, R.	SMART education technologies in mathematics teacher education – ways to integrate and progress that follows integration	It restructures math teacher training with SMART technologies, identifying essential IT skills for a modern curriculum.

(*continued*)

Table 1. (*continued*)

Year	Country	Authors	Title	Main aim
2019	China	Hwang, GJ., & Fu, QK.	Advancement and research trends of smart learning environments in the mobile era	It examines trends and advancements in intelligent learning environments, emphasizing personalization and the development of advanced skills.
2018	Germany	Freigang, S., Schlenker, L., & Köhler, T.	A conceptual framework for designing smart learning environments	It develops a conceptual framework for designing intelligent learning environments.
2016	China	Zhu, ZT., Yu, MH., & Riezebos, P.	A research framework of Smart Education	It introduces a conceptual framework for Smart Education, exploring its definition and applications.
2016	USA	Katalnikova, S., Novickis, L., Prokofyeva, N., Uskov, V., & Heinemann, C.	Intelligent Collaborative Educational Systems and Knowledge Representation	It examines intelligent collaborative educational systems and their approaches to representing knowledge.

The analysis of the ten selected articles [15, 20–28] reveals both an evolution and a convergence in the conceptual landscape of Smart Education, centered around four key dimensions: technological integration, the redefinition of the teacher's role, personalized learning, and the structuring of digital ecosystems. In terms of technology, Palomés et al. [20] examine the use of digital twins and computational thinking in teaching proportionality, while Ilkou and Signer [23] investigate knowledge graphs and personalized learning pathways as tools to address learning gaps. Similarly, Benita et al. [22] propose an IoT-based ecosystem designed to cultivate data-driven thinking in STEM education. Zhu et al. [27] introduce a foundational framework composed of environment, pedagogy, and student profiles, highlighting the importance of integrating emerging technologies with adaptive pedagogical strategies. Focusing on teaching and leadership, Wilson et al. [21] emphasize "soft" facts, such as leadership and human resource management, positioning them as essential participatory elements in Smart Education. Galimullina et al. [24] offer a practical approach by redesigning mathematics teacher training through smart technologies, thereby linking digital competencies with curricular innovation. At a more conceptual and structural level, Freigang et al. [26] and Katalnikova et al. [28] contribute theoretical frameworks for intelligent learning environments and collaborative systems, respectively, enhancing the understanding of the broader Smart Education

ecosystem. Lastly, Han and Xu [15] present an intelligent platform leveraging deep learning and image recognition, with a strong emphasis on personalization and predictive support as core features of effective digital environments. This rich variety of methodological perspectives and conceptual advancements highlights the necessity for an integrative framework—one that weaves together space, technology, pedagogy, and teaching as interdependent foundations for teacher professional development within Smart Education. To structure this analysis and reinforce the theoretical underpinnings of the proposed model, the selected studies were aligned with the four core dimensions: Space, Technology, Teaching, and Pedagogy (see Table 2). This mapping allows for a clear identification of each study's contribution to the development and consolidation of the *SMART Education Ecosystem.*

Table 2. Overview of the ten selected articles [15, 20–28] and their connection to the four subcategories of the *SMART Education Ecosystem.*

Title	Authors	Space	Technology	Teaching	Pedagogy
Physical and Digital Twin with Computational Thinking to Foster STEM Vocations in Primary Education	Palomés, X. P. I., Verdaguer-Codina, J., Casas, P. F. I., & Rubiés-Viera, J. L.	Integration of physical and digital twin environments	Computational thinking and use of digital twins in STEM	–	Interdisciplinary and exploratory STEM education
Unpacking smart education's soft smartness variables: Leadership and human resources capacities as key participatory actors	Wilson, J. C. M., Kandege, P., Edjoukou, A. J. R., & Teklu, M. T.	–	–	Teacher as a technology leader, coach and human resource strategist	–
A smart learning ecosystem design for delivering Data-driven Thinking in STEM Education	Benita, F., Virupaksha, D., Wilhelm, E., & Tunçer, B.	Creation of physical and digital ecosystems using IoT	Data-driven thinking: IoT and analytical platforms	–	Project-based and collaborative learning
Ecological evolution path of smart education platforms based on deep learning and image detection	Han, Z., & Xu, A.	–	Deep learning and image recognition in SLEs	Redefinition of the teacher role based on data analytics	–
A Technology-enhanced Smart Learning Environment based on the Combination of Knowledge Graphs and Learning Paths	Ilkou, E., & Signer, B.	–	Knowledge graphics and personalised learning paths	Teacher as learning path facilitator	Adaptive pedagogical strategies based on student data

(*continued*)

Table 2. (*continued*)

Title	Authors	Space	Technology	Teaching	Pedagogy
SMART education technologies in mathematics teacher education – ways to integrate and progress that follows integration	Galimullina, E., Ljubimova, E., & Ibatullin, R.	–	Smart technologies in mathematics teacher education	Professional development and teaching progression	Pedagogical integration of digital competencies
Advancement and research trends of smart learning environments in the mobile era	Hwang, GJ., & Fu, QK.	–	Personalisation using mobile and contextual-aware technology	–	Development of metacognitive and learner-centred skills
A conceptual framework for designing smart learning environments	Freigang, S., Schlenker, L., & Köhler, T.	Integration of physical and digital learning environments	Technological infrastructure of smart learning environments	–	Need for adaptive pedagogies in digital contexts
A research framework of Smart Education	Zhu, ZT., Yu, MH., & Riezebos, P.	General smart learning architecture involving intelligent spaces	Smart computing and data analysis	Adaptive development of teachers and learners	Collaborative pedagogy
Intelligent Collaborative Educational Systems and Knowledge Representation	Katalnikova, S., Novickis, L., Prokofyeva, N., Uskov, V., & Heinemann, C.	–	Intelligent collaborative educational systems	–	Collaborative learning supported by AI

4 Discussion

Smart Education has been widely researched globally, as shown in Table 1. The data indicate that most publications on this topic originate from China, followed by the United States, covering the period from 2016 to 2024. As technology advances, the need for changes in teachers' pedagogical competencies becomes increasingly important — one of the core aspects of the Smart Education concept. In this sense, the *SMART Education Ecosystem* framework (see Fig. 1) offers a comprehensive vision for education transformation.

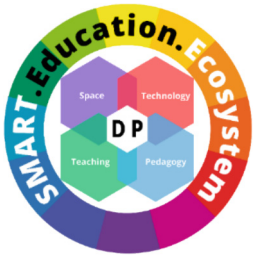

Fig. 1. ***SMART Education Ecosystem*** framework. Developed by the authors of this study.

Space

In the field of Smart Education, the concept of space transcends the traditional classrooms, evolving into dynamic and flexible learning environments that promote collaboration, creativity and engagement [20, 22]. These smart spaces are equipped with advanced technologies such as interactive whiteboards, virtual reality (VR) setups, and IoT devices, allowing for an immersive learning experience that can be adapted to an individual or a group [22]. The design of these spaces focuses on the student, with the flexibility to accommodate distinct teaching methods and learning activities. This shift to adaptable educational spaces facilitates a more active student-centred learning approach, encouraging engagement beyond the physical confines of the traditional classroom [29]. As Brown & Lippincott [30] suggest, flexible learning spaces are essential for supporting innovative teaching methods, where technology and educational architecture merge to create responsive and future-ready learning environments.

Technology

Technology is the keystone of Smart Education, integrating tools and platforms to improve teaching and learning processes. This includes the use of artificial intelligence (AI) to provide personalised learning experiences, the analysis of large volumes of data to support informed decision-making, and cloud computing, which enables to educational resources anywhere, anytime [15, 25]. Integrating technology into education allows the creation of an interconnected learning ecosystem where students can engage with dynamic content, collaborate with their peers worldwide, and develop essential digital literacy skills for the modern world. Through the strategic use of technology, Smart Education aims to make learning more accessible, engaging and aligned with the needs of today's digital natives [31, 32]. Mishra & Koehler [33] highlight in the TPACK model the importance of the intersection between technological, pedagogical and content knowledge, emphasising how technology must be integrated effectively to transform learning.

Teaching

In Smart Education, teaching is shifting toward more collaborative, interactive, and student-centred approaches. Educators use technology to create blended learning experiences, combining face-to-face instruction with digital resources to accommodate diverse learning styles and paces [34]. The teacher's role shifts from being a sole source of knowledge to a facilitator of learning, guiding students through personalized learning paths

while promoting critical thinking and problem-solving skills. By integrating technology into teaching methodologies, teachers can enhance engagement and effectiveness, using real-time feedback and data analysis to adapt their strategies to students' evolving needs [35, 36]. Laurillard [37] emphasizes that technology-driven teaching should actively engage students, allowing a more reflective and personalized teaching process.

Pedagogy

Pedagogy in Smart Education prioritizes student-centred approaches, relying on the use of technology to create personalized and adaptable learning experiences. Innovative pedagogical models such as flipped classrooms, project-based learning, and gamification enhance student engagement and motivation [27]. Digital tools and platforms facilitate collaborative learning, peer feedback, and self-directed exploration, empowering students to take an active role in their education. By aligning pedagogical practices with modern technological capabilities, Smart Education enables an interactive, engaging, and relevant learning environment that prepares students with essential skills for the modern world [38]. As Papert [39] advocated, constructivist pedagogy emphasizes knowledge construction through experimentation and interaction with the environment — an approach now enhanced by digital technologies in modern education.

Implementation of the *SMART Education Ecosystem*

The Digital Education Action Plan (2021–2027) [40] is a renewed European Union policy initiative that aims "to support the adaptation of the education and training systems of Member States to the digital age" [40]. The first priority is "Fostering the development of a high-performing digital education ecosystem" and to achieve this goal, the action plan outlines six key initiatives.

The *SMART Education Ecosystem* framework matches perfectly this action plan. Preliminary data suggests that veteran teachers are willing to integrate active methodologies in their classrooms, yet over 50% of the individuals lack familiarity with the concept "Smart Education". This highlights the need for targeted professional development programs that focus on bridging digital competencies and redefining instructional strategies.

A phased implementation approach is recommended, beginning with small pilot programs in selected schools. These initiatives can serve as testing grounds to assess the feasibility and impact of the *SMART Education Ecosystem.* Continuous feedback loops involving educators, students, and policymakers will be essential in refining the framework and ensuring its effectiveness.By embedding Smart Education principles gradually, institutions can facilitate a smooth transition that accommodates the needs and competencies of veteran teachers.

Beyond its scientific foundation, this framework aligns with the Digital Education Action Plan 2021–2027 [40], addressing key priorities such as digital teacher training, the development of inclusive learning environments, and the promotion of pedagogical innovation supported by technology. Smart Education holds transformative potential for mathematics instruction; however, veteran teachers often require structured support to navigate this transition effectively. The *SMART Education Ecosystem* offers a comprehensive framework that integrates both pedagogical and technological dimensions. Through the implementation of targeted training programs and the cultivation of a culture

of continuous professional development, educational institutions can empower experienced teachers to boost student engagement and enhance learning outcomes. Future research should include longitudinal studies to assess the long-term impact of Smart Education on teacher effectiveness and student performance.

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Assessing Digital and Info-Communication Competencies in Higher Education: A Blended Approach for e-Learning Environments

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Abstract. In an era increasingly shaped by information and communication technologies, assessing digital and info-communication competencies among students has become a focal point for academic and institutional initiatives. Various projects, both within and outside Academia, have sought to classify students' competencies at different levels, often relying on standardized tests and self-assessment questionnaires. However, as technological advancements rapidly evolve, universities face mounting pressure to align educational strategies with high levels of digital and info-communication proficiency and with the competitive demands of the labor market. It is, therefore, important to study these assessment tools further.

Blended assessment methods, combining practical tests with self-perception questionnaires, offer a more nuanced evaluation of students' digital competencies. By integrating objective skills assessments with self-reported proficiency, this approach captures a broader spectrum of abilities, recognizing the influence of diverse teaching models, students' academic backgrounds, prior digital exposure, and access to technological resources. This is particularly relevant in distance higher education, where continuous engagement in virtual learning environments provides ongoing opportunities for monitoring digital and info-communication competencies development.

Despite growing academic interest in this field, empirical research on digital and info-communication competencies in Portuguese higher education, particularly in e-learning contexts, remains limited. This paper presents the development of a digital literacy test and a questionnaire designed to assess students' digital and info-communication practices. These instruments were created as part of the ongoing research project Digital and Infocommunicational Competencies in Virtual Learning Environments: Practices in e-Learning Curricular Units in Portuguese Higher Education.

Keywords: Digital Competencies · Info-Communication Competencies · Higher Education

With the support of the Fundação para a Ciência e a Tecnologia (FCT) through the funding of the R&D Unit UIDB/03126/2020

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 122–134, 2025.
https://doi.org/10.1007/978-3-032-09080-5_13

1 Introduction

The rapid advancement of digital technologies has transformed various aspects of modern life, presenting both opportunities and challenges in personal, professional, and educational contexts. As digital interactions become more embedded in everyday activities, the concepts of digital and info-communication competencies have emerged as a crucial skills set required for active participation in a knowledge-intensive society (Council of the European Union, 2018). This growing emphasis, especially on digital competence, is reflected in numerous policy initiatives, particularly in Europe, where frameworks such as DigComp (Vuorikari et al., 2016) and DigCompEdu (Redecker, 2017) have been developed to standardize digital competencies assessment. However there remains significant variation in how digital competence is defined, measured, and evaluated in different educational and professional settings (Bawden, 2001), as well as info-communication competencies (Borges, 2018).

Researchers have long debated the terminology and conceptualization of digital competence, often using related terms such as digital skills, digital literacy, media literacy, information literacy, transversal skills, new media literacy, e-skills, e-competences (Spante et al., 2018). Initially, digital competence was primarily associated with technical skills, such as the ability to operate computers and software. However, as workplaces and educational environments integrate more interactive and collaborative digital tools, digital competence has evolved into a broader construct that encompasses knowledge, skills, and attitudes necessary for effective digital engagement (Van Laar et al., 2017). This shift underscores the need for comprehensive assessment methods that capture not only technical abilities but also cognitive and socio-emotional dimensions of digital competence (Falloon, 2020). This is also true for info-communication competencies, which need to be seen not as a domain of digital literacy, but as independent competence also operating in various media, one of which is digital.

To address these evolving demands, various digital and info-communication competencies frameworks have been introduced at international and national levels. Given the critical role of digital and info-communication competencies in higher education and beyond, there is a pressing need to develop robust and systematic assessment methods that reflect the complexities of this domains. This paper aims to explore the challenges associated with measuring digital and info-communication competencies among distance higher education students and the construction of valid assessment methods. With this objective in mind, this research seeks to deepen knowledge about literacies and competencies and how online higher education students operationalize them.

2 Digital and Info-Communication Competencies Frameworks in Higher Education: A Brief Review

Today's society demand new competencies for effective participation in professional and social spheres. These "21st century skills" - while context-dependent (Geisinger, 2016) - share a common purpose: enabling individuals to adapt their knowledge and behaviors to diverse situations. We operationalize competence as this context-responsive capacity

for adaptive action. The global expansion of higher education enrollment reflects institutions' dual mission of advancing knowledge and preparing graduates for labor market demands (Nyssen, 2018). This has driven international efforts to develop competence-based frameworks that define learning outcomes across knowledge, skills, and broader competencies (ESG, 2015).

Contemporary higher education aims to develop two complementary competence domains: discipline-specific expertise and generic transferable skills (Strijbos et al., 2015). Discipline-specific competences encompass the specialized knowledge systems (theories, models, and methodologies) required for professional practice within a given field (Allen et al., 2006). These contrast with generic competencies, which represent cross-disciplinary capacities for applying knowledge to solve complex, real-world problems across diverse contexts.

The integration of these competence domains reflects the fundamental demands of 21st century skills, where situational adaptability emerges through the synergy of specialized knowledge and transferable capacities. When considering different frameworks for 21st century skills in general, and concerning higher education outcomes in particular, we find several skills and outcomes overlap. The competence to communicate successfully in different situations using different means and the digital competence are not only part of several international 21st century skills frameworks, they are also part of international higher education qualification frameworks. As a result, a number of frameworks and models have been developed to assess and improve students' proficiency in these crucial areas.

The European Union's DigComp Framework (Vuorikari et al., 2016) outlines five key areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. The Digital Competence Framework for Educators (DigCompEdu), one of the fundamental frameworks in this field, describes the digital competences that teachers must possess in order to successfully incorporate digital technology into their lesson plans (Redecker, 2017). DigCompEdu was first created for educators, but by highlighting the value of digital literacy at all educational levels, it has impacted the creation of student-focused examinations. Meanwhile, the ISTE Standards (https://iste.org/standards) and the UNESCO ICT Competency Framework for Teachers (https://www.unesco.org/en/digital-competencies-skills/ict-cft) provide guidelines for digital skill development in educational contexts.

On the other hand, as far as info-communication competencies are concerned, Jussara Borges' theoretical framework emphasizes the sociocultural and pedagogical dimensions, framing info-communication skills as dynamic and context-dependent rather than static or purely technical (Borges, 2018). Her approach aligns with constructivist and connectivist learning theories, arguing that digital literacy and info-communicacion competencies should be assessed through authentic, collaborative tasks that mirror real-world practices (Educação para a Informação, 2022). Unlike traditional assessment models that isolate discrete skills, Borges advocates for holistic evaluations that consider how students navigate digital environments, engage in knowledge co-creation, and critically reflect on their digital practices.

Despite the proliferation of such frameworks, there is no universally accepted method for assessing digital and info-communication competencies, and existing approaches

often lack consistency in their methodologies and effectiveness (Sparks et al., 2016). Challenges persist in the standardization and implementation of assessment tools. Sillat et al. (2021) noted a lack of uniformity in digital competence assessment instruments, calling for more cohesive and validated tools to ensure reliable evaluations. Additionally, Ilomäki et al. (2016) highlighted the variability in definitions and frameworks, which can lead to inconsistencies in assessment outcomes.

Many studies employ self-assessment surveys, yet research suggests that self-perceived competence does not always align with actual performance (Maderick et al., 2015). While self-report methods offer insights into students' confidence and awareness of their digital and info-communication abilities, they fail to capture objective measures of proficiency. As a result, the state of the art seems to demonstrate the advantages of mixed-method approaches that combine self-assessment with performance-based evaluations to obtain a more accurate picture of students' competencies.

3 Method

3.1 A Digital Literacy Test and a Questionnaire Designed to Assess Students' Digital and Info-Communication Competencies

The construction of a digital literacy test and a questionnaire to assess distance higher education students' digital and info-communication competencies is a multi-step process that requires careful consideration of various factors. In an era increasingly shaped by technological advancements, these tools aim to gauge how well students are prepared to navigate, communicate, evaluate, and apply digital technologies in academic and professional contexts.

According to Ilomäki et al. (2016), digital competence refers to the ability to use new technologies purposefully and effectively in learning, work, and leisure. It includes understanding how digital technologies shape society and personal life, and having the motivation to take part in the digital world as a responsible and engaged participant. According to Borges & Oliveira (2011), the intersection of all these concepts and fields of analysis then seems to lead to the term infocommunicational competencies in digital environments, which can be characterised as the convergence of knowledge, skills and attitudes that make it possible to act appropriately in digital environments, mobilise resources and new contacts, articulating them for the production of meaning and knowledge, based on legal and ethical precepts. These foundational definitions serve as a guiding principle for designing the test and the questionnaire, ensuring that they assess a wide range of competencies essential for distance learners.

The first step in constructing the digital literacy test and questionnaire was to establish a framework of competencies to be assessed. As we've already mentioned, various models exist in the literature, such as the European Digital Competence Framework for Citizens (DigComp) and the DigCompEdu framework for educators, with its five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Redecker, 2017). In Portugal, it is important to add the Dynamic Reference Framework for Digital Competence – QDRCD (INCoDe.2030,

2019), a fundamental instrument developed under Portugal's National Digital Competence Initiative, INCoDe.2030, align with DigComp, and the work carried out, based on these references, by Academia Portugal Digital.

Regarding to info-communication competencies, Jussara Borges' theoretical and operational framework were adopted using what she called operational competencies, information competencies and communication competencies. Borges articulates that the contemporary information landscape, characterized by collaborative knowledge, construction and participatory culture, demands a reevaluation of traditional literacy models. She integrates concepts from Information Literacy (Alfin), New Media Literacy (NML), and Metaliteracy to propose a comprehensive framework for understanding info-communication competencies (Borges, 2018).

All the instruments mentioned share the same structure and objectives: the frameworks emphasize a comprehensive approach to digital and info-communication competencies, encompassing technical skills, cognitive abilities, and ethical considerations. And the areas worked on align closely with the demands of distance education, where students must engage with digital tools, evaluate and process online information, communicate and collaborate virtually, and manage their digital identity securely.

To ensure a comprehensive assessment, the digital literacy test and the questionnaire incorporated a mixed-methods approach, combining objective questions with practical tasks. Given the nature of distance education, the instruments were designed to assess competencies that are essential for online learning, such as information literacy, communication skills, data management, and cybersecurity awareness, in an accessible way, user-friendly, and capable of providing meaningful insights into students' digital and info-communication preparedness.

This study is being carried out as part of the PhD programme in Sociology at Iscte - Instituto Universitário de Lisboa, for the thesis entitled "Digital and Infocommunicational Competencies in Virtual Learning Environments: Practices in e-Learning Curricular Units in Portuguese Higher Education". The study is hosted by Cies_Iscte - Centre for Research and Studies in Sociology and has the support of the Foundation for Science and Technology (FCT) - FCT Doctoral Research Grant, reference 2021.08512.BD.

As this is an ongoing research project, both instruments are currently being applied exclusively and without the possibility of opening them up to other audiences, to a sample of students enrolled and registered for the first time in e-learning courses or curricular units at Portuguese public and private higher education institutions (the aim is to have an effective sample of no less than 500). Bearing in mind that we are talking about students starting their academic career at higher education level, the respondents will be over 17/18 years old, and there is no upper age limit. The way to reach the desired sample is by contacting Portuguese public and private higher education institutions with curricular units or e-learning courses which, with the appropriate authorisation, are responsible for sending the analysis instruments to their students.

This project follows the *Código de Conduta Ética em Investigação* of Iscte (s/d), having received a favourable opinion from the *Conselho de Ética do Iscte – Instituto Universitário de Lisboa* on 21/03/2025 - *Parecer 02/2025*. Specifically through compliance with its general principles of responsibility, honesty, reliability and rigour, objectivity and integrity. For both the test and the questionnaire, free and informed consent, with

informative content, is obtained online at the beginning of filling, and the instruments are only available after the respondents have validated this step. At the end of filling in both instruments, a thank-you message is left with the contact details of the researcher responsible, so that any respondent can clarify any questions or doubts.

This means that all participants in the study are being contacted in the light of the guarantee of informed consent, also in compliance with the General Data Protection Regulation (Parlamento Europeu e Conselho da União Europeia, 2016; Assembleia da República Portuguesa, 2019). The information provided will be treated confidentially, and at no time will there be access to personal data that implies that a person/respondent can be identified or identifiable. This is because, given the subject matter, no name, identification numbers, location data, electronic identifiers or other elements that could identify a respondent on a singular level are requested.

The test was built following the example of the digital skills self-diagnostic tool from the Portugal Digital Academy (available at https://academiaportugaldigital.pt/testes), and the questionnaire was designed based on instruments that have already been applied and tested in this area (Borges, 2018).

3.2 Analysis Dimensions

Based on the QDRCD, the test to be applied to distance higher education students was designed in line with other digital proficiency assessment tools for citizens available in Portugal (such as the Portugal Digital Academy). The aim was to create a comprehensive digital skills assessment designed to evaluate individuals across several key dimensions, ensuring a holistic understanding of their digital competencies. These dimensions were: Communication and Citizenship, Content Creation, Solution Development, Information Literacy, and Security and Privacy.

Communication and Citizenship focused on an individual's ability to effectively use digital tools for communication and to participate responsibly in online communities. This dimension included questions and tasks related to proficiency in managing email, navigating social networks, using collaboration tools and understanding the principles of digital citizenship. Content Creation assessed the capability to produce and edit various forms of digital content, including text documents, images, audio, and video. This dimension evaluated skills in using software tools for creating and modifying content, understanding design principles, and ensuring accessibility and inclusivity in digital materials.

Solution Development examined the ability to address technical challenges and efficiently utilize operating systems. This included troubleshooting hardware and software issues, customizing system settings, and optimizing device performance. Information Literacy, meanwhile, included questions and tasks related to the skills needed to analyse, store and retrieve information effectively. This dimension focused on the ability to use search engines proficiently, evaluate the credibility of online sources, and organize digital documents systematically. Security and Privacy assessed knowledge and practices related to protecting personal data, ensuring privacy, and understanding cybersecurity principles.

On the other hand, the questionnaire was mainly based on info-communication competencies and on Jussara Borges work. To translate the key dimensions essential for

assessing info-communication competencies into measurable indicators, we developed a structured assessment approach: specific questions aligned with each competence dimension to evaluate individuals' behaviors and attitudes in digital contexts (Information and Communication in Contemporary Times; Sources, Research, and Selection of Information; Comprehension, Organization, and Synthesis of Information; Critical Evaluation of Information; Production of Content; Intellectual Property, Copyright, and Plagiarism; Communication; Participation in Collaborative Media Environments and Development of Social Networks; Privacy and Ethics in the Communication of Information; Lifelong Learning and Metaliteracy; and the Learning and Internet dimension).

The framework emphasizes technical skills, socio-cultural awareness, and the ability to navigate vast information repositories while avoiding misinformation. Additionally, it highlights competencies like organizing and synthesizing information, producing original content, and understanding intellectual property laws. Effective communication, collaboration in digital spaces, and ethical considerations in information sharing are also central to the assessment. The framework further underscores the importance of lifelong learning and metaliteracy to adapt to evolving digital landscapes. The need for critical thinking, creativity, and ethical awareness in both consuming and producing digital content was also a constant in the preparation of the questionnaire. Key aspects included safeguarding privacy, engaging in collaborative media, and fostering social networks. Finally, the Learning and Internet dimension of the questionnaire assessed how students integrate digital tools into their academic activities. This dimension is critical for understanding how digital skills translate into educational success, particularly in distance learning environments.

3.3 The Supports

The questionnaire, aimed to capture students' self-perceptions of their digital and info-communication competencies, was designed on the Qualtrics platform, which allowed flexibility in assessing different aspects of these competencies.

We focused on a main type of questions, the Likert scale questions (e.g., "I can easily search for reliable information online"), which allows students to rate their abilities on a scale from "strongly agree" to "strongly disagree" for a series of statements. Likert-scale questions are a scientifically validated and widely used method for assessing skills due to their ability to quantify subjective constructs, such as perceived competence or behavioral frequency, while maintaining psychometric reliability and internal consistency (Boone & Boone, 2012). Their structured format ensures scalability and practicality, reducing respondent burden compared to open-ended questions while allowing for robust statistical analysis (Norman, 2010).

According to Yan et al. (2023), self-assessment tools provide valuable insights into learners' perceptions of their competencies, though they may not always correlate with actual performance. As a result, the questionnaire balanced self-reported data with more objective measures achieved through the test, with the intention of creating a comprehensive profile of digital and info-communication competencies.

The test was elaborated on the FlexiQuiz, a platform witch supports various question types, making it ideal for diverse assessments. To ensure comprehensive assessment, the test incorporated a variety of question formats. Multiple-choice and true/false questions

for evaluating theoretical knowledge, while matching exercises and fill-in-the-blank questions for testing applied understanding. Additionally, scenario-based questions, in which students must choose the best digital tool or response for a given situation, assessed problem-solving and critical thinking abilities.

Beyond self-assessment, the digital literacy test assessed practical competencies, focusing on how students apply their knowledge in real-world contexts. The test incorporated tasks such as identifying phishing attempts in emails, creating and sharing a digital document, or performing basic troubleshooting on an online platform. As Vlachopoulos & Makri (2024) suggest, authentic assessments that simulate real-world problems are more likely to reflect students' true abilities in digital environments. This approach ensures that students not only demonstrate theoretical knowledge but also practical problem-solving skills that are critical for success in distance education.

A key consideration was to ensure fairness and accessibility. With this in mind, the test and the questionnaire were designed to accommodate the fact that there were students with different levels of experience, and clear and concise language was used. The instruments were accessible on different devices, including desktops, tablets, and smartphones.

3.4 Questions and Tasks

As we have already seen, the assessment of digital competence in distance higher education requires a robust and multidimensional approach, grounded in established frameworks such as DigCompEdu (Redecker, 2017) and informed by validated assessment models like those employed by the Portugal Digital Academy. A comprehensive evaluation should encompass both self-reported competencies and performance-based tasks, ensuring a holistic measurement of students' digital skills. This dual approach captures not only learners' perceived abilities but also their practical application of digital competencies in authentic educational contexts.

Based on the Dynamic Reference Framework of Digital Competence for Portugal - QDRCD and the tests prepared by the Portugal Digital Academy, the test in focus in this article includes four levels of proficiency: Basic; Intermediate; Advanced and Highly Specialised, with the different digital competencies grouped into five areas: Information Literacy; Communication and Citizenship; Content Creation; Security and Privacy and Solution Development.

The test consists of 80 questions, grouped into the five areas of competences, which seek to understand how distance higher education students search, filter and evaluate information (and how they store and retrieve it); how they interact and collaborate through digital technologies, how they share information and content and how they approach the issue of citizenship through digital technologies; how they produce digital content, the issues of integration, reworking and copyright and licences; how they protect devices, personal data, health and the environment; and how they solve technical problems, innovate and use technology creatively, and identify gaps in digital competence.

The 80 questions cover topics such as basic computer operations, internet safety, online communication, and the use of productivity tools like word processors and spreadsheets. They were designed to evaluate both theoretical knowledge and practical abilities and, for that, they include multiple-choice questions, scenario-based tasks, and interactive simulations.

On the other hand, to effectively assess info-communication competencies in distance higher education students, a diagnostic questionnaire was used, in which students reflect on and declare their own competences through self-assessment Likert-scale items.

A total of 27 phrases referring to info-communication behaviours were drawn up, and for each one the students had to tick the option that best reflected their ease/difficulty in adopting the attitudes. The scale used was as follows: 1 - Extremely difficult, 2 - Partly difficult, 3 - I don't usually do this /I don't worry about it, 4 - Partly easy, 5 - Extremely easy. The last 17 sentences referred to the benefits of using the Internet for learning. For each of them, students had to tick the option that best reflected their response using the scale: Never/Rarely or 1 to 2 out of 10 times /Sometimes or 3 to 5 out of 10 times /Often or 6 to 8 out of 10 times/ (Almost) Always or 9 to 10 out of 10 times.

The first dimension, Information and Communication in Contemporary Times, was assessed through the examination of students' awareness of digital transformation and their ability to adapt to evolving info-communication technologies. The Sources, Research, and Selection of Information dimension involve the awarness of students' ability to identify credible sources and conduct effective online research. For the Comprehension, Organization, and Synthesis of Information dimension, the questionnaire included items to measure students' ability to process and integrate information from multiple sources. The Critical Evaluation of Information dimension focused on assessing analytical skills through items like "Distinguish between opinions and facts, recognising that values and beliefs are associated with information" or "Evaluate the correctness and veracity of the information".

The questionnaire also evaluated productive competencies through dimensions such as Production of Content and Intellectual Property, Copyright, and Plagiarism. Likert items for content production included "Choosing the best format for presenting information to best express an idea" or "Establishing links between dispersed information (such as the creation of hypertexts)". For ethical considerations, items like "Properly reference all sources of information used, such as images, videos and resources only available online" or "Use licences such as Creative Commons, GPL, MIT, Mozila or others in order to use the information legally" tested students' understanding of copyright rules and plagiarism avoidance. The Communication dimension assessed both written and digital communication skills through items evaluating clarity, appropriateness for different audiences, and netiquette awareness. These productive and ethical dimensions reflect Borges' emphasis on responsible participation in digital information ecosystems.

Finally, the questionnaire addressed collaborative and metacognitive dimensions including Participation in Collaborative Media Environments, Privacy and Ethics in Communication, and Lifelong Learning and Metaliteracy. Items evaluated students' comfort with collaborative tools and their awareness of privacy concerns. The lifelong learning dimension assessed students' metacognitive awareness through items like "Recognise your weaknesses and potential in terms of information and communication

competencies, and strengthen them based on the results of this self-assessment". The Learning and Internet dimension of the questionnaire, and within the framework of the courses attended by the students, focused on self-perceived competencies in managing information, collaborating online, and leveraging the internet for problem-solving and creativity.

4 Discussion

The methodological work being carried out as part of this ongoing research emphasises the importance of a mixed approach to assessing digital and infocommunication skills in higher education, combining objective performance-based tests with self-assessment questionnaires. The digital literacy test, based on frameworks such as DigComp and the Portuguese QDRCD, sought to work with the varying levels of proficiency among students in key dimensions - Information Literacy, Communication and Citizenship, Content Creation, Security and Privacy, and Solution Development. The questionnaire, based on Borges' framework (2018), sought to emphasise the importance of students' self-perceived competencies.

The mixed-methods approach of this study seeks to respond to a critical gap in the literature by integrating theoretical and practical assessments, offering a more holistic evaluation than standardised tests or isolated self-reports. Compared to previous research, this work emphasises the need for specific adaptations of global frameworks to specific contexts in order to meet educational demands. However, the fact that the study is based on a single higher education context limits generalisability, suggesting the need for broader empirical validation in diverse institutions and cultures.

Future research should explore longitudinal designs to track competence development over time and investigate the role of pedagogical interventions in bridging identified gaps. Additionally, expanding the assessment to include qualitative methods, such as interviews or observational studies, could provide deeper insights into students' digital and info-communication practices. The evolving nature of digital technologies also necessitates periodic updates to assessment tools to reflect emerging competencies, such as AI literacy or data ethics. By addressing these gaps, future studies can further refine frameworks and methodologies, ensuring they remain relevant in rapidly changing educational and professional landscapes. This study advances the discourse on digital literacy and info-communication assessment while underscoring the imperative for continuous innovation in measurement tools and pedagogical strategies.

5 Conclusion

This study highlights the necessity of comprehensive and adaptable approaches to evaluating digital and info-communication competencies in higher education. By integrating performance-based assessments with self-report questionnaires, the research (and when the instruments are applied) provides a dual perspective on students' abilities, revealing both their practical skills and self-awareness in digital environments.

The study's blended methodology, rooted in established frameworks like DigComp and Borges' model, offers a replicable model for other institutions seeking to assess

and enhance digital competencies. More assertive and pragmatic conclusions can be drawn when evaluating the answers to the test and the questionnaire. However, we can already deduce that its broader applicability requires further validation across diverse educational and cultural contexts. Additionally, the rapid advancement of digital technologies demands continuous updates to assessment tools to include emerging areas such as artificial intelligence, data privacy, and digital well-being.

To ensure that higher education remains responsive to these changes, the following actions can be recommended:

- Institutional collaboration: universities should work together to standardize assessment tools while allowing for contextual adaptations, ensuring consistency and relevance across different settings;

- Curriculum enhancement: digital literacy and info-communication competencies should be embedded across disciplines, with a focus on fostering critical thinking, ethical reasoning, and adaptability in digital spaces;

- Lifelong learning initiatives: institutions should promote ongoing professional development for educators and students alike, preparing them to navigate and leverage new technologies effectively.

Ultimately, this study reinforces the pivotal role of higher education in equipping students with the digital and info-communication competencies needed for academic, professional, and civic success in an increasingly digital world. By adopting innovative assessment methods and prioritizing continuous learning, universities can better prepare graduates to thrive in a dynamic and technology-driven society.

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Application of a Pedagogical Tool for the Construction of Differential Robots

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Abstract. This research describes the experience of a pilot test applied to the instruction of a technological-pedagogical tool developed in Moodle so that high school students could learn to build competition robots under the guidance of university students. They carried out the community engagement work with 11 selected students from a public school in Ecuador, for which they provided the materials for its development. The methodological process was structured in seven phases: identification of needs through interviews with teachers and robotics club coordinators; comparative analysis of free educational platforms (Moodle, Chamilo, WordPress, Google Classroom) using a modified Likert scale; design of pedagogical guides using the PACIE methodology, integrating audio-visual resources, simulations and practical activities; implementation of the tool in Moodle, adapting the flipped classroom model; application of pilot tests with university and high school students, where the former acted as facilitators; and analysis of results through cognitive, attitudinal and academic performance metrics, complemented with qualitative feedback. The main finding was that the tool facilitates autonomous and collaborative learning, improves motivation, and promotes skill acquisition. Students were able to program microcontrollers, build differential robots, and apply them in a course. It is concluded that the integration of open platforms and active methodologies in the teaching of differential robotics is viable, replicable, and favors curricular updating.

Keywords: differential robots · techno-pedagogical tool · microcontrollers · education · Moodle

1 Introduction

According to Foreman et al. [1] robotics is a disruptive technology that is part of the fourth industrial revolution; the different edges that this area can take addresses structure, application and movility.

Within the structure and shape we have polyarticulated robots [2], mobile [3], androids [4], zoomorphic [5], hybrids [6].

Applications category are industrial [7], medical [8], service [9], agricultural [10], disaster [11] robots.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 135–146, 2025.
https://doi.org/10.1007/978-3-032-09080-5_14

There are also those that are classified by mobility as: terrestrial, aerial, aquatic, subterranean.

Within the aforementioned, differential robotics is part of the subclassification of mobile robotic structure and form, characterized by the use of two wheels to move in various directions, such as domestic robots and research robots like the Khepera [12–14].

Also included in this subcategory are standard mobility differentials, traction differentials, track differentials, and tracked differentials.

The advantages of this category include structural simplicity since it is easy to program and control, maneuverability that makes it useful for small spaces, and versatility since it can be adapted to industrial, domestic, agricultural, and agricultural applications.

2 Bibliographic Review

At a global level, statistics show a 61% growth until 2028 in turnover considering data from 2023 of the world robotics market surpassed 40.7 billion US dollars [15], which allows inferring that in the labor field professional careers related to this area will have great opportunity for growth.

For this reason, several studies suggest the need to promote this learning in order to satisfy the supply of talent and enable students to have the skills for future employment [1]; as well as attempts to modify curricula in countries such as Colombia [16].

While others, such as the e-Yantra project born in 2012, focus on improving computational thinking or the development of complex engineering skills including the use of gamification, present challenges based on the real world and universities and polytechnics participate; they start with 34500 students in 2019, for example the so-called "Rapid Rescuer" that had integrated challenges with elements of image processing, algorithm construction, wireless communication, building a robot, programming in C, among others [17].

Then there is the doctoral work framed in educational robotics as the initial phase of a proposal for a curricular approach to computational thinking skills for primary education, developing a MOOC for teachers with the state of the art in computational thinking in order to include programming and robotics in educational curricula [18].

On the other hand, in a research that addresses gender and STEAM suggests the use of courses in open platforms as is the case of Open edX, with the open course Educational Robotics provides so that anyone who wants to update can opt for this option [19]; as well as they have been able to include in the university, secondary and school level in Poland, Italy, Romania, Turkey and Greece thanks to the project for a sustainable future-Green Edu that was funded by Erasmus; this works with micro-MOOC with STEM laboratories [20].

Another interesting work is the review of educational material related to robotics at different levels, including: videos, podcasts, coding tools [21].

The interest in this topic and the need for the workforce to be updated, led to the development of an intelligent mobile system based on Android and then a web system based on Django; with the purpose of providing learning advice called iCoursePlanner to provide course recommendations from known platforms such as EdX, Coursera, or Bradley University; whose recommendations are focused on courses in robotics and data

analysis, industrial engineering and manufacturing; also has the option to expand other recommendations after feeding the database; presents architecture of the learning advice system [22].

For the years 2017 and 2018 the e-Yantra project MOOC was applied to 1600 participants through a robotics competition unlike the one that started in 2012, students received guidance to solve modeling problems concluding that when the MOOC is conceptually difficult they had a '2.75' times higher completion rate compared to easier MOOCs, as well as inferring that it is better to teach to solve "one challenging problem" than to teach to solve a series of easy problems [23].

Foreman (2022) suggests the use of MOOCs with competency- and outcome-based learning, for which he discusses disruptive technologies, online competency-based approaches, and the form of inclusion in the university setting [1].

In 2023, in Portugal, they include preschool through the NAU platform for the development of the Technology, Programming and Robotics Learning Laboratory project, which has a combined learning model with theoretical-pedagogical and online interaction models; a pilot test was applied with an intentional sample and a validation was carried out with a Likert scale survey of open questions [24].

In 2024, they present a work considering control systems based on ROS Robotics Operating System, MOOL tools which are open online laboratories and MOOC massive open courses, which allowed the inclusion of the robotics educational program microROS micro robot operating system for the control of a self-made robotic arm of 4° of freedom, with RViz visualization and Movelt Framework for motion planning; in addition to presenting the analysis and educational advantages of this area [25].

In the same year, they applied a MOOC course translated into 4 languages, developed as part of a collaborative European project focused on social welfare theft with artificial intelligence that included knowledge about the functionality of social welfare, operability, legal, ethical and human rights aspects. The modules covered awareness, knowledge, sensitivity, competency [26].

Also, we have the construction and validation of an educational proposal of a didactic for the inclusion of educational robotics for secondary education in public schools in Bogota based on the existence of a conceptual vacuum without a didactic of teaching for this field since it is worked with methodologies from other areas of knowledge such as Design Thinking, Stem, industrial engineering, problem-based learning, focused on the medical area [16].

3 Methodology

In this project, mixed research was applied: the techniques of qualitative and quantitative analysis for the development, implementation and evaluation of a pedagogical tool; it constitutes an applied and exploratory study, composed of pedagogical design and educational intervention in a real learning environment where the pilot was applied with high school students under the tutelage of higher education students of the Electronics and Automation career who were doing a work of linkage with society.

The bibliographic review was taken from recognized academic databases such as Scopus, Google Scholar and Scielo with the purpose of identifying relevant background

on the use of pedagogical tools in the field of educational robotics, as well as criteria for the selection of open source technology platforms.

In the analysis and selection of technological platforms, we worked with popular free systems in the educational field, prioritizing those with greater penetration in Spanish-speaking and Latin American environments. The Moodle, Chamilo and WordPress platforms were selected and evaluated using a modified Likert scale for ordinal classification, with both qualitative and quantitative criteria [26, 27]. This evaluation made it possible to identify the most appropriate platform for implementing the pedagogical tool in diverse educational contexts.

Seven phases were considered in the organization of this project, which are detailed in Fig. 1.

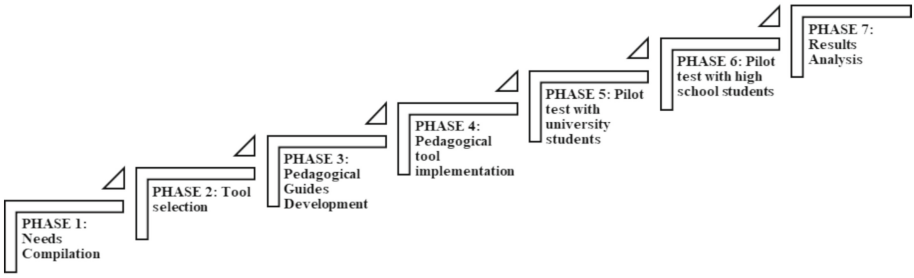

Fig. 1. Implementation Phases

Phase 1: Needs compilation, a survey of information was conducted through interviews to discover the main pedagogical and technical needs in the teaching of robotics; which were applied to two professors in the area of electronics and automation and to the Coordinator of the Robotics Club of the Universidad Tecnológica Israel de Ecuador.

Phase 2: Tool selection, preparation of a comparative analysis matrix to compare different free software platforms based on criteria of usability, pedagogical adaptability, accessibility and technical compatibility (see Table 1).

Phase 3: Pedagogical Guides Development, structured instructional guides were designed, oriented to facilitate the process of autonomous and collaborative learning in the construction of differential robots. These guides included graphic resources, simulations and step-by-step practices with the following content: Introduction to Robotics, Introduction to programming and component selection, mini sumo RC programming, Mini sumo RC robot assembly, Functional tests, Final competition.

Phase 4: Pedagogical Tool Implementation of the, the tool was implemented in Moodle with a PACIE structure.

Phase 5: Pilot test with university students, this test was applied to 8 university students as training so that they can make links with society, in addition to validating the guidelines and the functionality of the tool.

Phase 6: Pilot test with high school students, this test was applied to 11 students of the Unidad Educativa Fiscal Pichincha where university students, previously trained, acted as facilitators in the implementation of the tool with high school students, also promoting the link with society and the development of social and communicative skills.

Table 1. Grading Scale

Scale	Value	Acronym	Description
Very High	5	VH	The platform far exceeds expectations or requirements in this indicator.
High	4	H	The platform meets the requirements of the indicator in an outstanding manner.
Medium	3	M	The platform complies acceptably with the requirements but has room for improvement.
Low	2	L	The platform does not fully comply with the requirements or has significant limitations
Very Low	1	VL	The platform does not meet any requirements or has significant limitations.

Phase 7: Analysis of results, data obtained during the pilot phases were collected and analyzed. The analysis included cognitive, attitudinal and end-product academic performance metrics, qualitative feedback from participants.

4 Results

4.1 Phase 1: Needs Compilation Results

The interviews allowed gathering information about the lack of knowledge of the students about the applicability, implementation, development and programming of differential robots; as well as the need to reinforce the knowledge of microcontroller programming; on the other hand, the constitution of the Robotics Club in the institution required attracting members to represent in competitions with other institutions and at the same time make links with society in secondary education entities.

4.2 Phase 2: Technological Platforms Comparison

For the analysis of platforms, free use platforms of wide penetration in the local Latin American environment such as Moodle, Chamilo, Google Classroom and WordPress [27] were selected, taking into account a modified Likert scale for ordinal classification, both for qualitative and quantitative criteria [28] (see Table 2).

The table above shows a qualitative analysis in relation to the indicators and e-learning platform. However, in order to have an accurate understanding of the results, it is necessary to have quantitative results in order to obtain results in an objective and numerical way.

The quantitative results show that the Moodle platform complies satisfactorily with the indicators established for the comparative analysis.

Table 2. Qualitative comparison of platforms

Platform	Usability	Documentation	Support	Adaptability	Flexibility
Moodle	VH	VH	VH	VH	VH
Chamilo	H	H	H	VH	M
WordPress	H	M	M	VH	H
Google Classroom	H	L	M	VH	M

Table 3. Quantitative comparison

Platform	Usability	Documentation	Support	Adaptability	Flexibility
Moodle	5	5	5	5	5
Chamilo	4	4	3	5	3
WordPress	4	3	3	5	4
Google Classroom	4	2	3	5	3

4.3 Phase 3: Development of Pedagogical Guides

Structured instructional guides were designed to facilitate the process of autonomous and collaborative learning in the construction of differential robots. For this purpose, the PACIE methodology was used, which includes the following stages: Presence, Outreach, Training, Interaction, and E-learning: Presence, Outreach, Training, Interaction, and E-learning [29], constituting a techno pedagogical approach that allows the creation of meaningful virtual environments. The guides include audiovisual resources, simulations, and step-by-step practices, all in a scheme of interrelated capsules with a short execution time.

For each of the units, a set of pedagogical blocks will be defined that will group the material as follows:

Academic block: Includes general information about the title of the unit, its contents and objectives.

Prior knowledge: Set of audiovisual elements that are required as a basis for understanding the subject matter of the unit.

Individual learning: Autonomous learning activities, of individual realization and evaluation.

Collaborative learning: Group access and development activities that allow collaboration and exchange of information and ideas.

Classroom learning: If synchronous or asynchronous classes are applied, the necessary material will be included, as well as recordings of classes given, or specific tutorials.

Evaluation: Activities evaluated, either automatically or by tutor review, are included as inputs for quantitative and qualitative review of results.

4.4 Phase 4: Implementation of the Pedagogical Tool

The implementation was carried out in Moodle as an e-learning platform, also considering the option of hybrid work in face-to-face and blended learning. The modules were designed to adapt to the inverted classroom methodology, so that their structure favors active and collaborative learning, as well as the responsible autonomy of the participants.

In the implementation carried out, and in order to integrate the inverted classroom with the PACIE model, the Presence component is presented through the constant availability of the teacher and the presentation of introductory resources; Scope is ensured by guiding the student on the objectives and materials to be reviewed before the synchronous sessions; Capability is developed through practical and self-assessment activities that allow the application of previous knowledge; Interaction is enhanced through forums, chats and live classes dedicated to solve doubts, discuss cases or work in groups, thus reserving synchronous time for application and not for theoretical exposition; finally, E-learning guarantees a technologically integrated environment where the student's progress can be tracked and continuous feedback can be provided.

4.5 Phase 5: Results of the Pilot Test of the Technology Tool with University Students

It was applied to ten university students and lasted 5 weeks with two-hour meetings per session and three hours of autonomous activities, for a total of 25 h. To conclude the course, the students built a differential robot, after which, to evaluate their performance, they had a competition with meetings in 5 groups of two participants, classifying the winners of each group. In the second stage of the competition they were all against all and qualified the first four, where they played the semifinals and then the finals.

4.6 Phase 6: Results of the Pilot test with High school students

This test was applied to 11 students with no previous knowledge of robotics and programming from the Unidad Educativa Fiscal Pichincha who had no previous knowledge of the subject; due to this particularity, the first two meetings were intended for students to acquire the aforementioned knowledge as well as the basic rules of competencies in the mini-sumo category.

4.7 Phase 7: Global Results Analysis

To evaluate cognitive performance, basic robotics concepts, understanding of the tools and the moodle environment, the ability to interpret electronic diagrams and schematics, and the implementation of specific firmware for the operation of the robot were evaluated.

In the attitudinal and socioemotional performance the evaluated criteria involve: teamwork, correction of failures in the robot hardware, in the implementation of firmware, self-evaluation capacity, participation in the moodle platform with regard to forums, questionnaires, tasks.

The last criterion evaluated was the performance and functionality of the differential robot implemented by the students, presentation of the robot, performance in the final event of the course.

The parameters used to determine the performance and efficiency of the differential robots built are detailed below.

It was possible to obtain an optimal performance with Bluetooth technology for wireless control of the robots, with a distance of 5 m line of sight, which decreases when there are walls or metal structures, which concludes that for optimal performance of the robot the environment of competition with obstacles would cause a decrease in the distance of control of the differential robot.

In the tests, the response time to the commands sent through a cellular application was close to 200 ms, being a low latency allowing an adequate performance in the development of the combats.

Simulated combat 80% of the tests the differential robots succeeded in pushing their opponent out of the dohyo, which helped them to improve their combat strategies.

Regarding the experience of the course, the majority of students indicated that they obtained new tools that complement their knowledge in the field of electronics, by learning in an innovative environment and allowing them to collaborate closely with people passionate about technology, improve the criteria for design and construction of differential robots, with the expectation of testing the performance upon completion of its implementation..

5 Discussion

This research from a design point of view helps to articulate methodological stages that respond to specific educational problems: such as the lack of knowledge of students about programming microcontrollers in differential robots, low extracurricular robotics activities, and the absence of pedagogically significant virtual environments in secondary education. The planning, structured in three phases: diagnosis, selection of the technological tool and design of learning guides, reflects an approach consistent with contemporary models such as PACIE [29] and effective practices of technology integration in STEM education.

In the diagnostic stage, the use of semi-structured interviews made it possible to determine gaps in the academic training of students, which coincides with previous studies in Latin America where the lack of conceptual and technical mastery of adolescents with respect to applied robotics was noted [16, 18]. The identification of these needs was fundamental to guide the development of pertinent pedagogical resources aligned with the expected competencies, reinforcing the results-based training approach suggested by Foreman (2022) [15].

When comparing similar platforms, the qualitative and quantitative analysis under an adapted Likert scale made it possible to justify the choice of the moodle platform as the virtual teaching environment. This methodological decision is based not only on its high score in usability, support and adaptability, but also on its ability to integrate multimedia resources, continuous assessment, and learning monitoring, as evidenced in successful experiences such as the e-Yantra MOOC [17, 23] and the NAU project in Portugal [24]. Unlike platforms such as Google Classroom or WordPress, Moodle offered greater versatility to implement the PACIE model and articulate it with the project components of the method.

The development of the guide is one of the most significant contributions of the project, as it adapts robotics technical contents to an accessible asynchronous environment, structured by pedagogical blocks with audiovisual didactic resources, individual and collaborative activities and automated evaluation spaces. This methodological design responds to the principles of meaningful learning, interaction and autonomy, and represents an advance over other proposals that prioritize only the transfer of knowledge or individual work with simulators [21, 25].

In the data collection and analysis technique, a robust methodological triangulation was applied: structured pre- and post-intervention questionnaires to assess the impact on knowledge and perceptions; performance rubrics that allowed assessing the achievement in the construction of the differential robot; and non-participant observation during the practical sessions, which provided complementary qualitative evidence. The use of inferential statistical analysis made it possible to identify significant improvements in academic performance after the intervention, aligning with what was reported by research such as MOOC e-Yantra (2017–2018) [23], where the level of challenge and pedagogical structure were key factors for a higher completion rate.

For a second phase of the project, it is advisable to seek funding to be applied in other public schools in Ecuador in order to contribute to the cognitive development of students, as well as to the reduction of the technological gap.

6 Conclusions

This tool was very well accepted by the students who applied for the pilot test, since in both cases 100% of the students finished the course, demonstrating that they were able to improve and strengthen their knowledge by following the course with the implementation of differential robots.

Overall, the methodology applied not only validated the effectiveness of the use of Moodle as a pedagogical tool for the development of differential robotics projects in adolescents, but also laid the groundwork for future sustainable curriculum integration, replicable and adaptable to other similar educational contexts.

The implementation of the design method, with the inclusion of the Moodle platform, strengthens active learning, the fusion of theoretical and practical knowledge and the acquisition of technical skills in differential robots, allowing high school students to strengthen their skills in electronics, programming and problem solving.

It was evidenced that the moodle platform is a more robust pedagogical tool than (Wordpress, Google classroom, among others) by providing greater ease of use, more adaptable and provides monitoring tools in terms of learning, allowing to concentrate collaborative activities, evaluations and others, allowing students to have a continuous, solid and structured learning experience.

The implementation of instruction guides under the PACIE guidelines allows for autonomous, collaborative and distributed learning by showing the contents of the organized sessions, continuous and progressive evaluations as well as the complement of the classes with audiovisual materials, which helped to promote a greater retention of knowledge to the students during the development of a differential robot.

The quantitative results based on questionnaires before and after the work sessions, evaluation rubrics and systematic observation, provide a significant improvement in the reception of knowledge by the students when applying the proposed methodology.

Communication, teamwork, complemented with technical competencies is an alternative and integral pedagogical proposal in accordance with the demands of the 21st century, and it guides students in their training for the fourth industrial revolution.

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How to Learn About Social Media Through Digital Science Fiction Narratives: The Case of Black Mirror's Nosedive Episode

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Abstract. Digital narratives have proven to be innovative pedagogical tools to foster critical thinking in education. This study analyzes the episode Nosedive of the Black Mirror series, exploring its potential as an educational resource to reflect on the impact of social networks. The objective is to analyze the use of digital science fiction narratives, taking the episode Nosedive of Black Mirror as a case study, to evaluate its potential as a pedagogical tool in critical reflection on the impact of social networks on young people. The methodology is an empirical, qualitative and analytical analysis, including non-participant observation and content analysis, breaking down the narrative elements into key thematic categories, such as the ecosystem of social validation, construction of digital identity, psychological impact of overexposure, technology as a tool of exclusion and human relations mediated by algorithms. The results highlight that the episode allows to open debates on the ethics and risks of social networks, fostering a deep and reflective understanding in students. In conclusion, this study demonstrates the effectiveness of digital science fiction narratives as educational tools that integrate technology and critical pedagogy, promoting meaningful learning and ethical questioning.

Keywords: Digital narratives · Science fiction · education · social networks

1 Introduction

Digital narratives have acquired a significant role in contemporary education, especially in a global context characterized by digitalization and the integration of emerging technologies. Some digital narratives offer opportunities for critical analysis and reflection on ethical, social, and technological issues [1].

In this research, the use of a digital narrative belonging to the science fiction genre is used. Science fiction is a narrative genre that tells stories that take place in hypothetical and alternative futures, in present or future societies [2, 3, 4]. In academia, science fiction has been used for the teaching of various disciplines, such as physics, ethics, and computer science, allowing for a more dynamic and contextualized understanding of knowledge [5, 6]. In this context, the Nosedive episode of the Black Mirror series stands out for its ability to critically illustrate the dynamics of digitized societies and their dependence on social networks.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 147–155, 2025.
https://doi.org/10.1007/978-3-032-09080-5_15

The present study has the following research question: How can digital science fiction narratives, specifically the Black Mirror episode Nosedive, be used as pedagogical tools to encourage critical thinking and reflection on the impact of social media on young people?

The aim of the research is to analyse the use of digital science fiction narratives, taking the episode Nosedive of Black Mirror as a case study, to assess its potential as a pedagogical tool in critical reflection on the impact of social networks on young people.

This study has a qualitative approach, with an empirical and analytical design, focused on non-participant observation and content analysis. The research is based on the episode Nosedive of Black Mirror as a case study, examining the narrative and thematic elements present in the work. Categories of analysis are developed to break down the aspects of the episode, allowing a detailed organization of the ethical, social and technological problems addressed. This methodology seeks to combine rigorous observation with a reflective approach, aimed at promoting critical thinking and constructive debate in the educational field.

1.1 Black Mirror and Nosedive

The episode "Nosedive" is from the British television series Black Mirror, created and co-written by Charlie Brooker. [7].

Black Mirror is a science fiction series that critically addresses various issues of contemporary society through standalone episodes [8]. It has six seasons and a TV movie and has won numerous awards, including six Emmy Awards.

Through stand-alone episodes, the series explores topics related to mass surveillance, artificial intelligence, digitalization, and automation in everyday life [7]. The title, Black Mirror, is associated with the unlit screens of technological devices, which offer a dark and distorted reflection of reality [9]. This symbolism underscores the central criticism of the series: although technology has the potential to improve the quality of life, its inappropriate use or for domination purposes can lead to serious social impacts [10].

The episode Nosedive offers a critical reflection on contemporary reliance on social media and the search for approval online [11]. In an educational context, these problems are significant for young people, who are in constant interaction with this type of digital platform.

1.2 Young People and Social Networks

The growth in the use of social networks continues to increase globally. 62.6% of the world's population uses social media, which equates to 5.07 billion users, of which 259 million joined in 2024 [11]. In addition, 94.2% of Internet users have an identity on social networks [11]. On average, people of all ages spend 2 h and 20 min a day interacting on social media [11].

The highest social media penetration rates are recorded in Northern and Western Europe, at 79-80%, followed by East Asia at 75% and North America at 71% [12]. In South America, this figure reaches 68%, while the West Africa and Central and Eastern Africa regions have considerably lower rates of 16% and 10%, respectively [12].

En Estados Unidos, los Millennials (28-43 años) son el grupo más representado, acumulando 68,8 millones de usuarios, seguidos de la Generación Z (12-27 años), con 60,7 millones [13]. Estas cifras ponen de manifiesto la relevancia de las generaciones jóvenes en el uso de estas plataformas digitales.

Several researchers agree that excessive social media use among young people has significant implications for their psychological, social, and physical development [14, 15]. Adolescents are vulnerable to problems such as cyberaddiction, distortions in interpersonal relationships, and inappropriate behaviors stemming from anonymity and misrepresentation of identity [14]. In addition, these platforms encourage exhibitionism and deception, which negatively affects their ability to establish genuine relationships [14]. On the other hand, excessive use of social media can contribute to problems such as insomnia, anxiety, stress, and a decline in academic performance, underscoring its impact on students' overall well-being [15].

Other researchers identify negative effects related to mental health, such as depression, low self-esteem, and difficulties managing emotions [15]. The prolonged use of social networks is linked to the appearance of sleep disorders and symptoms of social isolation and digital dependence, generating anxiety and limitations in personal communicative development [16]. These problems are aggravated in contexts of cyberbullying, which increases the likelihood of depressive behaviors and, in extreme cases, self-injurious tendencies [17].

These consequences must be addressed through education, promoting a critical and thoughtful use of social networks to mitigate their negative effects [14]. For this reason, digital science fiction narratives such as the case of the episode Nosidive can be valuable tools for achieving this reflective thinking.

2 Materials and Methods

The present study follows a qualitative approach, with an empirical and analytical design, based on non-participant observation and a detailed content analysis. This method allows for an in-depth examination of digital narratives, identifying key elements without the direct intervention of the researcher in the development of the observed events. [17]. This approach is particularly useful in research focused on audiovisual narratives, as it facilitates a broader understanding of the underlying social and technological issues [18].

In the case of this research, the episode Nosedive of the series Black Mirror was analyzed. The episode presents a dystopian society in which everyday life is governed by a social scoring system based on digital interactions. The protagonist, Lacie, strives to improve her rating to achieve certain social privileges, but her obsession with appearances and digital validation leads her into a spiral of unexpected consequences.

Based on the above, the established categories are:

1. Social Validation Ecosystems: Examines how social networks establish a reward system based on external validation. Compulsive social media use is closely related to the need for external validation, especially in individuals with high levels of narcissism or low self-esteem [19].

2. Construction of digital identity: Analyzes how individuals project an idealized version of themselves on digital platforms. Social networks, such as Facebook, foster distorted perceptions about the lives of others, due to the tendency of users to project idealized versions of themselves [20]. This phenomenon, when comparing these representations with personal reality, can intensify feelings of dissatisfaction and decrease emotional well-being [21].
3. Psychological impact of overexposure: Reflect on the emotional and mental consequences of constant use of social networks. Heavy social media use is associated with higher levels of depression, anxiety, and psychological distress in adolescents, highlighting the negative impact of overexposure to digital content [22].
4. Technology as a tool for exclusion: Explores how digital platforms can generate dynamics of exclusion and social discrimination. The algorithms and metrics used by digital platforms can reinforce prejudices, generate exclusionary dynamics and discriminate against certain groups, based on superficial or biased values and parameters [22].
5. Human relations mediated by algorithms: It addresses how social interaction on networks is influenced by algorithms that prioritize certain content. These algorithms prioritize certain types of content, based on commercial values or inherent biases, that can shape social relationships by limiting exposure to diverse perspectives and reinforcing pre-existing dynamics of power and inequality [23].

This analysis seeks to generate in students a critical reflection on the challenges and implications of social networks.

3 Analysis and Discussion

Next, the episode Nosedive of the Black Mirror series is analyzed according to the established categories.

The first category is social validation ecosystems. In the episode Nosedive it is depicted that the story takes place in a dystopian society where people's lives are governed by a social scoring system based on ratings given by others [7]. This is evident from the beginning, when Lacie interacts with a barista in a coffee shop and, after receiving her coffee, makes an effort to leave a positive rating and get an approving smile in return [7].

This aspect of the plot illustrates how social media, like the scoring system in the episode, can encourage external validation.

External validation on social media is an important issue. These platforms, by relying on interaction systems that reward likes, comments, and other visible metrics, foster an emotional dependence on other users' opinions and ratings [19]. This reinforcement mechanism can intensify addictive behaviors, as users constantly seek social approval as a form of emotional regulation and reinforcement of their self-concept. It has therefore become a central aspect of digital interaction, significantly influencing the construction of user identity and behavior [23]. This fuels the need for constant approval [23, 24].

This category allows us to reflect on the mechanisms of social networks. An activity can be carried out with the students to review the social networks and the validation system and reflect on the importance they give to the assessment of their image on social

networks. In this way, we encourage a thoughtful and critical use of social media [23, 24].

The second category is the construction of digital identity. In the episode, Nosedive manifests through Lacie's efforts to project an idealized image of herself into a system obsessed with social appearance. In this society, the ratings given by others not only determine a person's social status, but also their access to essential opportunities and services, such as housing or flights [7].

Lacie tailors her behavior, language, and decisions to what she finds acceptable and attractive to her social network. For example, he desperately seeks the approval of Naomi, a former friend with a high rating, to earn points through his association with her [7]. This leads her to go to extremes, such as a carefully rehearsed speech to fit into the lavish setting of Naomi's wedding [7]. However, this artificial construction of her identity falls apart when she is faced with rejection and criticism, showing the disconnect between her true self and the image she is trying to project.

This aspect allows us to reflect on how social networks can affect the identity of people, and especially adolescents.

Social networks can negatively influence the construction of identity in adolescence [15, 16]. Adolescents, being highly susceptible to social feedback, tend to adapt their behavior and posts to align with perceived standards, which can lead to a loss of authenticity and personal freedom [16]. In addition, anonymity and lack of empathy in online interactions increase the likelihood of cyberbullying, which severely affects young people's mental and emotional health [15].

This category allows you to carry out activities that promote a conscious and balanced use of social networks. Teachers can create digital resources to accompany parents and families in fulfilling this purpose. For example, the Mídete campaign, promoted by UNICEF Cuba, promotes the responsible use of social networks, emphasizing the creation of safe and violence-free digital environments for the integral development of children and adolescents [25]. Recognizing the growing role of digital technologies in everyday life, the initiative offers resources for parents and family members to support young people in the challenges associated with the use of digital devices, networking platforms, and games [25]. The aim is to encourage children to have the necessary skills to function fully in these environments, ensuring their protection and that of other users [25].

The third category refers to the psychological impact of overexposure. In the episode, Nosedive is reflected in what Lacie faces: the emotional consequences of living in a society where every interaction is publicly evaluated and stored. This constant scrutiny generates in the protagonist a growing anxiety to maintain a high grade, which leads her to experience an emotional breakdown when her score begins to drop.

A key moment occurs when Lacie desperately tries to recover points after a series of unfortunate events. As your rating drops, you not only lose social and material privileges, but also your sense of emotional stability [7]. The pressure to please and avoid negative criticism leads her to irrational behaviors, including angry outbursts in public that further aggravate her situation.

This category allows us to illustrate how constant exposure to the judgment of others can amplify issues such as anxiety, stress, and low self-esteem.

Heavy social media use among young people has shown significant impacts on their mental and emotional health [15, 21]. Issues such as anxiety, depression, and low self-esteem are linked to addiction to these platforms, while exposure to unrealistic standards reinforces body dissatisfaction and feelings of isolation [16, 26]. This effect is amplified by limited interaction in real environments, affecting their social and family relationships [26]. However, the impact of social media can be mixed [27]. During the pandemic, while stress and anxiety increased, platforms also facilitated emotional support and a sense of community among users [27]. This highlights the importance of conscious and critical use to minimise risks and enhance benefits in young people [27].

In an educational context, this narrative opens up the possibility of having a discussion with students about how social media, by encouraging constant exposure and social comparison, can affect the mental health of users, particularly in young people, who are more vulnerable to these dynamics.

The fourth category is technology as a tool of exclusion. In the episode Nosidive, the social scoring system is depicted as establishing a mechanism of segregation based on digital ratings. In this future world, people with higher scores enjoy important privileges, such as access to better housing, exclusive services, and preferential treatment, while those with low scores are marginalized and excluded from essential aspects of everyday life [7].

An example in the plot is when Lacie, losing points due to a series of incidents, is unable to access basic services such as renting a car or a flight [7]. Her declining score not only limits her material choices, but also isolates her socially, as those around her avoid interacting with her for fear that her grade will be negatively affected [7].

The episode allows us to reflect on how social networks can reproduce these dynamics by classifying and segmenting users through algorithms that prioritize certain content or interactions.

Social media algorithms classify and segment users based on their interactions, prioritizing content designed to maximize their time on the platform [22]. This process favors the creation of filter bubbles by limiting access to various perspectives, affecting users' critical thinking [22]. In addition, algorithms prioritise polarising or sensationalist content, which can negatively influence the way young people access and process relevant information [26].

In an educational setting, this narrative can help make a discussion about the risks of allowing technologies designed to connect to end up dividing and excluding.

The fifth category is human relationships mediated by algorithms. In the episode Nosidive it is reflected in the way Lacie carefully selects the people she interacts with, looking for relationships that increase her score [7]. This is seen when he tries to reconnect with Naomi, whose high rating could improve his status [7]. However, these relationships, guided by algorithmic metrics and not by genuine affinity, are fragile and self-serving [7]. In addition, algorithms reinforce a dynamic in which the value of a relationship is measured by its impact on ratings, dehumanizing personal connections and prioritizing quantifiable results over emotional authenticity.

This narrative allows us to analyze how current social networks, through algorithms that prioritize specific interactions, shape human relationships by emphasizing metrics such as likes, shares, and comments [19], rather than fostering meaningful bonds.

In an educational context, a panel discussion can be organized with students to reflect on the risks of relying on algorithms to mediate our interactions and on the importance of preserving authenticity in human relationships.

4 Practical Pedagogical Applications

The results of the categories analysed can be used to plan and develop activities in the classroom.

In the first category, what is examined can be used to encourage collaborative work among students – for example, through brainstorming – with the aim of analysing the use of social networks, validation systems and reflecting on the importance they give to the valuation of their image in these spaces. In this way, critical and reflective thinking is promoted.

Regarding the second category, focused on the construction of digital identity, the findings can serve as an input for teachers to develop digital teaching materials that favor a conscious and balanced use of social networks, and that at the same time are useful for both students and parents.

In relation to the third category, referring to the psychological impact of overexposure, a debate can be organized with students on how social networks, by encouraging constant exposure and social comparison, can have a negative impact on the mental health of users.

Finally, the analyses corresponding to the fourth category – technology as a tool of exclusion – and the fifth – human relationships mediated by algorithms – allow us to propose a round table in which students reflect on the forms of exclusion that technology can generate, the risks of delegating our interactions to algorithms and the importance of preserving authenticity in human relationships.

Each of the activities promotes the student's reflection on their management and interaction on social networks, critical thinking and alertness to possible risks.

5 Conclusions

Nosedive's analysis allows us to understand how digital science fiction narratives can be used as educational tools to reflect on the impact of social networks on contemporary society. Topics such as social validation, the construction of digital identity, technological overexposure and human relations mediated by algorithms offer a critical framework for analysing the current dynamics of the digital environment. These narratives are useful for developing critical thinking skills in students, as they facilitate the connection between the problems presented in fiction and their own everyday experiences.

The episode shows how digital technologies, far from being neutral, can perpetuate dynamics of exclusion and social inequality when they are designed or used without ethical considerations.

Students, as the main users of digital platforms, need to develop competencies to identify the risks associated with these technologies and adopt responsible practices that allow them to navigate the digital world safely and consciously.

In this context, Nosedive is a relevant case study to discuss the technological and social implications and is a gateway to foster debates on the relationship between technology and humanity.

The integration of digital narratives in the classroom can enrich education by addressing contemporary issues and encouraging more active and critical student participation in digital environments [28]. This pedagogical approach contributes to the development of academic skills, and to the formation of ethical and responsible citizens in an increasingly interconnected world.

In future research, it would be pertinent to explore how the systematic incorporation of digital science fiction narratives, such as Nosedive, can influence the development of critical competencies in students of different educational levels. It would be especially relevant to examine the impact of this type of content on digital literacy, the construction of identity in virtual environments and awareness of the psychosocial effects of the use of social networks. Also, research can be carried out that delves into the potential of digital science fiction narratives to be articulated with constructivist didactic approaches. As stated in a recent literature review on the applicability of didactics in the constructivist approach [29], teaching should be understood as a complex and organized activity, in which the student actively builds his or her learning based on interest, prior knowledge, and critical reflection.

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Strengthening Perimeter and Endpoint Infrastructure With Open Source SIEM Platform Wazuh

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Abstract. This article presents the implementation of a Wazuh SIEM platform at Innotech-EC with the aim of strengthening its security posture through log correlation and integration with a firewall. This project aims to improve the detection and response to security incidents; a mixed methodology was used for its development, bibliographic information from cybersecurity projects was collected, a survey was conducted with the company's staff, and a GAP vulnerability analysis was performed. Subsequently, a server was installed as the central component along with its agents on the staff's computers. The collection of agent information was considered for a month, during which the presence of: suspicious malware on the computers, the use of simple passwords to access the Windows operating system, pending updates, and the version of the host operating systems was detected. With these obtained results, it is demonstrated that the implementation of the SIEM has been effective in the evaluation of the infrastructure, the detection of threats, and the fulfillment of the established security objectives.

Keywords: Cybersecurity · endpoint · Wazuh

1 Introduction

The exponential increase in devices connected to corporate and home networks has made cybersecurity a critical priority; therefore, users and organizations are exposed to a wide range of cyber threats such as denial-of-service attacks, brute force attacks, and various types of malware. Consequently, the need has arisen to protect sensitive data, ensure privacy in the digital environment, and implement robust security measures [1]. In response to the aforementioned, organizations have access to a wide range of specialized products for detecting and alerting suspicious activities, along with the number of false positives that a SIEM-type monitoring system can identify. A real attack is rarely overlooked when constant monitoring is in place [2].

A network monitoring system is used to better identify risk components and prevent failures; the task of these systems is to find a weak point, present a report, and if possible, solve the problem. Given the growing challenges in cybersecurity and the increasing amount of data generated globally, network and security administrators are facing an

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 156–162, 2025.
https://doi.org/10.1007/978-3-032-09080-5_16

ever-growing challenge; most engineers and security specialists use the host intrusion detection system to detect and identify attacks and the Intrusion Prevention System to prevent them [3].

Security Information and Event Management (SIEM) platforms facilitate the collection, normalization, and correlation of events from hosts within an organization; this correlation capability allows for the organization and management of logs, providing processed information to respond to security events that may affect the integrity, availability, and confidentiality of information; additionally, they allow for the evaluation of compliance with national and international standards, such as the Payment Card Industry Data Security Standard (PCI DSS), Sarbanes-Oxley Act (SOX), General Data Protection Regulation (GDPR), and the Organic Law on Personal Data Protection of Ecuador (LOPDP) [4], among others, which are relevant to the company [5].

Similarly, the use of free software has gained a lot of attention recently, and this, along with the use of standards, has allowed companies to add third-party source code to their developments. The existence of communities supporting open source has facilitated collaboration and knowledge exchange, and consequently, its use has led to a reduction in licensing costs, which in turn has lowered the costs of IoT.

Specifically referring to Wazuh as a SIEM tool, it is designed to allow users to perform global vulnerability queries on multiple endpoints in a centralized manner; users can view vulnerabilities on all monitored endpoints within an IT infrastructure. Being an opensource platform, vulnerability information is constantly being added from external sources, on Canonical, Debian, Red Hat, Arch Linux, ALAS, Microsoft operating systems; Wazuh acts as a central source for vulnerability data and update checks [6].

2 Methodology

A mixed methodology is applied where the qualitative approach is first applied in the review of similar projects considering academic theses with an analysis of objectives, methods and results; subsequently a GAP security gap analysis is executed in which compares the current state of IT equipment with the best practices and desired standards then the quantitative approach for the analysis of results of a survey and the results of the project [7].

A survey composed of 12 questions is applied to the total population working in the company Innotech-EC which are 11 employees; the purpose of this instrument was to collect knowledge of the implementation of security in the company and the level of general knowledge of security, virus attacks, how to act before a malware attack, defense platform, expectation on the implementation of the platform.

Finally, a field research on the SIEM cybersecurity platform is carried out, with the objective of evaluating the security of the software against threats and vulnerabilities, for which security surveys, penetration tests and risk analysis were chosen. The software was put into production and data was collected from file system monitoring logs, reading log messages, inventory data, analyzing system configuration and searching for suspected malware logins.

3 Results

3.1 Survey Application

First, a review of the results of the questions is conducted, in which 100% of the respondents are aware of cybersecurity; as well as types of attacks or viruses, 72.7% have heard about phishing, 100% about malware, 54.5% about denial of service (DoS) attacks and SQL injection attacks, and 9.1% about MitM attacks; moreover, 54.5% know how to act in the event of a computer virus attack; 81.8% determine that preventive measures have been taken to protect their company against virus and malware attacks; likewise, 63.6% consider that the policy for preventing cyber attacks in the company is known.

Regarding the most critical threats, 54.5% consider phishing, 81.8% malware, 36.4% DoS attacks, and 18.2% MitM attacks; 63.6% have heard about SIEM platforms and their usefulness, and 81.8% believe that implementing a SIEM platform like Wazuh would be beneficial for the company.

Finally, 54.5% view Wazuh's ability to generate security alerts as good, 36.4% as very good, and 9.1% as average, while 45.5% have a good expectation regarding the correlation and alert capabilities of a SIEM platform and 54.5% a very good expectation; in the open-ended question, they indicate that Wazuh could have a significant and positive impact, in addition to having centralized event monitoring and logging, real-time attack detection, generation of security policies for subsequent implementation, proactive detection and alerting on suspicious activities, the ease of a quick response to threats, centralization of cybersecurity events, continuous open-source monitoring at no additional cost are other mentioned benefits. Although some pointed out the need to test all the functionalities of Wazuh, the majority agreed that its implementation would improve the company's security layer and would be a valuable option to comply with security regulations.

As a result of the analysis of the data obtained through the survey, a gap between theoretical knowledge of cybersecurity and the practical application of preventive measures is evident. The implementation of security policies and the general awareness of the staff require greater attention. The results suggest the need to develop more robust training programs and to foster a proactive security culture within the organization.

Similarly, it revealed a positive perception towards SIEM platforms, particularly Wazuh, as key tools for improving cybersecurity. However, a need was identified to strengthen staff knowledge in the use of these tools and to effectively integrate them into the existing security infrastructure. The results obtained support the implementation of Wazuh as a strategic measure to improve threat detection and incident response.

3.2 GAP Analysis

The implementation of the SIEM Wazuh platform has allowed for a GAP analysis, resulting in the following outcomes, which are presented in Table 1.

Table 1. Parameters identified after the GAP analysis

Area	Vulnerabilities	Potential impact	Mitigation strategies
Hardware	Obsolete equipment, weak passwords, unrestricted physical access	Data loss, service interruption, unauthorized access	Keep equipment updated, implement strong password policies, physical access control
Software	Unpatched applications, pirated software, incorrect configuration	Exploitation of vulnerabilities, malware, data loss	Keep software updated, avoid pirated software, configure applications correctly
Network	Weak network configuration, unencrypted Wi-Fi, unprotected IoT devices	Unauthorized access, data loss, leakage of confidential information	User training, implement multi-factor authentication, use security software
Process	Lack of security policies, inadequate backups, poor incident response	Data loss, business interruption, damage to reputation	Develop security policies, perform regular backups, establish an incident response plan

According to the compilation of the survey results, it is determined that the staff at Innotech has knowledge about the types of cyber attacks and that the company has taken action to mitigate these attacks. However, the implementation of a SIEM-type platform is considered very beneficial as it would allow us to centralize the monitoring and supervision of events to take action at the right moment by identifying suspicious activities and anomalous behaviors [7, 8].

3.3 Implementation

Wazuh is implemented and running on a company server, which is currently collecting information from the agents deployed on the computers of the staff working at Innotech. Consequently, Wazuh has been collecting information for a month from the logs with its discovery and vulnerability detection module, and in the login events, normal parameters can be verified. The operating systems on which the agent is running are Windows 11 machines.

As a result of this phase, the Malware Detection module was able to identify malware on two of the machines, so attention must be paid to the case; after analysis and investigation, the presence of an email was discovered in which there was an attachment with a possible malicious file that is presumed to have been opened.

4 Discussion

There are several general types of internal cybersecurity solutions available: SIEM, as a security solution that collects and analyzes information from different sources, such as systems, network devices, and applications; SOAR, which is a security solution that

combines automation and orchestration to improve the efficiency of security operations; and XDR, which is a solution that combines threat detection and response across different data sources, such as endpoints, networks, and clouds; we can also add XSOAR to the list, which offers deeper and more centralized integration with multiple security tools and intelligence sources, facilitating a coordinated and automated response in complex environments. When choosing one of these security solutions, it is essential to consider the specific characteristics of each solution and its adaptation to the specific needs of the organization [9].

In the present project, the SIEM platform called Wazuh was implemented, which was successfully implemented. In the present project, the SIEM platform called Wazuh was implemented, which was successfully deployed. The solution detects endpoints when they connect to the network and starts capturing information, events, operating system, vulnerable applications, presence of malware; however, there is a need to integrate additional sensors for cloud and online email; as well as platforms that notify important events via instant messaging, thus always being aware of the company's network events. Actions must also be taken regarding phishing awareness and internet file management; additionally, the passwords set on the equipment must be improved, as they can be vulnerable if they do not have an adequate number of characters. It is considered that SIEM solutions, over SOAR, XSOAR and XDR, are better suited to the resources of medium-sized companies, where the economic factor is often a limitation.

With the results obtained from the implementation of the SIEM platform in event correlation, it is determined that Innotech personnel are vulnerable to phishing and malware attacks due to the handling of email attachments, as their relationship with clients is conducted through email and instant messaging applications, from which they receive files in PDF format or compressed in RAR format. This is in accordance with the SIEM's ability to correlate events and generate useful results for cybersecurity personnel to take action thanks to the alert levels [5, 10].

5 Conclusions

The implementation of the Wazuh SIEM platform at Innotech-EC facilitated the identification and analysis of vulnerabilities present in the technological infrastructure. The detection of malware on endpoints, associated with the execution of attachments from emails, highlights the persistence of this attack vector and the need to strengthen preventive controls at the user level. Additionally, the identification of weak password policies in Windows systems highlights the importance of applying security configurations aligned with industry benchmarks and the continuous monitoring of compliance with these policies. These findings validate the usefulness of Wazuh as a tool for the continuous auditing of security posture and the early detection of potential attack vectors.

The event correlation capability provided by Wazuh has proven to be a valuable asset in identifying security incidents and generating real-time alerts. Through the joint analysis of logs from various sources, including firewalls, operating systems, and applications, the platform enables the detection of anomalous activity patterns that could indicate the presence of intrusions or the execution of malicious code. Although the current implementation has focused on the endpoints of the internal network, integration with cloud

services and email platforms is considered a critical step to extend visibility to the entire operational environment. The implementation of push notification mechanisms through instant messaging platforms is proposed as a way to optimize response times to critical incidents.

The results of the survey conducted with Innotech-EC staff revealed a disparity between theoretical knowledge of cybersecurity and the practical application of preventive measures. Despite the fact that the majority of respondents recognized the importance of protection against malware and phishing attacks, a significant percentage admitted to being unaware of the organization's internal security policies. This finding underscores the need to strengthen training and awareness programs, with the aim of fostering a proactive security culture and promoting the adoption of good practices by all members of the company. The implementation of Wazuh, by providing visibility into threats and vulnerabilities, can act as a catalyst for cultural change, driving the adoption of safer and more responsible behaviors.

Compared to more complex and expensive security solutions, such as SOAR, XDR, or XSOAR, Wazuh is a cost-effective alternative for medium-sized organizations like Innotech-EC. While the initial implementation and configuration require technical expertise, the availability of a large user community and an extensive knowledge base facilitates the adoption process. The ability to integrate with other pre-existing security tools, such as firewalls and intrusion detection systems, allows for the optimization of the security ecosystem.

The implementation of Wazuh can significantly contribute to compliance with data protection regulations, such as the LOPDP; by centralizing the logging and analysis of security events, the platform facilitates the identification of unauthorized access to sensitive data and the detection of potential privacy breaches. It should be considered that the implementation of Wazuh should be framed within a compliance program, which includes the definition of clear policies and procedures, staff training, and the adoption of robust technical security measures.

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The Podcast as an Educational Tool: The Case of Motivo de Consulta

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Abstract. The podcast has become an innovative educational tool that allows the dissemination of knowledge in an accessible and flexible way. In this context, the present study aims to analyze how the podcast Motivo de Consulta contributes to psychology education by transmitting knowledge about mental health in academic and professional contexts. The research follows an exploratory and empirical approach with a qualitative design, developed in several phases: first, a survey was applied to 100 people to identify their learning needs; Subsequently, these results were contrasted with a review of scientific literature to select the topics of the podcast; then, ten episodes were designed, produced and broadcast on Spotify with interviews with psychology experts; Finally, a content analysis was carried out to evaluate the alignment of the podcast with contemporary pedagogical principles. The results showed that the podcast not only addresses the concerns of the public, but also facilitates the appropriation of knowledge through a dynamic and interactive format. It is concluded that Motivo de Consulta is an effective educational strategy that complements traditional teaching methods and promotes autonomous and meaningful learning in psychology training.

Keywords: Podcast · Education Technologies · Psychology · Education

1 Introducción

The podcast has established itself as an innovative educational tool that transforms the way information is accessed and processed in the academic field. Its accessible and flexible format allows the dissemination of specialized content to a wide audience, favoring autonomous and meaningful learning [1]. In the field of psychology, the use of podcasts as an educational resource has proven to be effective in transmitting complex knowledge in a clear and understandable way, promoting reflection and debate around mental health problems [2].

In this context, this research studies Motivo de Consulta, a series of ten episodes broadcast on Spotify, whose purpose is to address various psychological problems in the workplace, education and society. This podcast is proposed as a space for dissemination and education accessible to students, teachers and the general public.

The study is based on the paradigm of educational connectivism, which emphasizes learning based on digital information networks and the interaction between receivers

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 163–171, 2025.
https://doi.org/10.1007/978-3-032-09080-5_17

and educational content [3]. This research explores its potential as a didactic tool in psychology training. In a context of digital transformation, understanding the role of podcasts in higher education is essential for their integration into innovative teaching-learning environments [4].

The research question guiding this study is: How does the Motivo de Consulta podcast contribute to psychology education by transmitting knowledge about mental health in academic and professional contexts? This question seeks to explore the role of the podcast as an educational resource that facilitates access to specialized information on mental health, addressing relevant topics for psychology training.

The aim of the research is to analyse how the podcast Motivo de Consulta contributes to training in psychology by transmitting knowledge about mental health in academic and professional contexts.

The present study follows an exploratory and empirical approach, with a qualitative design, aimed at the analysis of the content of the podcast Motivo de Consulta as an educational tool in the field of psychology.

1.1 The Podcast as an Educational Tool

The generation and transmission of information in society 2.0 has a connotation of more dynamic interaction mediated by the network. Communication requires other ways to capture text and cross the boundaries of one-way, real-time exchange. In this context, the more frequent use of the virtual has required an adaptation of traditional media towards new transmedia narratives. In fact, traditional radio has been adapting to a new system of information consumption: the podcast [5].

The podcast has established itself as a deterritorialized means of interaction, transforming the way information and entertainment are accessed. Its growth responds to technological convergence, massive access to the internet and the demand for personalized content. Today, it is a key tool in journalism, education, marketing, and social debate.

In a world where time is a limited resource, the possibility of listening to content while carrying out other activities has consolidated the podcast as one of the most influential forms of communication in modernity, with a significant reach in education, being a valid and efficient teaching-learning strategy in the university context [1].

The podcast is an innovative educational tool that allows the transmission of knowledge. Their integration into teaching environments has proven to be an effective strategy to complement learning processes, especially in higher education [2]. Unlike other traditional formats, the podcast facilitates the acquisition of information through a structured narrative that combines pedagogical elements with a close and understandable language. This makes it a valuable resource for students and teachers, as it promotes autonomy in learning and allows the assimilation of specialized content at any time and place [1].

From a pedagogical approach, the podcast aligns with the paradigm of educational connectivism, which emphasizes the importance of digital interaction and the collective construction of knowledge [3]. This model argues that learning not only occurs in formal settings, but also in spaces mediated by technology, where students can access up-to-date information and build knowledge from connectivity with different sources of knowledge. In this sense, transmedia education, which incorporates multiple formats and digital

platforms, enhances the function of the podcast as an educational cybermedium capable of generating meaningful learning experiences [4]. In addition, by structuring its content according to the learning needs of the audience, the podcast favors the personalization of knowledge and facilitates the appropriation of key concepts in disciplines such as psychology and social sciences [6].

2 Materials and Methods

The study has an exploratory and empirical design, with a qualitative approach, based on the analysis of the content of the podcast series Motivo de Consulta as an educational tool in psychology training.

The research is based on the review of the ten episodes that make up the series, which were published in 2024 on Spotify. The podcast Motivo de Consulta was selected for this research because it presents characteristics that allow us to analyze its educational potential in the teaching of psychology. Firstly, its content is structured around mental health topics of academic and professional interest. Secondly, its format based on interviews with experts in psychology allows an accessible and informed dissemination of specialized knowledge. In addition, the podcast is available on a wide platform such as Spotify, which facilitates its access and consumption in various educational contexts. These characteristics make it an ideal object of study to evaluate the impact of podcasts as a learning tool and their alignment with pedagogical models such as connectivism and transmedia education.

The Motivo de Consulta podcast series was reviewed with the aim of identifying its themes and its alignment with mental health learning needs. To this end, a thematic categorization process was carried out, understood as a qualitative analysis technique that allows the data to be grouped according to common units of meaning, facilitating the systematic interpretation of the contents [7]. This process was based on the theoretical approaches of connectivism and transmedia education, which highlight the importance of digital interaction in the construction of shared and meaningful knowledge [3]. In addition, the podcast's ability to transmit scientific information in clear and simple language was valued, which favors the appropriation of the content by diverse audiences. Based on the analysis of the episodes, a list of topics was drawn up that were grouped into the following categories: (1) educational and psychopedagogical context, which includes content related to special educational needs and learning problems in children and adolescents; (2) psychological well-being in the workplace, which addresses issues such as unemployment, organizational climate, and psychosocial effects of work; (3) psychological well-being in family environments, focused on emotional dynamics, affective bonds and coexistence; and (4) the couple, where problems such as love grief, dysfunctional behaviors, sexuality in older adulthood, and affective relationships are addressed.

Likewise, a review of the scientific literature on the use of podcasts in education was carried out, with the purpose of contrasting the findings of the study with previous research and theoretically supporting their pedagogical potential.

Through this methodology, the study seeks to demonstrate the relevance of podcasts as an educational cybermedium, as well as their ability to promote autonomous and meaningful learning in the field of psychology.

One of the main limitations of this study is that, as it is a case study, the findings are not generalizable to other formats, educational contexts or populations. This limitation does not invalidate the value of the study, but it does point to the need for future research that broadens the analytical perspective from comparative approaches.

3 Analysis and Discussion

Table 1 is presented below. The first column is the episode number, the second column is the title, and the third column is the story of the episode.

Table 1. Episodes of the podcast series "Motivo de Consulta".

Number	Título	Storyline
1	Love Duel: Cupid Is Dead	Inquire about the psychological effects of the loss of a partner
2	Why don't they hire me?	Indicates weaknesses in job interviews
3	Let's Talk About Special Educational Needs (SEN)	It analyzes the special educational needs of children and adolescents in different educational contexts
4	Winter in the company	Provides coping strategies in unfavorable work climates
5	The meaning of life	Talk about the purpose of life of people in adverse situations
6	Skin is ageless	It talks about sexuality and relationships in older adults
7	My child doesn't recognize letters	Analyzes learning problems in children and adolescents
8	My pet and I	Examine the different bonds people have with their pets and their importance in their lives
9	How toxic am I?	It identifies causes, symptoms and consequences of people who are anxious about their partners, as well as the dynamics of the different love languages

The podcast series "Motivo de Consulta" was the second most listened to audio content in the educational podcast section, made by universities on Spotify [8]. Its audience was distributed in 64.6% Ecuador, 16.8% Colombia, 8.4% United States, 2.9% Mexico and 7.3% the rest of the world [8]. 42.5% of the audience was between 18 and 27 years old [8].

The findings of the analysis of the podcast episodes show the following:

The first category is the educational and psychopedagogical context. Episodes 3 and 8, related to special educational needs and early interventions in educational contexts,

become spaces for the transmission of information and meaningful learning. Parents can identify with the information, recognize situations that may be affecting their children at school and link this problem with the need for a psychopedagogical solution.

Episode 3 explains and describes the importance of the different educational needs according to the characteristics of the students, and how the family can support pedagogical processes where there is a condition that prevents an adequate development of learning. For his part, in episode 8, the specialist describes learning difficulties and problems in children and adolescents and the psychosocial consequences that this could cause if they are not detected in time.

These episodes demonstrate that podcasts have educational value as a cybermedium that provides information and promotes debate, reflection and the necessary solutions to transform a reality.

The second category addressed is psychological well-being in the workplace. Episodes 2 and 5 dealt with issues related to the employment situation and the organizational climate, aspects that are constant concerns in contexts marked by high rates of unemployment and underemployment. This job instability has a negative impact on mental health, generating existential questions and psychosocial manifestations such as anxiety, depression, and conflicts in the family or couple environment [9]. In this sense, the importance of providing clear and pertinent information on the factors that hinder labor insertion is highlighted, as well as on the effects of the organizational environment on the quality of interpersonal relationships, which contributes to making visible and mitigating the associated psychological discomfort.

These two episodes related to this problem provided strategies to promote an improvement in the quality of life of people who are going through a situation of anxiety and depression in the workplace, or simply have not been able to get a job in relation to their professional skills.

The third category is psychological well-being in family contexts. In episode 10, information is provided so that the audience can recognize themselves with toxicity as a behavior, as well as information with which they can identify if they are victims of these links that can bring long-term emotional sequelae. In this context, the content of educational value was presented through an explanation of the relationships with primary figures that, for each individual, are shaped from childhood and adolescence, until in adulthood fixed patterns of feelings, thoughts and behaviors are established that mark our relationships with others. These modes of bonds will be established in the different environments (family, social, work, etc.) in which we develop, from early adulthood to older adulthood and even with domestic animals with whom we can share our daily lives [10].

At this point, it is necessary to highlight that educational cybermedia promote discursive and didactic strategies that allow the audience to take information, interpret it and restructure it based on their own life experiences, so that connectivity becomes interactivity and learning is modeled according to the needs of recognition of their own problems that can be solved with the information learned [2].

Along the same lines, it is necessary to analyse the different learning needs related to psychological disorders. For example, episode 6 reflects on the meaning of life, and how this worry can generate anxiety and depression in people who have fragile ties

with their environment, since they will not have support networks when they begin to ask themselves these types of questions. For this reason, if questions arise about the meaning of life and, in addition, there are tenuous bonds with others, people can look for adaptive mechanisms to prevent a separation or breakup from occurring [11]. These adaptive mechanisms can lead to violent possession or imposition behaviors. Therefore, it is important to ask ourselves, what do we call today the "toxic" behaviors of a person who is in a kind of bond with others responds?

The fourth category refers to the couple. Episode 1 explored the different emotional and psychosocial effects of losing a partner. Bearing in mind that grief is not necessarily a process that occurs from the physical death of the other, but as a consequence of the loss of the other. Undoubtedly, this content, with a very high educational value, provides different audiences with illustrative resources to identify their own experiences of love grief and to know the consequences that may arise if professional psychological therapy is not carried out, which leads to reflect on the psychosocial importance of the educational cybermedium, as a non-traditional alternative to promote intellectual and emotional development in the current era [2].

Regarding the need for learning related to grief and psychological well-being in the couple, Cianconi et al. [12] find that environmental changes have generated an increase in mental health problems in the last decade. Due to these changes, human beings have faced different scenarios of loss: whether in relationships, social ties or family ties [12]. That is why one of the main concerns of people, whatever their age, is the breakdown of the love bond, either by death or physical separation.

On the other hand, episode 7 addressed issues of sexuality and psychological well-being in older adults, analyzing those processes of interdependence where the needs for affiliation, intimacy, and sexuality are based on behaviors that promote companionship and, therefore, problems that include the lack of time to be together and the feeling of boredom in the company of the partner [13]. Sexuality problems are substantial problems, especially in older adults, as they include loss of attraction in the partner, lack of desire, and sexual dissatisfaction [14]. In this adult population, the podcast as a non-formal educational resource not only allows a remembrance of traditional radio, but also allows the resource to be taken anywhere and played at any time, achieving a relationship of complicity, interest and curiosity with its users, and, consequently, a clearer appropriation of the contents [15]. In this way, as proposed in non-formal education for adults, information is linked to life experience, to subjective perceptions in relation to social links and dynamics, so that the podcast for educational purposes promotes this connection between the information provided by experts and the adult's own subjectivity. promote meaningful learning based on life experiences and expectations [16].

It is important to mention that the appropriation of the contents studied implies a need for learning, so the link is reinforced from the sense of belonging and identification that is produced through the relevant language and the need for information, which involves both the substance and the form of transmission of the information.

Table 2 systematizes the findings.

Table 2. Summary table of findings.

Category	Episodes	Key Themes	Podcast Contributions
Educational and psychopedagogical context	3 and 8	Special educational needs, early interventions, learning problems and psychosocial consequences	Educational support for parents and teachers, promoting early detection and psychopedagogical solutions
Psychological well-being in family contexts	2 and 5	Unemployment and underemployment, organizational climate, anxiety, depression and family instability	Strategies for emotional well-being and job stability
Psychological well-being in family contexts	6 and 10	Toxic behaviors, meaning of life, fragile bonds and adaptive mechanisms	Reflection on harmful bonds and resignification of personal experiences
Couple and affective relationships	1 and 7	Love Grief, Sexuality in Older Adults, Intimacy, Desire, and Satisfaction	Resources to cope with emotional losses and reflect on bonds and sexuality in adulthood

As a practical recommendation, for use in formal educational settings, the Motivo de Consulta podcast can be incorporated as complementary material in psychology subjects, especially in mental health topics. It is recommended to use selected episodes as a basis for discussions, case studies or reflective activities. Teachers can also design listening guides with key questions to facilitate analysis. Thanks to its asynchronous format, the podcast adapts well to methodologies such as the flipped classroom, promoting autonomous and meaningful learning.

4 Conclusions

The use and consumption of the podcast as an educational resource is valuable in the current scenario of information mediated by the knowledge society, and with the convergence of digital tools that allow the deterritorialization and democratization of academic content [2]. Thus, the Reason for Consultation Podcast is built as a learning ecosystem, friendly and lasting, and each of its episodes can be used as a didactic strategy, with a comprehensive and innovative approach that transmits scientific information.

The present study has shown that the Motivo de Consulta podcast is an innovative and effective educational tool for the teaching of psychology and the dissemination of knowledge about mental health in academic and professional contexts. It was evident that this format allows an accessible and flexible transmission of knowledge. Its pedagogical structure, based on transmedia education and connectivism, facilitates the understanding of psychological problems and encourages critical reflection in listeners.

This study shows that podcasting aligns with the principles of digital education, promoting autonomous and meaningful learning [4]. The combination of interviews with experts, accessible language and thematic structure based on scientific evidence reinforces its value as a didactic resource in psychology education. In this regard, the study highlights the importance of further exploring the impact of podcasting on higher education and its integration into broader pedagogical strategies.

The scientific contribution of this study lies in the systematization and analysis of the podcast Motivo de Consulta as an educational resource in the field of psychology, from a qualitative, empirical and exploratory approach. Through the thematic categorization of its contents, the study shows how a digital medium can be pedagogically structured to address mental health problems based on principles of connectivism and transmedia education. This research contributes to the academic literature by demonstrating that podcasts, beyond their communicative function, can be constituted as an educational cybermedium with the capacity to promote autonomous and meaningful learning in formal and non-formal contexts. This study offers a replicable model for future research on the integration of digital technologies in vocational training processes in the social sciences and humanities.

In future research, it would be pertinent to include feedback from listeners through mixed methodological approaches that combine qualitative and quantitative analysis, such as surveys or in-depth interviews. This would allow for a more accurate assessment of learning outcomes, knowledge appropriation, and perception of the educational value of the podcast. In addition, it is recommended to carry out comparative studies between this format and other educational resources, such as videos, academic texts or virtual classes, in order to analyze the advantages and limitations of each in terms of pedagogical effectiveness, accessibility and degree of public participation. These comparisons would contribute to establishing more robust criteria for the integration of digital media in higher education contexts, especially in disciplines such as psychology, where the understanding of abstract concepts and the development of reflective skills are fundamental.

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Motivation Levels in Construction Companies: Case Study of Constricom Cía. Ltda

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Abstract. Nowadays, motivation significantly influences the performance of employees in organizations. In this framework, this research examines the degrees of motivation at work in the construction company Constricom Cía. Ltda., using a quantitative method of cross-sectional and non-experimental design. Fundamental elements such as recognition, remuneration, incentives, objectives and training, which make it possible to strengthen the work environment and increase competitiveness, were addressed. The results show that monotony, poor communication of incentives and the absence of recognition reduce motivation at work, impacting dedication and quality of service. Thus, organized strategies are proposed to promote more comfortable and appropriate work environments that promote employee growth. This research, based on theories such as those of Herzberg and Vroom, seeks to contribute to the continuous improvement of organizational performance in the Ecuadorian construction sector.

Keywords: Motivation · strategy · performance · employees and organization

1 Introduction

The construction field offers a variety of services such as construction, renovation of industrial projects, shopping centers and real estate, focused on the execution of civil works, metal-mechanical structures and electrical installations. Its expansion is based on quality and excellence of service, meeting customer demands and requirements and promoting customer loyalty. These financial, operational and administrative tasks have been intensified thanks to the commitment of the personnel, which is supported by the study of the degree of motivation of the employees of the construction companies.

Motivation promotes a work and emotional balance, fostering an effective organic environment. Without motivation, demotivation, resistance and adverse repercussions on employee well-being are generated [1] Therefore, it is necessary to implement strategies that motivate employees to achieve goals, reward their effort and promote positive transformations in their attitude and responsibility.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 172–179, 2025.
https://doi.org/10.1007/978-3-032-09080-5_18

This analysis focuses on examining the degrees of motivation in the company Constricom Cia. Incorporated in Ecuador, Ltda. The study assumes that a positive motivational environment directly influences employee performance, productivity and well-being [2].

A motivated employee directly influences the quality of the service and the final product, standing out in the industry through training, a positive work environment, remuneration, recognition and team collaboration [3]. The motivation is essential to constantly improve the results of the organization through strategies and incentives that enhance the recognition and sense of belonging of the employees; this enhances productivity, excellence and the image of the organization focusing on integral human growth [4].

In a challenging context, companies in the construction sector need to innovate in motivational tactics, including management and operating teams, to motivate workers and produce favorable results. Despite the importance of the issue, there is little research focused on the construction sector, which supports this proposition [5].

2 Theoretical Basis

Work motivation varies in each person, since individual needs generate different patterns of behavior [6]. Through motivation, individuals fulfill their functions with an organizational goal oriented to profitability and the fulfillment of objectives.

In entities, the personnel administration department plays a crucial role, since it interacts directly with employees in internal procedures [7]. The absence of incentive tactics, proper leadership and effective communication leads to dissatisfaction that negatively impacts the work environment and performance.

The operation of the organization is also based on the internal structure and leadership present in each sector [3]. Proper work management and good interpersonal relations foster motivation, reduce disputes, and increase employee productivity and creativity.

Types of Work Motivation

Certain people have different ways of identifying their needs and satisfying them, allowing them to rely on motivation both inside and outside the organization, for which two important types of motivation are mentioned, from which we can limit the necessary strategies to be applied in the labor and personal field, as follows:

Intrinsic Motivation

It is produced on the basis of certain fields that highlight people such as values, norms, objectives, goals to be met and individual interests [8] and indicates that intrinsic motivation "satisfies the worker's needs for progress and competitiveness. An individual whose motivation towards his work is intrinsically produced tends to be more productive and maintains a better work performance".

Extrinsic Motivation

Also known as monetary rewards or external recognitions can be economic, material or even based on an incentive [8] where it relates the forms of retribution these can be bonuses, commissions, days off in a familiar environment, among others being that it generates a personal interest in the tail-borrowers to obtain prizes.

Motivational strategies assign specific responsibilities, improving the organizational environment and fostering professional and personal development [9].

The application of these diverse processes in the organization complements the main and essential aspect of commitment, the responsibility of the collaborator, who in his full level of satisfaction of his needs covers with a spontaneous motivation [10] that "the employees give the best of themselves in their work, that implies a differential advantage and a better productivity for the company" creating in the collaborator an adequate organizational climate and in accordance with the needs of the organization with excellent results.

Theories of Work Motivation. Work motivation results from external factors that satisfy personal and organizational needs, such as pressure from superiors, the influence of colleagues, technology, family needs, learning and working conditions, generating an external stimulus in the employee [11]. In addition, the motivational cycle identifies a stimulus that generates the need to meet expectations, developing a behavior oriented to the fulfillment and responsibility of the employee.

Herzberg's Theory. Herzberg's theory deals with external factors that motivate employees to be dependent on the following factors mentioned by the author [11]:

Hygienic Factors. Work motivation is linked to the conditions provided by the organization, such as social benefits, adequate physical environment, legal regulations, salary and stability. These factors, besides serving as supervisory points, prevent dissatisfaction and positively affect the individual's behavior [11].

Motivators. When working conditions are optimal, lasting satisfaction and increased productivity are achieved. This leads people to strive, achieve high performance, be motivated in the long term, perform quality work and meet professional goals while growing and developing personally [11].

Vroom's Theory. It is also known as the theory of expectations or known as consequences of actions that derive from the individual's behavior [11]. It is described as follows:

Expectation. An individual's belief that, through his or her efforts, skills, availability and support will be the basis for successful performance.

Reward. It is the value that a person receives and can be intrinsic being something personal such as personal satisfaction or extrinsic such as tangible rewards, money or recognition.

Research on motivation in construction companies highlights facto-res such as quality, costs and productivity, with the aim of offering the customer a Total Quality service and meeting quality standards recognized worldwide [12]. Employees should be involved in decision making and receive constant training to strengthen their knowledge and work motivation.

Motivation should be managed as a necessity in the work environment, understanding the individual employee and his or her satisfaction in productivity. It is essential to recognize and promote growth opportunities within the organization, encouraging participation and strengthening the mutual commitment between employees and the company [13]. In Latin countries, the collaborator in construction companies is key to the success of the projects. Motivation, through strategies such as rewards, incentives and training, is essential to improve communication, avoid misunderstandings and stimulate creativity in their functions [14].

3 Methodological Process

This research was carried out with a quantitative perspective, using a non-experimental and cross-sectional design. A census was carried out for all employees of the construction company Constricom Cía. Ltda. with the objective of collecting direct field information for the study of the levels of motivation at work [8].

A structured questionnaire was used as an evaluation tool, which was previously validated by specialists in social research, guaranteeing its relevance, transparency and reliability. This instrument facilitated the collection of data on the independent variable (motivation) and other related dependent variables such as performance, work environment and productivity, detected from employees' responses to different motivational tactics [15].

The study of the data was carried out through descriptive statistics using the SPSS program, which facilitated the identification of trends, distributions and possible correlations between the variables under study. This technique ensures the reproducibility of the results and guarantees the validity of the findings achieved [8]. In addition, strategic combinations resulting from the study were identified, which provide resources for future research with different approaches, enabling a more complete approach to work motivation in similar situations.

4 Results

As can be seen in the table, the analysis shows that employee motivation is impacted by monotony at work, the demand for assertiveness and creativity, as well as the perception of stimuli. The absence of recognition can lead to discouragement, reducing the importance of achieving goals. As an alternative, tactics to strengthen recognition and enhance motivation in the work environment are suggested [8]. The findings indicate that 61.5% of employees think that monotony impacts their motivation.

When referring to the degree of skills used by employees in the work they perform, it is shown that a high percentage manage to use their expertise in daily tasks. However, a smaller group indicated that they still do not have the opportunity to do so, which is related to a survey taken from a previous study [16] and suggests that this aspect should be considered when analyzing motivational factors within the company.

Regarding teamwork, a high percentage of employees stated that they sometimes worked in groups according to the client's request. Those who indicated that they do not

do so regularly belong to individual positions. This pattern, also identified by Flores [17] is evidence of the need to strengthen the work environment and encourage teamwork to achieve institutional objectives.

The analysis concludes that some employees receive support in situations of workload, although a small percentage of them say that they do not perceive it. The company, for its part, is seen by the majority as a guarantor of job stability, although this perception varies among employees. Despite efforts to promote motivational strategies, the lack of clarity in their communication limits their effectiveness, which represents a significant opportunity for improvement (Table 1).

Table 1. Motivation.

MOTIVATIÓN	Never	Almost never	Sometimes	Almost always	Always
Do you feel that your work motivation decreases when you perform your daily monotonous activities	11,50%	7,70%	61,50%	19,20%	0,10%
Every work effort you make in your duties with your work group is recognized by your leader	3,80%	19,30%	50,00%	15,40%	11,50%
Have you received any incentive or recognition for achieving and reaching the proposed objectives	3,90%	26,90%	42,30%	11,50%	15,40%
Do you believe that your level of knowledge is commensurate with your position	3,80%	0,10%	34,60%	26,90%	34,60%
Teamwork is practiced	8,00%	0,00%	36,00%	32,00%	24,00%
Your colleagues support you when you have a workload	11,50%	23,10%	34,60%	30,80%	0,00%
Do you consider that the company guarantees you job stability	0,00%	11,50%	30,80%	26,90%	30,80%

Notes: Rating criteria Scale: (never; almost never; sometimes; almost always; always).

Motivating staff is key to improving their performance. A good working environment, adequate incentives and ergonomic materials, although scarce, help to reduce absenteeism. In addition, constant training is essential, especially in the construction sector, to take on new challenges and strengthen skills (Table 2).

Table 2. Performance.

Staff Performance	Never	Almost never	Sometimes	Almost always	Always
Motivational strategies should be implemented in the organization	3,80%	3,80%	15,40%	15,50%	61,50%
Do you consider that the workplace has ergonomic chairs	36,00%	24,00%	20,00%	16,00%	4,00%
Do you think you are willing to take on a new position to perform your duties	3,80%	3,80%	16,40%	26,00%	50,00%
You may consider implementing a training plan in the company	3,80%	7,70%	26,90%	19,20%	42,40%

Notes: Rating criteria Scale: (never; almost never; sometimes; almost always; always).

The company presents opportunities for improvement in the motivation and well-being of its employees, with challenges in the participation in sports activities and the implementation of performance incentives. However, there are positive aspects such as flexible working hours in teleworking, which is valued by the administrative staff, and the recognition of the importance of motivational strategies, which opens the way for future improvements in the work environment (Table 3).

Table 3. Estrategies.

MOTIVATIONAL STRATEGIES	Never	Almost never	Sometimes	Almost always	Always
Do you know if there are sports activities events in the company	26,90%	23,10%	26,90%	7,70%	15,40%
Do you know if the organization has strategies that encourage motivation	23,10%	15,40%	42,30%	7,70%	11,50%

(*continued*)

Table 3. (*continued*)

MOTIVATIONAL STRATEGIES	Never	Almost never	Sometimes	Almost always	Always
The company implements remuneration plans for personnel	26,90%	26,90%	26,90%	7,70%	11,50%
Do you think the company has a flexible schedule for teleworking	16,00%	16,00%	32,00%	16,00%	20,00%

Notes: Rating criteria Scale: (never; almost never; sometimes; almost always; always).

5 Discussion

The results obtained reflect the existence of structural and cultural factors that limit the effectiveness of motivation strategies within Constricom. The absence of constant recognition, the scarce use of incentives and the perception of work monotony directly affect the attitude and commitment of employees. This finding coincides with previous studies, such as those conducted by Morales (2022) which emphasize the importance of transparent internal communication and collaborative leadership to strengthen the organization's culture. In addition, the scarcity of opportunities to put the knowledge gained into practice underscores a mismatch between staff skills and assigned tasks.

Despite current efforts to foster teamwork and promote job stability, employees perceive deficiencies in the implementation of motivational strategies. This demonstrates the urgent need to establish formal feedback mechanisms, effective dissemination of existing incentives and a review of organizational practices based on staff expectations. It is also proposed to create a system of indicators to objectively measure the impact of motivational actions, adjusting them to the specific context of the construction sector.

6 Conclusions

This research used a quantitative method, based on questionnaires given to the employees of the company Constricom Cía. Ltda., which facilitated the identification of the key factors that affect their motivation at work. The findings showed deficiencies in elements such as recognition, work environment conditions, the absence of evident stimuli and insufficient organizational communication. Based on these findings, strategies to strengthen motivation are proposed, including: the development of a structured incentive plan, the improvement of internal communication, the creation of a more positive work environment, and the implementation of continuous training programs.

This study was based on theoretical foundations such as the theories of Herzberg and Vroom to support proposals that respond to the needs of the Ecuadorian organizational

context, and is aligned with previous studies in Latin America that point out motivation as an essential factor to achieve excellence in service.Its main scientific contribution lies in the adaptation and application of classic motivation models to the construction sector in Ecuador, offering a useful framework for future research and evidence-based organizational decisions.

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The Interrelationship Between the Code of Ethics, Workplace Coexistence Standards, and the Violet Law: An Approach Toward Building Violence-Free Spaces

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Abstract. The code of ethics is a vitally important document within an organization, which guides the behavior of employees. This regulation embodies the values, principles, and ethical standards that the company requires to maintain a respectful and harmonious work environment. The Violet Law is mandatory within an organization because it helps ensure equal rights and duties among coworkers, with an emphasis on the most vulnerable, primarily women, who have suffered abuse and discrimination. The methodology applied in this research highlights the importance of having a code of ethics to promote an inclusive work environment of equality and diversity with discrimination-free spaces. Organizational leaders are responsible for faithfully complying with and enforcing each of these standards and principles.

Keywords: Code of ethics · values · Violet Law · equality · discrimination

1 Introduction

The code of ethics is a fundamental part of organizations. This instrument embodies the values, principles, and standards of coexistence that the company considers necessary. This document serves as a guide for the behavior of all employees and also notifies the relevant sanctions for noncompliance. The purpose of the code of ethics is to establish ethical values and principles, as well as the conduct to be observed in the activities carried out by employees within the organization. To follow up on what has been established, it is recommended that a Code of Ethics and Workplace Coexistence Committee be formed. These committees will forward suggestions or cases in which actions leading to compliance with established regulations to the relevant authorities [1].

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2025
J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 180–187, 2025.
https://doi.org/10.1007/978-3-032-09080-5_19

Therefore, it represents a set of rules and regulations that describe how employees should be involved in different situations, such as being punctual during working hours, not smoking in offices and closed places, not harassing colleagues and users, etc. Ethical standards mean that compliance is an obligation that must occur among people in organizations. The standards are the rules and behaviors that must be followed by everyone who makes up the organization [2].

When creating a code of ethics, an ethics committee or individual responsible for developing and monitoring compliance with the document must be designated. Those responsible are responsible for reporting directly to management regarding any anomalies or noncompliance. To draft this instrument, it is necessary to understand several points, which are detailed below [3]: a). Review the company's mission, principles, and values; b). Gather input from company members; c). Analyze ethical issues the company has faced in the past; d). Draft and approve the code of ethics; e). Present the code of ethics to company personnel.

The purpose of a workplace coexistence manual is to promote healthy and peaceful organizational coexistence, within a framework of harmony and good treatment among different hierarchies. It also establishes the principles, values, and standards of coexistence and the procedure for the conciliatory handling of situations that may arise. The responsibility of the workplace coexistence manual is to address and respond to alleged instances of workplace harassment in order to provide sufficient evidence for the closure of each case presented [4].

Compliance with workplace coexistence rules is important because it helps the company have greater protection against claims from employees, significantly reduces the number of accidents, and provides a climate of safety and trust that will positively impact the employment relationship. This will help attract and retain talent, as well as maintain a positive reputation and strengthen the company. Furthermore, providing a safe work environment and complying with legal policies and regulations will contribute to employee engagement, as the company meets its employees' expectations [4].

It should be noted that the implementation of the violet law within organizations requires compliance as described in **Article 1. Purpose**. Strengthen, promote, guarantee, and implement the transversality of the gender and multicultural approach through the generation of incentives and public policies that encourage the civilian population to empower women in their diversity, mainly those who have been victims of violence or are in vulnerable situations, women belonging to the different duly recognized peoples and nationalities; to the diversities of communities, peoples, and nationalities that the Ecuadorian State recognizes as unique and indivisible, gender sex, sex workers, and women with informal employment.

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In the economic environment, to achieve inclusive personal, economic, social, and labor empowerment, growth, and independence, generating benefits, access mechanisms, and designing action strategies, planning, and schedules that guarantee women's access in their diversity to economic, knowledge, social, labor, and personal development. A gender approach is understood as the direction of public or private conduct in pursuit of achieving equity between the genders, so that they can enjoy equal opportunities despite their differences [5].

2 Theoretical Foundation

Code of Ethics

The Code of Ethics contains standards related to business ethics, institutional development, and personal behavior. The standards of coexistence are related to the duties, responsibilities, and obligations of each member of the company. Therefore, it is everyone's obligation to know each of the standards and comply with them to maintain a harmonious coexistence in accordance with the principles and values established by the organization's management [6].

Codes of ethics provide people with a set of guidelines expected of professionals. This allows us to know when people are fulfilling their obligations and responsibilities. If they are in violation, a complaint can be filed, or, more seriously, the professional can be replaced. In organizations, it is even more important because it helps ensure professional harmony among team members [7].

The process of developing a code of ethics should be carried out by the ethics committee or the responsible department, typically the risk department or the legal department. In developing it, the perspectives of the Human Resources department must be considered, as this is a fundamental part of developing necessary strategies. The following steps should be followed to develop a code of ethics [8]: a). Identify risky behaviors and develop action plans; b). Consult references; c). Review content; d). Develop communication channels; e). Disseminate and incorporate the code of ethics.

Workplace Coexistence in an Organization

Workplace coexistence refers to the interpersonal behavior of the individuals who make up an organization—including managers, leaders, administrative staff, and operational personnel—with the goal of creating a positive, motivated, harmonious, and healthy work environment for all employees, regardless of their position. Employees must live together with equal rights and responsibilities. "Organizational communication and coexistence standards are fundamental pillars in the business world, directly influencing the productivity and quality of the services offered" [9].

Maintaining a healthy relationship isn't always easy, but it directly impacts productivity, effectiveness, and the willingness to face the tasks at hand. To be a well-rounded professional, it's essential to know how to manage emotional intelligence. Otherwise, any disagreement or argument can become a bigger problem that directly affects work. Managing difficult situations helps you grow personally and fosters a good work relationship [10].

Below are some guidelines for a good workplace environment: a). Workplace coexistence manual and/or work regulations; b). Workplace coexistence committees; c). Organizational climate measurements; d). Training, skills, and personal growth.

The benefits of a good workplace environment include facilitating individual and team growth, improving efficiency and speed in group projects, and increasing productivity and employee disposition. It positively influences workers' mental health, allows for better problem-solving, and increases employee happiness and satisfaction. It fosters better relationships of friendship and trust with coworkers and helps build a healthy environment in different work areas [11].

Interactions between different individuals require the development of soft skills to foster a positive work environment. Interpersonal relationships are important because they can significantly affect workplace dynamics. It's necessary to foster these relationships and a close management style, in which managers promote horizontal communication, are accessible, and thus contribute to building a positive work environment [3].

Ethical standards are essential for understanding the rights, obligations, principles, values, and ethical behaviors of all people, regardless of whether they belong to a company. Ethics and morals are rooted in the personalities of human beings and are reflected in the behavior and responsibilities of their assigned activities in the company or, in turn, in their personal lives. These standards are what characterize human beings and help us understand what a person is like [12]**.**

Organic Law to Boost the Violet Economy

The Violet Law in Ecuador emerges as a response to the urgent need to confront gender-based violence, guarantee women's rights, and promote equality. This law not only seeks to punish violence, but also to prevent it through education, health, culture, and communication, incorporating a cross-cutting gender perspective. This law proposes: a) comprehensive protection for women in situations of violence; b) timely access to justice, health, employment, and education.

Art. 2.- Scope of Application. This Law shall apply to all natural and legal persons present or operating within the national territory, in order to guarantee full access to and exercise of fundamental rights for all women in their diversity, primarily those who have been victims of violence or are in vulnerable situations, women belonging to the various duly recognized peoples and nationalities; and to the diversities of communities, peoples, and nationalities that the Ecuadorian State recognizes as unique and indivisible, gender, sex, sex workers, and women in informal employment, promoting gender equality and equity and multiculturalism. The State shall adopt affirmative action measures to guarantee the participation of vulnerable or discriminated groups, in accordance with the Constitution [5].

Art. 3.-Purpose. To reduce institutional barriers, such as wage gaps, discriminatory maternity and breastfeeding leave, the institutionalization of gender roles and multiculturalism, among others, by adopting measures aimed at promoting access to power and decision-making through the incorporation of gender quotas in management and executive positions in both the private and public sectors, encouraging and strengthening the participation of women in their diversity, primarily those who have been victims of violence or are in vulnerable situations; to the diversities of communities, peoples, and nationalities that the Ecuadorian State recognizes as unique and indivisible, gender genders, sex workers, and women with informal employment [5].

Art. 5.- Guiding Principles. For the purposes of the application of this Lawin, addition to the principles contemplated in the Constitution of the Republic, in the international human rights instruments ratified by Ecuador, and other current regulations, the following shall apply [5]:

1. **Equality and Non-Discrimination:** Equal opportunities are guaranteed, and all forms of discrimination are prohibited.
2. **Mainstreaming:** The gender perspective constitutes a cornerstone of analysis for regulations developed at all levels and throughout the entire production cycle within the national territory. Women must be involved in the development and implementation of these regulations.
3. **Progressiveness:** Continually adopting the necessary measures to guarantee the full and effective enjoyment of women's rights as established in this Law. We must gradually advance toward a more equitable society by applying all measures available to public and private operators, placing gender needs as a priority in their management.
4. **Autonomy:** The freedom a woman has to make her own decisions in the different areas of her life and to make choices without external pressure or violence, whether mental or physical, is recognized.
5. **Monitoring:** All actions aimed at fulfilling the object and purpose of this Law must be monitored to determine progress and its social and economic impact.
6. **Evaluation:** Programs and projects implemented and developed under this Law must be evaluated to determine their effectiveness.
7. **Intersectionality:** Intersectionality is understood as one or more systemic inequalities that arise from the superposition of different social factors such as sex, gender, ethnicity, social class, place of origin, political ideology, or any other limitation on the free access to opportunities for women in their diversity, primarily those who have been victims of violence or are in vulnerable situations; those with gender diversity, sex workers, and women with informal employment.
8. **Equality and equal treatment between men and women**: The principle of equal treatment between women and men assumes the absence of all discrimination, direct or indirect, based on sex, and especially those arising from motherhood, the assumption of family obligations, and marital status; as well as equal opportunities and treatment between men and women, recognizing their particularities and individualities.
9. **Women's rights in all their diversity**: Women, in all their diversity, have the right to the recognition, enjoyment, exercise, and protection of all human rights and freedoms contemplated in the Constitution of the Republic, the international instruments ratified by the State, and current legal regulations, specifically guaranteeing the right to a dignified life, personal integrity, and work for women in all their diversity.
10. **Equal treatment between women and men:** The principle of equal treatment between women and men implies the absence of all discrimination, direct or indirect, based on sex, and especially those arising from maternity, the assumption of family obligations, and marital status, with a gender, intercultural, human mobility, disability, intergenerational, and intersectional approach. Equal treatment and opportunities between women and men is an informing principle of the legal system and, as such, shall be integrated and observed in the interpretation and application of legal norms.

Art. 6.- Obligations of the State. The State, through its government agencies and entities, as well as the Decentralized Autonomous Municipal, Metropolitan and Parish Governments, have the obligation to promote, protect, guarantee and respect the human

rights of women in all their diversity from a gender and multicultural perspective, with their right to a life free of violence, with free access to employment under equal conditions and the generation of benefits that enhance their skills and abilities in the different productive spaces, through the adoption of political, legislative, judicial, administrative, control and any other type of measures that are necessary, timely and appropriate to ensure compliance with this Law [5].

Art. 14. Equality of Treatment and Opportunity in Access to Employment, Vocational Training and Promotion, and Working Conditions. The principle of equal treatment and opportunity between women and men, applicable in both private and public employment, shall be guaranteed, under the terms provided for in the applicable regulations, in access to employment, including self-employment, vocational training, professional promotion, working conditions, including pay and dismissal conditions, and in membership and participation in trade union and employers' organizations, or in any organization whose members exercise a specific profession, including the benefits granted by them [5].

Art. 17. Equality Plans. Companies are obliged to respect equal treatment and opportunities in the workplace and must adopt measures aimed at avoiding any type of employment discrimination between women and men. In the case of companies with fifty or more employees, the equality measures referred to in the previous paragraph must be directed toward the development and implementation of an equality plan, with the scope and content established in this chapter, which must also be subject to negotiation in the manner determined by labor legislation. The development and implementation of equality plans will be voluntary for other companies, after consulting with the legal representatives of the workers.

Without prejudice to the provisions of this article, companies must develop and implement an equality plan when so established in the applicable collective bargaining agreement, under the terms provided therein. In the case of companies with fifty or more employees, the equality measures referred to in the previous section must be directed toward the development and implementation of an equality plan, with the scope and content established in this chapter, which must also be subject to negotiation in the manner determined by labor legislation. The development and implementation of equality plans will be mandatory for both the public and private sectors, after consultation with the legal representatives of the workers [5].

3 Methodological Process

Methodological process. This study was developed based on exploratory research, which aims to investigate and analyze specific information that has not been studied in depth. That is, it provides an initial approach so that a more detailed investigation can be carried out later. The problem is formulated and is more in-depth than explanatory research [13]. Like descriptive research, which details the characteristics of an observed object and also collects data on the aspects mentioned in said study, descriptive research answers the compelling questions of the research being conducted. Descriptive research is useful for obtaining information accurately, allowing the researcher to visualize what will be measured in the study [14].

Consequently, different instruments were used, such as surveys and interviews with the organization's managers and collaborators. The importance of developing a code of ethics and workplace coexistence standards was analyzed. The needs of the organization for the development of institutional regulations were verified, as well as the strengthening of the application of the Violet Law in the company, whose objective is to achieve an equitable work environment, equality, a healthy and harmonious environment in the different work areas; perform their tasks in an operational manner, maintain interpersonal and professional relationships, both internally and externally, effectively [14].

4 Results and Discussion

Based on the information obtained from surveys conducted among employees of a company located in Ecuador, it was determined that a code of ethics and workplace coexistence standards are essential to ensure appropriate employee behavior and a peaceful work environment. The implementation of the Violet Law, whose objective is to create spaces free of violence and discrimination among colleagues in the organization, is also analyzed. For the following analysis of the proposed hypothesis, some results are presented, which are described below (Table 1):

Table 1. Analysis of the results obtained

Approach	Description	Development	Application	Resoursos
Commitment	All members must be communitted to this regulation.	Provide training on the content of this regulation and its function.	15 min	Update on government laws, in accordance with changes made by the government.
Effectiveness	The regulations must have a positive effect, both internally and externally.	Develop practices for applying these regulations and monitor compliance with each of these standards.	15 min	
Promote an inclusive and diverse environment	The company must promote spaces free of discrimination and vulnerability, with equal treatment between people.,	Provide training on trust and self-esteem so that people who experience discrimination can speak with their supervisors with confidence	30 min	

Note: Prepared by the authors. Criteria for successful application.

5 Conclusions

The pedagogical model and its application at the upper secondary level are social, emotional, inclusive, and timely, given that the structured structure of phase and time segmentations ensures long-term, meaningful learning through its initial opening of sensory memory and its subsequent recovery by the student. The study guaranteed the application of cooperative learning. It is important to add that brain-friendly classes can be applied with different pedagogical techniques. Regarding mathematics, it is a subject for life, and its configuration requires procedures, analysis, and reasoning in problem-solving and decision-making. Neurodidactics adapts to its development. It is recommended to strengthen teaching practices from the development perspective, considering the training and development parameters, thus enabling an integration of knowledge that guarantees quality and compassionate education at different stages of the school year.

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The Digital Transformation of the Television Industry

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Abstract. The study analyzes the digital transformation of the television industry, driven by digitalization and the emergence of streaming platforms. Its objective is to evaluate how this evolution has affected television production, distribution and consumption, using Albarrán's model of the five external forces in the media industry. Through a qualitative approach and analysis of industry data, it is concluded that these five forces have profoundly transformed the television industry. Globalization has allowed the expansion of streaming platforms, regulation is still key to managing rights and concessions, and technology has revolutionized the production and distribution of content. In addition, audiences have become more active and personalized, presenting new challenges and opportunities for the industry in an ever-evolving environment.

Keywords: Digital televisión · streaming · industria de los medios · tecnología de la comunicación · televisión

1 Introduction

In the first and second decades of the 21st century, the media industry underwent a major transformation [1–3]. This transformation meant digitizing media, its products and services, taking advantage of the speed of fiber optics, managing documents through cloud computing and storing them in the cloud [4]. That involved the use of technology such as smart TVs, computers, consoles and mobile devices, all connected to the Internet. This digitization of content and the multiplicity of access to it [5] allowed new opportunities for the media, on the one hand it provided greater convenience to users, because they could watch their content as many times as they wanted and in the place they wanted; on the other hand, the media increased their volume of distribution and increased their audiences. Added to this is the irruption of social networks that changed the panorama, because it multiplied content and had an influence [5]. In other words, technological advances have changed the modes of production and distribution, the paradigms of consumption, and audiences [6].

The television medium went from a traditional model to a digital model of multiple screens [7], which led to several changes in the conception of content, production, post-production, broadcasting and distribution. It also had changes in audiences and business guidelines [8].

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 188–196, 2025.
https://doi.org/10.1007/978-3-032-09080-5_20

The research question of this study is: What is the current state of television as a means of communication in the context of its digitalization and technological transformation?

The objective of this research is to carry out a detailed analysis of the current state of television, evaluating how digital transformation has impacted its production, distribution, consumption and audiences.

The research employs a qualitative approach, with a strategy based on the critical analysis of Albarrán's [9] approaches to the media. A comprehensive review of case studies, sectoral reports, reports, white papers, and specialized academic literature is carried out in order to identify the main changes facing the sector in the digital age.

2 Methodology

This study is based on a qualitative approach, whose purpose is to explore in depth the processes of structural, technological, legal and cultural transformation that have impacted the television industry within the framework of digitalization. Far from simply describing technical changes, this approach allows us to examine how digital convergence has redefined the models of production, distribution and consumption of content, as well as the relationships between broadcasters, audiences and platforms. In this sense, the qualitative approach offers the conceptual tools to interpret these dynamics.

This study develops a critical analysis of the current state of the television industry, based on Albarrán's model [9] exposed in the article The media and the communication industries: a 21st century perspective. This model identifies five external forces that influence the media: globalization, where companies expand their market beyond their borders; regulation, which refers to the regulations of each country; the economy, affected by capital and investments; technology, driven by innovations; and social aspects, where audiences have greater power and influence [9]. The analysis is complemented by the review of case studies, sectoral reports, reports, official documents and specialized academic literature.

The selection of sources for this study was made through an intentional process and based on criteria of thematic relevance, timeliness and reliability. Priority was given to academic documents, institutional reports and specialized publications that addressed the digital transformation in the television industry and the impacts of emerging technologies on the production, distribution and consumption of content. The timeliness of the sources was considered to ensure the validity of the analysis. Finally, materials from academic publishers, international organizations, recognized databases, and media with verifiable track records were included, to ensure the quality and robustness of the evidence used.

The organization of the analysis was structured based on the model of the five external forces proposed by Albarrán [9], which allowed the information to be categorized into five key dimensions: globalization, regulation, economy, technology, and audiences. This categorization functioned as an analytical axis to systematize the findings and facilitate a comparative and integrated reading of the different factors that affect the digital transformation of the television industry.

This analysis is relevant because television, despite the diversification of digital media, continues to be a central reference in mass communication. Understanding how its model has evolved in the context of digitalization and the emergence of new technologies

and platforms is key to understanding the current challenges of the media industry, as well as anticipating its future in a media landscape that is increasingly interconnected and dependent on digital technology.

An important consideration in this study is its fundamentally documentary nature. This approach allows us to build a comprehensive and well-founded vision of the digital transformation process in the television industry. Admittedly, the inclusion of primary data could have provided additional nuance and perspective for television producers and professionals. This limitation does not detract from the validity of the findings, but future research is invited to delve into empirical aspects that complement the theoretical and contextual analysis developed in this work.

3 Analysis and Discussion

As we have pointed out, we will use Albarrán's [9] approaches to the five external forces that influence the media industry.

3.1 Globalization

Globalization has affected the television industry in two aspects:

First, several television companies have begun to offer services beyond their national borders; among them, networks such as the BBC in the United Kingdom or CNN in the United States stand out. Global streaming platforms such as Netflix, Amazon Prime, HBO and Apple TV have joined this expansion process. Likewise, companies that were traditionally dedicated exclusively to the production of content – such as series, programs and movies – have ventured into this area, including Disney and Viacom CBS. In the case of Disney, the company launched Disney Plus, a service that began operations in the United States and Canada in November 2019 and subsequently expanded to Europe and Latin America in 2020 [10]. In 2024, Disney plus merged with Star plus, and expanded its catalog, which is mainly made up of content from its subsidiaries, such as Pixar, Marvel, Star Wars, National Geographic, 20th Century Studios, Blue Sky Studios, ESPN, and National Geographic [10]. For its part, Viacom CBS launched the Pluto TV platform in March 2019, which operates under a different model from Disney Plus or Netflix, as it offers free content financed through advertisements.

Secondly, several companies in the television sector have been the subject of purchase or merger processes. A prominent example is Disney's 2019 acquisition of 20th Century Fox for $71.3 billion, cementing the latter as the largest entertainment company globally [10]. This operation led to the merger of some services, such as ESPN, which absorbed Fox Sports in Latin American countries such as Chile, Colombia, Peru and Argentina, thus setting up a scenario of monopoly in sports broadcasting in the region [11]. Another relevant case occurred in 2016, when Viacom acquired Argentina's free-to-air television network Telefe for $345 million [12].

Globalization, too, can be evidenced when companies in the media industry set up offices in other countries. For example, Netflix set up offices in Sao Paulo for its operations in Latin America, and in 2019, it moved its offices to Mexico City [13], and

committed to invest 200 million in content purchases [14]. It also has offices in Spain, London, Paris, Singapore, Amsterdam and Tokyo.

Globalization has allowed an unprecedented expansion in the distribution of content, facilitating access to international productions and expanding audiences. However, this process has also favored the concentration of the market in the hands of large corporations, which poses risks of cultural homogenization and competitive imbalance. The opening of offices in other countries, although positive, responds more to commercial interests than to a real commitment to the development of local industries.

3.2 Regulation

Like traditional radio companies, regulations in traditional television companies are inserted into telecommunications laws [15]. Television companies must manage the acquisition of radio frequency concessions, depending on the laws and regulations by country [16]. The traditional television and radio industries have these regulations of their frequencies [16]. In addition, each country has television watchdogs that regulate the activity.

As for streaming platforms, the regulations are in the payment of royalties on the content and its royalties. For example, in the United States, Netflix does not pay royalties for original content, it only does so on a one-time payment [17]. It should be considered that many series have a mass reproduction that exceeds ten million views and producers do not receive additional payments [17]. But things are changing, in the United States and Europe the European Community Directive 2019/790 on copyright and related rights in the digital market is going to be applied [17].

Regulation in the television industry faces the challenge of adapting to an ever-evolving digital environment. While traditional media continue to be subject to national regulatory frameworks, streaming platforms often operate with less supervision, generating regulatory asymmetries. This shows the urgent need to update public policies to guarantee equity, protection of rights and fair competition in the global audiovisual ecosystem.

3.3 Economy

The global revenues of traditional television networks had very small increases between 2019 and 2022. Between 2019 and 2020, the increase was 0.64%. In 2019, revenues were $262,700,000 and in 2022 it was $269,400,000 [18]. In other words, traditional television networks did not expand significantly.

As for global subscriber revenues in traditional television networks, there was a slight growth from 204,800 million dollars in 2018 to 205,300 million in 2023 [19], which came from the hand of new subscribers, but these failed to balance the scales of the companies. As for cable TV, there was a slow decline in subscribers estimated from 438.8 billion users to 416 billion users in 2023 [19]. On the other hand, in the streaming sector, companies with Netflix, Amazon Prime or Disney plus grew. For example, Netflix, in the months of January, February and March 2020 had revenues of 5,767 million dollars, 27.6% higher than the 4,520 million dollars recorded in 2019 [20].

Video platforms such as Netflix, Amazon Prime, Apple Tv, Disney plus deliver various content to audiences and accumulate subscribers. For example, in the case of Neflix, in the first quarter of 2019, Netflix had 149 million subscribers. In the first quarter of 2020, Netflix gained 16 million new subscribers, which means it added 183 million subscribers [20]. It gained subscribers in all markets, 63% in Asia-Pacific compared to March 2019; and Latin America more than 25% with respect to year-on-year growth [20].

But 2020 was a beneficial year for streaming platforms. The confinement due to the effect of the global pandemic caused subscriptions to increase [21]. Netflix increased 20% from 2019 to 2020, Amazon Prime increased 58.7% from 2019 to 2020 and the big surprise was Disney plus which increased by 224.5% [21]. This shows that audiences are increasingly attracted by video platforms, and to a lesser extent by traditional pay networks.

As for advertising revenues on traditional television, it is established that there were slight increases. There was a slow growth in television advertising revenues, between 2018 and 2019 there was a growth of 0.96%, and between 2019 and 2020 it was 3.37% [21]. In 2019 there was an income of 166,300,000 dollars and in 2020 it is expected to reach 172,100,000 dollars [22].

La economía de la industria televisiva refleja la transición del modelo tradicional hacia el digital. Mientras los ingresos de la televisión convencional muestran un crecimiento limitado, las plataformas de streaming registran aumentos significativos en suscriptores y beneficios. Esta brecha evidencia un cambio en las dinámicas de consumo y en la sostenibilidad de los modelos de negocio, que obliga a los actores tradicionales a reinventarse para seguir siendo competitivos.

3.4 Technology

Technological changes have altered the way they produce and distribute audiovisual content. In the past, television had production and editing lines with equipment with cassette and tape; and moved to digital production [23].

On the one hand, the quality of the images increased, the supply of video equipment was diversified, prices were reduced, and they became popular [23]. At the same time, post-production began to be carried out in digital editing, supported by computers, through audiovisual editing and post-production programs. These changes in production and post-production meant that access to them was democratized, technical resources were saved, and program budgets decreased [24]. On the other hand, the distribution was altered, before it was carried out by distribution areas it became a global distribution. The insertion of the internet led to enormous changes in the sector, including the entry of new actors, which are platforms [24].

In terms of audiovisual content production, enormous changes have been made, where technology and experience are combined. Prediction tools based on consumer preferences are included, so that specific content can be produced for a specific consumer [25].

On the other hand, in the television industries, actors have understood the challenge and opportunity that the internet represents. Many traditional television channels have websites where, in addition to their conventional broadcast, they distribute their content.

In this way, the content can be seen whenever the viewer wants. Cases such as the American network CBS are interesting. The North American network has 16 acquired seasonal channels and 200 affiliated channels throughout the United States [26]. It has CBS All, an OTT that distributes content from stations such as CBS News, BET, Comedy Central, MTV, Nickelodeon, Smithsonian Channel, in addition to coverage of the UEFA Champions League [26].

The length and format of the series have undergone significant changes. While previously series seasons used to have between 21 and 24 episodes, now original productions on streaming platforms usually have between 8 and 13 episodes. Likewise, the duration of the episodes has increased, from 45–50 min to between 52 min and just over an hour [24]. Formats that were not common in traditional television, such as short films, have found their place on streaming platforms. An example of this is the animated series Love, Death and Robots, made up of short films ranging from 6 to 17 min [24]. In addition, productions from countries such as Norway, Germany or China, which previously had limited distribution and did not arouse great interest abroad, are now accessible globally. Examples of this are the German series Dark and the Chinese film The Wandering Earth, available on international platforms.

The impact of artificial intelligence has revolutionized the television industry. In 2018, the Chinese channel XinHua introduced the first virtual anchor, followed in 2023 by People's Daily News with Ren Xiaorong, a virtual anchor who broadcasts news 24/7 using AI to generate realistic language and images [27]. In Russia, SvoyoTV launched Snezhana Tumanova, a virtual weather presenter who interprets and presents climate data [28]. In 2024, India Today combined AI avatars with human presenters, enabling broadcasts in different dialects and improving audience inclusion [29].

Technology has been a central driver in the transformation of television, by digitizing production, distribution and consumption processes. The adoption of tools such as artificial intelligence and big data has optimized content creation and allowed for greater personalization. However, this development poses challenges in terms of ethics, equitable access, and technological dependence, especially for actors with fewer resources.

3.5 Audience

Audiences on traditional and pay TV channels have remained the same. For example, audiences on television channels in the United States. In 2019, broadcast and cable television channels CBS, NBC, ABC, Fox are the most watched channels in the United States. Channels like Univision and Telemundo have Hispanic supremacy [30].

In conventional television, audience measurement continues to be carried out through the rating system, which represents constant competition between the different television networks in each country. An illustrative example is found in Argentina, where the program El Gran Pastelero, broadcast by Telefe between March and June 2020, reached an average rating of 14.79% and an average of 679,223 viewers [31]. However, it is important to note that these figures are modest when compared to the reach of streaming platforms, such as Netflix, whose level of penetration is significantly higher. For reference, the documentary series Tiger King: Murder, Chaos and Madness, released on March 6, 2020, recorded approximately 64 million viewers worldwide [32].

On the other hand, a complementary tool for measuring audiences in the digital environment is engagement, understood as the level of interaction and behavior of audiences in front of content. This manifests itself mainly on social networks through indicators such as "likes", comments and shares [33]. Along these lines, Fernández-Gómez and Martín-Quevedo [34] carried out a study focused on Netflix Spain's engagement strategy on Twitter, analysing a total of 1,048 tweets. The research concludes that an effective promotion strategy consists of using the characteristic visual language of each series, which favors a greater connection and interaction with users [34].

There are significant attempts to incorporate the use of big data into audience analysis. In this sense, Prakash and Wenger [35] conducted a study that explores the relationship between Facebook engagement and the rating levels of local news channels. The research covered 705 newsrooms [35], and was based on data obtained from Facebook, as well as audience measurements provided by Nielsen and Shareablee. Through a regression analysis, the authors found a positive correlation between social media engagement and TV ratings, suggesting that certain news events can generate a simultaneous increase in digital interaction and traditional TV viewership [35].

Audiences have ceased to be passive recipients to become active participants in the television ecosystem, interacting through social networks and digital platforms. This transformation requires new forms of measurement, such as engagement, which complement the traditional rating. However, it also poses challenges in terms of audience fragmentation and the need to generate more segmented and dynamic content.

4 Conclusions

The television industry underwent several changes. In the analysis based on the five forces, proposed by Albarran, it is established that globalization has been key in the digital transformation of television, allowing streaming platforms to expand international markets, which has intensified competition and diversified the offer of content. This change has affected production, distribution and consumption, with audiences becoming more active and demanding.

In terms of the economy, streaming platforms, such as Netflix, Amazon Prime, and Disney+, have achieved accelerated growth in both revenue and subscriber numbers. Conventional advertising on traditional television has slowed down, focusing on the internet, leading to a decrease in revenue.

Technology in production and post-production plays an important role. Digitalization has democratized access to previously costly and complex resources, optimizing processes and reducing costs. Digitalization has enabled the creation of personalized content thanks to advanced technological tools and the use of data to predict consumer preferences.

Regulation continues to be a key aspect, especially in relation to frequency concessions and the management of copyright on digital platforms, highlighting the need for a legal framework that adapts to these technological changes.

The emergence of streaming platforms has largely shifted the public's attention towards these new formats, which allow greater control over content and its consumption. In addition, social media and engagement have added a new layer of interaction with audiences, changing the way content success is measured.

Based on the findings obtained, it is recommended that producers and other actors involved in the television industry adopt a strategic vision that actively integrates the opportunities and challenges posed by digital transformation. It is essential to strengthen technological and creative capacities to develop multiplatform, personalized and culturally relevant content, in tune with the new consumption habits of audiences. Greater articulation with digital platforms and social networks as spaces for distribution, promotion and feedback is suggested. Finally, the need to incorporate data analysis tools and trend prediction systems is emphasized, to make evidence-based decisions and maintain competitiveness in a constantly changing media environment. In this context, it is essential that professionals in the sector maintain an attitude of constant updating and openness to change, understanding that the sustainability and competitiveness of the television medium increasingly depend on its ability to adapt with agility to a technological environment in permanent evolution.

For future research, it is suggested to delve into empirical studies that collect the perceptions and practices of the different actors in the television ecosystem, including producers, content creators, audiences and technological platforms. Other studies could compare regional or national contexts, to identify patterns of technology adoption and cultural adaptation in different markets. These lines will enrich existing knowledge and offer more specific guidelines for decision-making in a sector marked by constant innovation and digital convergence.

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Arduino as a Tool to Support the Teaching of Microcontrollers at the Israel Technological University

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Abstract. The objective of this work was to analyze the effectiveness of Arduino as a support tool in the teaching of the subject Microcontrollers at the Israel University of Technology. We used an exploratory-descriptive study and a mixed approach with qualitative data such as activities performed in the subject, student averages and quantitative methods through the application of a survey to sixth level students of Electronics and Automation who took the subject in the academic period April–September 2024. It is concluded that the use of Arduino had a positive impact on the development of the subject Microcontrollers, reflected in the averages of students who passed the subject with grades higher than 9/10 points, in addition to participation in competitive events that encouraged motivation, surveys show that 90.28% of students strongly agree in the contribution of Arduino for the teaching-learning process, 91.67% strongly agree in satisfaction with the methodology and 94.44% strongly agree in the relationship of the content with professional practice.

Keywords: Arduino · simulators · teaching-learning · education

1 Introduction

Higher Education Institutions (HEIs) worldwide play a fundamental role in the development and progress of humanity. In addition to their role in training professionals, HEIs have a responsibility to society to incorporate technological tools to support the teaching-learning process.

The subject of microcontrollers facilitates the instruction of projects that utilise embedded circuits for the purpose of controlling the physical world. To this end, the utilisation of hardware platforms or free software has been expanded in the educational field, with Arduino proving to be a particularly useful tool, as it enables novices to acquire fundamental microcontroller programming skills.

According to Ocaña (2021), "Arduino is a very basic controller board designed with free hardware and software, simple and inexpensive, these features have made Arduino has become a very popular system for all kinds of control systems; being a free hardware, there are many low-cost clones, and being a free software, there are many new functions

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 197–207, 2025.
https://doi.org/10.1007/978-3-032-09080-5_21

available and programmed that anyone can use". Arduino is a valuable open-source electronics creation platform, offering free hardware and software, flexibility, and ease of use for creators and developers (Schmidt, 2022). It facilitates the optimisation of codes considering the hardware resources offered by the Arduino UNO board, enabling the creation of interactive objects, the reading of data from switches, sensors, and the control of lights, motors, and other devices. Notably, Arduino projects can either be stand-alone or configured to communicate with a computer program (software) (Fig. 1).

Fig. 1. Arduino UNO board taken from Schmidt (2022)

The Ecuadorian academic sector is seeking to address societal demands, as articulated in the National Development Plan, entitled the Opportunities Creation Plan (2021–2025). In terms of education, the Plan underscores the adequacy, relevance, effectiveness, and quality of the higher education provision, emphasising its alignment with societal needs and expectations. The Plan advocates for research, development, and innovation to foster employment opportunities within these sectors, while also fostering connections between institutions and global knowledge networks. Additionally, the Sustainable Development Goals are highlighted, particularly Goal 12, which is entitled Responsible Production and Consumption. Among the policies that guide this goal is 12.3, which states, "Implement best environmental practices with social and economic responsibility, which promote awareness, production, and sustainable consumption, from research, innovation and technology transfer". Undoubtedly, the Academy plays a pivotal role in environmental protection, a fact that should be reflected in its activities.

In accordance with the Educational Model of the Israel Technological University (USRAEL 2021-2025), innovation and research are encouraged among students. Within the context of Engineering Sciences, it is projected that the challenges of the diversification of intelligent systems for the command of production processes and services, intelligent telephony, digital television, robotics, information systems for all human activities with greater possibilities for decision making and level of reliability in their efficiency, robotics, information systems for all human activities with greater possibilities for decision making and level of reliability in the efficiency of the same. In this context, the use of Arduino contributes to the generation of projects applicable in various fields as it offers "a programming environment with which anyone can use and modify it" (Ocaña 2021).

In the context of classroom-generated research and projects, the extant literature posits that project-based learning, facilitated by tools such as Arduino, can enhance students' comprehension of concepts and boost their motivation (Perez et al. 2019).

The integration of practical activities involving Arduino is anticipated to foster a more profound comprehension of the subject matter, concurrently exposing students to a tool that is prevalent in industry settings.

According to Kourouklis et al. (2020), Arduino not only provides a conducive environment for learning, but also enhances students' practical skills. In the context of the Israel University of Technology, teaching microcontrollers presents a challenge, as students often face difficulties in understanding complex theoretical concepts that require practical skills for their application (Kourouklis et al. 2020). The application of technological tools is very effective in such cases.

This assertion is further substantiated by the findings of Smith and Johnson (2021), who determined that the incorporation of diverse activities and experiments employing Arduino fosters active and participatory learning, enabling students to apply theoretical concepts in authentic scenarios and practical endeavours.

1.1 Other Background

According to Salinas and Rodríguez (2019), "Arduino has become an effective pedagogical tool in higher education, facilitating active learning and critical thinking". This tool enables students to develop essential skills for contemporary professional contexts, such as problem-solving, collaboration and innovation.

The flexibility and accessibility of Arduino hardware and software have been shown to encourage inclusive teaching practices, Resendiz and López (2021) further posit that "devices such as Arduino provide opportunities for students from different backgrounds and skill levels to interact with technology in productive ways."

The UISRAEL educational model (2021–2025) is founded on a dialectical conception and emphasises the active role of the student in academic, labour and research domains, equipping them with the necessary skills to respond effectively to societal challenges and demands, thereby ensuring continuous improvement and societal needs.

The integration of Arduino in the educational curriculum has been demonstrated to be an effective means to strengthen critical thinking and problem solving (Anicha et al. 2020). Anicha et al. (2020) emphasise that the implementation of Arduino in the educational environment fosters active learning and stimulates students' creativity, thereby aligning with constructivist approaches that emphasise the construction of knowledge through experiential learning.

A fundamental aspect of UISRAEL's pedagogical resources is the adoption of new technologies in higher education, which is in accordance with the use of Arduino, as part of the open educational resources among which are: The Internet of Things (IoT) is predicated on the concept of a world in which all people, objects, and devices are interconnected and operating in synergy, irrespective of brand or provider.

The Integration of Arduino in the Context of Electronics Education

In the domain of engineering, the utilization of Arduino has demonstrated remarkable efficacy. As Torres et al. (2020) observe, "students can design, build, and test prototypes in a safe learning environment, which complements the theories learned in class." This practical application has been shown to enhance not only theoretical understanding but also to boost motivation and interest in learning.

A study by Korkmaz and Tüzün (2020) underscores the efficacy of Arduino in enhancing student engagement and motivation in the classroom setting. The authors further posit that students exhibit heightened motivation when confronted with the tangible components of the programming curriculum. This experiential educational approach not only reinforces theoretical concepts but also fosters active learning, thereby enhancing subject comprehension.

Furthermore, the integration of Arduino-based projects within the microcontroller education curriculum fosters the development of critical thinking and problem-solving skills. A study by Kocak et al. (2019) found that students working with Arduino tend to improve their ability to tackle complex problems and develop creative solutions (p. 78). This pedagogical approach, which emphasizes project-based learning, facilitates the application of students' knowledge in authentic real-world settings, thereby enhancing their readiness to enter the workforce.

Arduino has demonstrated notable efficacy in the domain of STEM education, particularly in its capacity to integrate theoretical concepts with practical applications and to equip students with the necessary skills to address authentic challenges in the real world (Bada et al. 2021).

Arduino has gained prominence as an effective educational instrument for instructing electronics on a global scale. This can be attributed to its simplicity, affordability, and the active user community that emphasizes hands-on learning (Méndez et al. 2020). This platform enables students to apply theoretical concepts through projects, thereby fostering a more profound comprehension of electrical and electronic principles. According to González (2021), Arduino-based projects not only stimulate interest in electronics, but also cultivate essential skills such as critical thinking and problem solving.

The effective integration of Arduino in educational settings necessitates the provision of comprehensive training for educators, complemented by a curriculum that is meticulously aligned with established educational objectives. This underscores the imperative to equip educators with the necessary skills to effectively guide students in their technological endeavors (Perez and Ramirez 2022). The capacity to swiftly prototype has led to enhanced student engagement in engineering and applied science initiatives. Karp et al. (2021) posit that the utilization of platforms such as Arduino not only fosters theoretical comprehension but also enables practical application, thereby engendering meaningful learning.

2 Development

2.1 Method

The methodological design is predicated on an exploratory-descriptive study because it analyzes the current situation of the University regarding the use of the Arduino tool as a support for teaching and learning. It employs a mixed approach by combining qualitative methods to describe the academic aspects in terms of activities performed as part of the subject Microcontrollers. The research was conducted at the Israel University of Technology (Israel University of Technology) in Israel. A survey was administered to all 72 students enrolled in the Electronics and Automation course at the sixth level during the academic period from April 2024 to September 2024.

The research was conducted at the Israel University, located in the province of Pichincha, in the canton of Quito, in the city of Quito, in the Ecuadorian highlands.

2.2 Results

The initial information reviewed was the results of the survey conducted by Albuja et al. (2023) among students and professors at the Israel Technological University on their criteria for digital badges as a tool for motivation and visibility of achievements at the academic level.

It is imperative to consider the graduate profile that has been formally declared for the Electronic Engineering and Automation graduate programme at Israel Technological University. "The graduate will be able to implement, operate and optimise electronic systems of automation and process control; with the ability to develop, understand and apply advances in science and technology in the labour field in which they work" (Israel Technological University, n.d.). An extract of the curriculum is presented in which it is appreciated in the sixth level of the career the subject Microcontrollers, which has a duration of 160 h (Table 1).

Table 1. Curriculum (excerpt from sixth level with subject brea down).

	LEVEL	Subjects	ACD	AP	AA	TOTAL
Professional Unit	VI	Microcontrollers	64	40	56	160

According to the Educational Model of the Israel Technological University (2021–2025), the following is true. According to this model, teachers and students are responsible for developing the educational teaching process. The model posits that learning is the result of the interrelation of three key elements: the learner's motivational intention, the process he or she uses—strategy—and the achievements he or she obtains—performance. In this regard, it is imperative to consider the development of cognitive and metacognitive strategies, in addition to the content to be learned. Furthermore, the manner in which students assume the task, the techniques they utilize, and the time and effort they dedicate to it must be taken into account.

Accordingly, the contents of the subject, "Microcontrollers with the Use of the Arduino Tool," are presented to support the teaching-learning process. This process is based on practical workshops that focus on the assembly of basic and complex circuits. The workshops also include individual and group projects that allow students to design applications using Arduino. Furthermore, the workshops include permanent evaluations to measure students' progress, understanding, and analysis of concepts to be applied (Table 2).

2.2.1 Use of Moodle Platform for Microcontrollers

Despite the face-to-face format of the Electronics and Automation course at UISRAEL, a virtual platform, Moodle, is utilized. This virtual platform contains a variety of ICT

Table 2. Learning Activities System Planning.

WEEK	TOPIC	EVALUATION ACTIVITIES
1	INTRODUCTION TO MICROCONTROLLERS 1.1 Introduction 1.2 Fundamental knowledge to enter the world of microcontrollers (Ar-duino)	- Write an essay on the fundamental principles of microcontrollers.
2	INSTALLATION, CONFIGURATION AND MANAGEMENT OF SOFTWARE 2.1 Installation 2.2 Electronic Platform	- Develop basic programs based on ARDUINO
3	MICROCONTROLLER PROGRAMMING 3.1 Programming and recording Microcontrollers	- Develop ARDUINO-based programs
4	MICRONTROLLER PROGRAMMING 3.2 Application Exercises	- Elaborate programs based on ARDUINO
5	MICRONTROLLER PROGRAMMING 3.2 Application Exercises	- Develops programs based on ARDUINO
6	APPLICATION PROJECTS WITH MICROCONTROLLERS 4.1 Development of skills for the design and construction of solutions, based on the needs posed.	- Develop projects in ARDUINO
7	APPLICATION PROJECTS WITH MICROCONTROLLERS 4.2 Actual practice in handling, programming and application of micro-controllers	- Develop projects in ARDUINO
8	APPLICATION PROJECTS WITH MICROCONTROLLERS 4.2 Actual practice in handling, programming and application of micro-controllers	- Develop projects in ARDUINO

As illustrated in Table 2, beginning in the second week of the eight-week course, Arduino programs and projects are incorporated into the learning outcomes.

resources designed to augment the course's subject matter, including microcontrollers, H5P, forums, and interactive activities. Additionally, this virtual platform serves as a repository for the submission of project evidence.

2.2.2 Final Project of the Subject Microcontrollers

To culminate the course, students will undertake a final project that will allow them to apply the knowledge they have acquired. The project will entail the development of a miniature juice robot utilizing the Arduino programming language. The following materials are to be utilized in the development of the project:

-Arduino board -High adherence rims with aluminum rim and screw × 2
-Two micromotors Pololu 300 RPM or 600 RPM - 8.50 17.00
-One 3D chassis -Three infrared proximity sensors Sharp
-One lipo battery 7.4 V at 300 mA Nanotech -One QTR1A floor sensor for motor
-One Arduino Nano controller with cable -One driver for TB6612FNG motor

As part of the subject project, a mini-juice robot competition is carried out to promote competitiveness and demonstrate the concepts of microcontrollers acquired in the classes. In addition, the competition demonstrates the usefulness of microcontrollers for areas of society in which they can contribute to the responsible consumption of resources by optimizing them through automation.

2.2.3 Results of Applied Surveys

The results of the surveys administered to the entire cohort of sixth-level students enrolled in the Electronics and Automation career demonstrated that the perception of students regarding the utilization of Arduino for the instruction of microcontrollers was satisfactory. This is attributable to the practical nature of the subject, which involves the creation of products through the execution of programs and projects guided by the instructor. Furthermore, the survey assessed students' satisfaction with the subject matter and the alignment of the curriculum with the demands of their future professions.

The survey utilized a scale ranging from 1 to 5, with 1 representing strong disagreement and 5 representing strong agreement. 5 strongly agree; 4 agree; 3 neither agree nor disagree; 2 slightly agree; 1 disagree.

Question 1. Do you consider that the use of Arduino as a tool in the subject Microcontrollers supports and facilitates the teaching-learning process?

A significant majority of respondents expressed strong agreement with the contribution of Arduino to the teaching-learning process of the subject Microcontrollers. Specifically, 90.28% of respondents strongly agreed, while 5.56% expressed agreement. In addition, 2.78% of respondents neither agreed nor disagreed, and 1.39% disagreed.

Question 2. How satisfied are you with the methodology used for teaching Microcontrollers?

The results indicate a high degree of satisfaction with the methodology of using the Arduino tool in the subject Microcontrollers. Specifically, 91.67% of respondents strongly agree with this methodology, while 4.17% agree, 2.78% neither agree nor disagree, and 1.39% disagree.

Question 3. Do you consider that the theoretical and practical contents of the subject Microcontrollers contribute to your training for the application in professional practice? contribute to your training for the application in professional practice?

An overwhelming majority of 94.44% of respondents expressed strong agreement regarding the alignment between the course's content and professional practice, while a modest proportion of 5.56% expressed agreement.

2.2.4 Grades Obtained by the Students in the Subject Microcontrollers

In the four existing parallel courses of the sixth level of the Electronics and Automation career, satisfactory results are presented in terms of content assimilation and practice with the use of Arduino. These results are reflected in the grades obtained at the conclusion of the course (Table 3).

Table 3. Averages achieved by the students who took the course Microcontrollers with the support of the Arduino tool.

Level/ parallel	No. of students who took the course Micro controllers	Number of students who passed the course with a grade greater than or equal to 7/10	Number of students who passed with grades higher than or equal to 9/10	% of students who passed with grades higher or equal to 9/10	Parallel/10 average
6 "A"	17	17	8	47,06	9,0
6 "B"	25	25	24	96,00	9,6
6 "C"	21	21	17	80,95	9,4
6 "D"	9	9	5	55,56	9,2
TOTAL	**72**	**72**	**54**	**75,00**	**9,3**

The findings indicate that 100% of the students successfully completed the Microcontrollers course, with 75% attaining grades of 97 and above, which is considered a passing grade. The mean average of all sixth-level grades is 9.3/10.

3 Discussion

The integration of open-source hardware platforms, such as Arduino, into higher education has generated significant interest within the academic community. This interest stems from Arduino's capacity to promote hands-on, active learning, a pedagogical approach that has proven particularly effective in the instruction of complex subjects, such as Microcontrollers.

The integration of microcontroller instruction has become a fundamental component of engineering and technology curricula, and the utilization of platforms such as Arduino has been demonstrated to be an effective pedagogical tool in this domain. Arduino, an open source hardware, enables students to engage with programming and electronics in a manner that is both accessible and practical, thereby facilitating their comprehension

of theoretical concepts. As asserted by Ponciano et al. (2020), the Arduino platform not only assists students in comprehending microcontrollers but also nurtures creativity and innovation. This is due to the platform's capacity to facilitate projects that integrate diverse academic disciplines, thereby enriching the learning experience.

Arduino is presented as an accessible solution that allows students to interact with electronic components and develop projects that consolidate the theory learned in class. According to Acuña et al. (2020), "the use of platforms such as Arduino in higher education not only enhances theoretical understanding, but also fosters the development of practical skills essential in the field of engineering" (p. 12). This hands-on approach is fundamental in a field such as microcontrollers, where learning is significantly enhanced through practice.

Conventional teaching methodologies, which are frequently lecture-based, have been found to be inadequate for effectively imparting knowledge related to microcontrollers. In this regard, the incorporation of active learning methods, facilitated by tools such as Arduino, has proven to be effective. Papert's (1980) constructivist learning theory posits that students can achieve knowledge construction through direct manipulation of materials, facilitating experiential learning. The Arduino platform offers a tangible medium for direct manipulation, thereby fostering an experiential learning environment where students can observe the immediate outcomes of their actions. This aspect is particularly pivotal in facilitating the assimilation of theoretical concepts.

In addition to technical learning, the utilization of Arduino fosters the development of soft skills, such as problem-solving and teamwork. As Hsu and Chen (2018) observe, "collaboration on Arduino-based projects strengthens interpersonal and project management skills among engineering students." Engaging in collaborative project-based learning with Arduino not only fosters an understanding of microcontrollers but also cultivates critical competencies that are essential for future careers. These competencies, as delineated by the graduation profile, encompass the implementation, operation, and optimization of electronic automation and process control systems.

Notwithstanding the aforementioned advantages, the implementation of Arduino as an educational instrument is not without its challenges. Preliminary studies indicate that the technological infrastructure within educational institutions may prove inadequate in supporting project-based teaching methodologies. Garcia and Martinez (2021) posit that "the lack of adequate resources and poor institutional support may limit the effectiveness of teaching with Arduino in educational settings." Addressing this issue necessitates the provision of comprehensive training for educators, ensuring they are equipped to provide guidance to students in their learning endeavors and to address any technical challenges that may arise.

Conversely, it is imperative to acknowledge the challenges associated with the integration of Arduino within the educational curriculum. Despite its benefits, some educators encounter difficulties in training and preparation to teach with this tool. As Alimisis (2013) astutely observes, "the absence of adequate training for educators can impede the efficacy of Arduino as an educational instrument." This underscores the necessity for training programs designed to equip educators with the necessary skills to effectively incorporate Arduino into their instructional practices, thereby maximizing its educational benefits. The effective implementation of Arduino in the classroom has the potential to

not only enhance technical education but also to prepare students for a future in an increasingly technological world.

The integration of hardware platforms such as Arduino has been demonstrated to transform conventional teaching methods, enabling students to engage more actively with theoretical concepts and enhancing their academic performance both before and after the implementation of Arduino (Brown and Patel 2020).

4 Conclusions

The findings lend support to the notion that Arduino, when employed as a pedagogical instrument, enhances the efficacy of the educational process in the domain of Microcontrollers. This assertion is substantiated by the observation that Arduino fosters active learning and facilitates the practical application of knowledge among students.

The utilisation of Arduino in the domain of Microcontrollers has been demonstrated to be efficacious in enhancing academic performance and fostering student motivation at the Israel Technological University, as evidenced by the learning outcomes, which demonstrate a 100% approval rate for the subject among students, with an average score exceeding 9/10.

The integration of theoretical foundations with practical applications has been demonstrated to facilitate the development of critical practical skills among students, with the support of the Arduino tool.

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From Competency Mapping to Cognitive Navigation: The OLIVE Project and the Metro Map Metaphor in Educational Guidance

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Abstract. The OLIVE (Online Learning and Interactive Vocational Education) project proposes a novel interdisciplinary framework to address the fragmentation and opacity of competency-based educational systems. It introduces a visuo-cognitive approach to academic guidance using the metro map metaphor. Drawing on research in cognitive metaphor theory (Lakoff and Johnson, 2003), educational semiotics (Sander, 2024), and visual knowledge representation (Burkhard, 2004; Shahaf et al. 2012; Wallinger, 2020), OLIVE leverages AI, UX/UI design, and semantic web technologies to develop a dynamic, navigable model of educational pathways. The project's ambition is to enhance the accessibility, modularity, and personalization of academic trajectories across French and Brazilian educational ecosystems. This paper presents the project's theoretical foundations, methodological structure, and expected impacts. It also explores OLIVE's ambition to foster the creation of a double-degree program based on the master's curriculum Management et Valorization de l'Information Numérique – MAVINUM at Université Paul-Valéry Montpellier 3, which specializes in data, knowledge, and digital information professions should summarize the contents of the paper in short terms, i.e. 150–250 words

Keywords: Knowledge Visualization · Metro Map Metaphor · Visual Learning · Competency-Based Education · Academic Guidance · AI Recommendation

1 Introduction

The transformation of educational systems in the 21st century increasingly demands personalized, flexible, and intelligible learning trajectories. Competency-based education—now a central paradigm in many national policies, particularly in France and Brazil—faces significant implementation challenges: heterogeneous frameworks, complex documentation, and insufficient tools for guidance. OLIVE emerges in this context as a response to the need for cognitive accessibility, interoperability, and learner autonomy.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 208–217, 2025.
https://doi.org/10.1007/978-3-032-09080-5_22

France and Brazil share similar educational concerns. In both countries, students often struggle to grasp the rationale behind competency-based curricula. Guidance counselors and academic coordinators lack interactive tools to articulate potential learning paths. The metaphor of the "learning journey" remains abstract without a shared visual or interactive representation. OLIVE seeks to operationalize this metaphor through a metro map-inspired interface that integrates data visualization, artificial intelligence, and pedagogical engineering (Fig. 1).

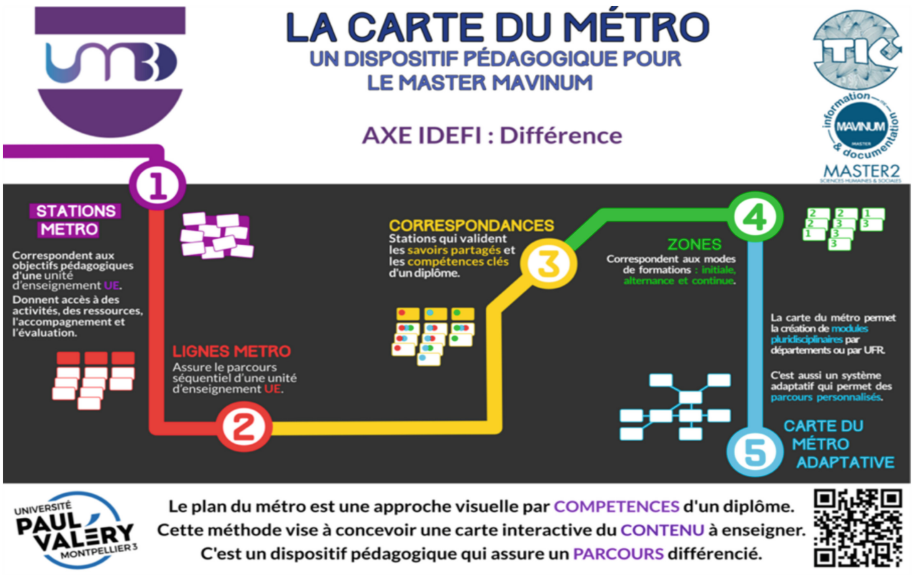

Fig. 1. Master Mavinum learning resources using metro map structures. Adapted from Blumer, E. and Schneider, R.

This article presents the OLIVE project in detail, linking it to current research on metaphors in education, knowledge visualization, and the cognitive structuring of digital environments. It aims to demonstrate how the metro map metaphor supports both the design of educational tools and the transformation of learners' mental models.

1.1 Theoretical Foundations: Metaphor and Cognition

Metaphors are not merely rhetorical devices but central to human cognition. As Lakoff and Johnson (2003) argue in *Metaphors We Live By*, *"our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature"* (p. 3). Conceptual metaphors structure the way individuals understand abstract domains through more familiar, embodied experiences.

In education, metaphors play a vital role in shaping how learners engage with knowledge. Emmanuel Sander (2024), in his introduction to *Les métaphores pour l'éducation*,

emphasizes that *"en provoquant le transport, la métaphore participe à la transformation de l'être humain"* (p. 2). Metaphors thus enable learners to transfer concepts across domains and reconfigure their understanding of learning situations.

The process of metaphorical thinking involves analogical reasoning. Holyoak and Thagard (1995) describe this process as a *"transport d'une idée associée à un mot vers une autre idée dont il fait ressortir la similarité avec la première"* (cited in Sander, 2024, p. 3). This is particularly relevant when attempting to explain complex, non-linear learning processes. For instance, the metaphor of a "journey" or "navigation" has been widely used in educational discourse, but rarely formalized into tools accessible to users.

Collard et al. (2012) explore the role of conceptual metaphors in the design of interactive systems: *"la convivialité […] résulte de la capacité de l'utilisateur à comprendre son activité. Cette capacité repose […] sur la cohérence du modèle mental élaboré par l'utilisateur à propos du système"* (p. 472). They argue that user-friendly interfaces align with users' metaphorically structured mental models.

In OLIVE, metaphors are not merely illustrative but constitutive of the design: they guide the ontology, the user interaction, and the overall logic of the system. The metro map does not merely represent knowledge—it structures how knowledge is encountered and navigated.

1.2 The Metro Map Metaphor in Knowledge Visualization

The metro map metaphor has gained recognition in knowledge visualization and digital learning environments. Burkhard (2004) introduced the "Tube Map Visualization" to represent long-term projects in a healthcare education context. He noted that *"the Tube Map Visualization is a powerful metaphor to communicate a complex project to different target groups and to build up a mutual story."*

Bang et al. (2002) developed the WebNize system to organize web-based learning resources using metro map structures. Their implementation demonstrated how *"Metro Map based tours"* could enhance guided exploration and collaborative knowledge building. Similarly, Shahaf et al. (2012) introduced *"Metro Maps of Science"* as tools to visualize coherent research lines: *"such methods can allow a user to explore a new, complex topic and discover hidden connections effectively"* (Shahaf et al. 2012).

Wallinger (2020), in his thesis on visualizing set data, confirmed that *"the Metro Map metaphor could be a good compromise between readability and scalability for medium-sized datasets"* (p. xi). He designed a seven-step pipeline to create coherent and legible metro-style diagrams from complex data structures.

These contributions emphasize the metaphor's dual function: cognitive (structuring knowledge) and communicative (facilitating dialogue and orientation). In the context of OLIVE, the metro map becomes both a tool for design and a tool for thought, enabling a new form of educational cartography that connects competencies, training modules, and professions.

1.3 Theoretical Foundations: Metaphor and Cognition

MetroTeach (Gonzales et al. 2019) serves as a precursor to OLIVE in its use of the metro map metaphor to model knowledge and skills in MOOCs. The authors explain that *"the*

metaphor of the metro map and of the journey makes it possible to design connections between the representation of knowledge and learning" (p. 2). Their system, MetroViz, supports personalized orientation through modular visual pathways, aligning with both pedagogical intentions and learner profiles.

The model builds upon Lakoff and Johnson's theory of embodied cognition by treating educational progression as spatial displacement. This metaphorical structure proves highly productive for mapping modularity and progression, with each "line" representing a thematic or disciplinary path, and each "station" indicating a skill, competence, or learning milestone.

MetroTeach also incorporates learner profile identification and adaptive itinerary suggestions, features that anticipate OLIVE's recommendation engine. As noted by the authors, *"we model a MOOC scenario as a metro map composed of intersecting lines and nodes, representing choices and dependencies between learning activities"* (Gonzales et al. 2019).

1.4 Theoretical Foundations: Metaphor and Cognition

OLIVE extends the logic of MetroTeach into a broader, multilingual, and institutional framework. Its primary objective is to render educational offers and their associated competencies intelligible to learners, trainers, and institutional actors. The project adopts a participatory approach to ensure inclusivity and cognitive accessibility.

At its core, OLIVE operates under the postulate of educability (Sander 2024), meaning that every individual is capable of learning and self-transforming if provided with adequate support. In this perspective, educational guidance must be dynamic, personalized, and transparent. OLIVE aims to bridge gaps between fragmented educational offers by visually aligning training units with job market needs and national competency frameworks.

Among its goals, OLIVE seeks to:

- Create shared visual grammar for education and training data;
- Facilitate academic orientation with AI-based recommendations;
- Integrate data from Brazilian and French repositories into interoperable maps;
- Support institutional decisions and policy alignment with UN Sustainable Development Goals (SDG 4, 9, and 17).

These objectives materialize through six interconnected Work Packages (WPs), addressing data engineering, ontology modeling, interface design, AI algorithms, pilot implementation, and dissemination. Each WP relies on iterative, design-based research to co-construct tools with educators and learners.

Ultimately, OLIVE positions itself at the intersection of educational science, design, and artificial intelligence, offering a paradigm shift from fragmented curriculum lists to integrated, navigable, and learner-centric educational ecosystems.

2 Methodology and Interdisciplinary Framework

The methodological foundation of OLIVE is rooted in a hybrid, interdisciplinary approach that integrates documentary engineering, pedagogical design, cognitive sciences, human-computer interaction, and artificial intelligence.

2.1 The OLIVE Project: Work Packages (WPs0)

The project is structured into six interconnected Work Packages (WPs), each contributing to the systemic modeling of an educational navigation platform:

- **WP1: Data Collection and Modeling** – focuses on harvesting educational frameworks, skill repositories, and training program data from French and Brazilian institutions. The harmonization of multilingual and heterogeneous data sources is achieved through ontology engineering and semantic web technologies.
- **WP2: Ontology Construction** – builds formal ontologies representing competencies, learning units, and professions. Inspired by existing frameworks (ESCO, CNP, RNCP), the goal is to create an interoperable semantic structure enabling cross-comparative exploration.
- **WP3: UX/UI Design and Visual Metaphors** – draws on design thinking and visual semiotics to create interfaces that support cognitive navigation. This WP employs user-centered methods including co-design workshops and persona-based prototyping, in line with Collard et al. (2012) and Verlaet's work on digital governance.
- **WP4: Recommendation Engine and AI Modeling** – uses machine learning to provide adaptive learning trajectories based on learner profiles, educational goals, and labor market demands. The engine suggests "next stations" on a user's learning path using similarity metrics and competency gaps.
- **WP5: Implementation and Evaluation** – includes technical development and pilot testing in real educational environments in France and Brazil. Evaluation criteria include usability, learning outcomes, and user satisfaction.
- **WP6: Dissemination and Policy Impact** – ensures the communication of results through open-access platforms, scientific publications, and engagement with institutional stakeholders.

3 OLIVE Visual Schematics

To concrete the project's concepts, several figures illustrate the design logic and implementation architecture.

OLIVE System Architecture – This diagram presents the modular composition of the platform, showing the flow from data sources through ontologies, visual interfaces, and recommendation services.

This network diagram of Master 2 MAVINUM, Fig. 2, highlights a modular structure where **Digital Project Management** acts as a central hub linking several key skills: digital communication, data valorization, and information governance.

- **"Information and Documentation Sciences"** serves as a theoretical foundation that connects to both transversal competencies and more applied modules.
- The **Professional Internship** is directly tied to **Research Methodology**, indicating that practical integration relies on strong academic foundations.
- **Information Governance** and **Cultural Data Valorization** emphasize the program's focus on real-world challenges in managing and promoting digital heritage.

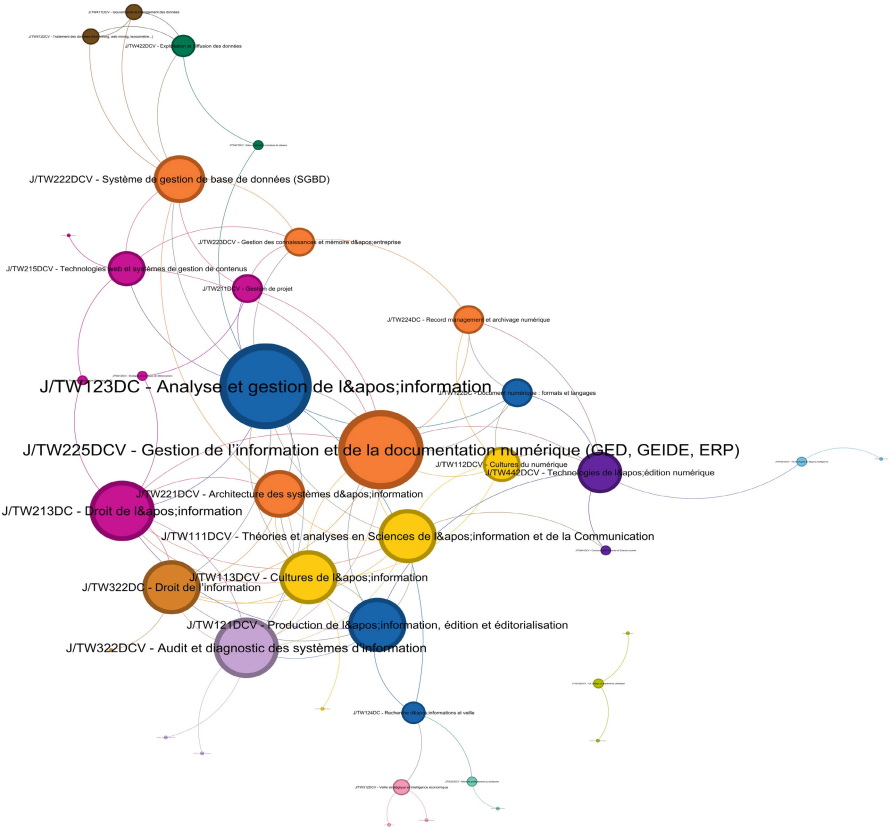

Fig. 2. Network Diagram of Master 2 MAVINUM.

The methodological innovation of OLIVE lies in its cross-pollination between disciplines and the translation of abstract educational constructs into interactive, navigable representations. It reflects a commitment to both scientific rigor and social utility.

Competency Ontology Schema, Fig. 3, shows a simplified ontology structure linking competencies to learning objectives, assessment criteria, and occupational profiles, modeled in OWL format.

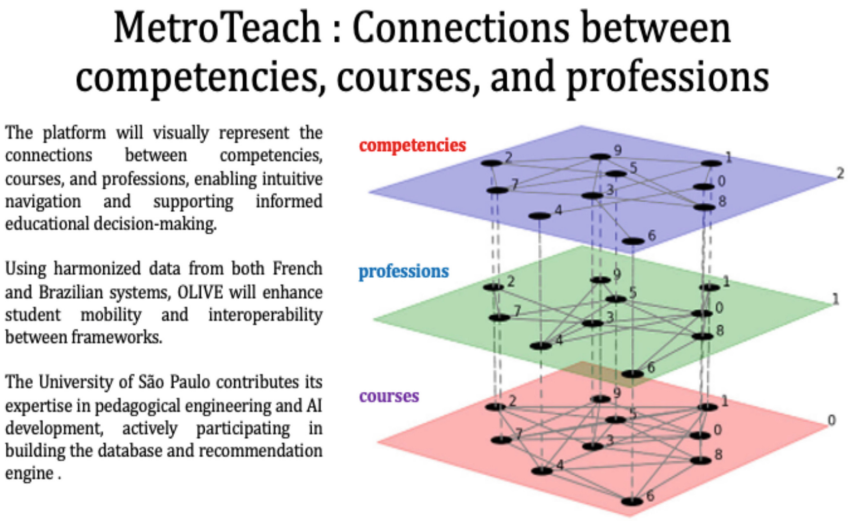

Fig. 3. MetroTeach connections: competencies, courses and professions.

These visual tools are not just illustrative. As emphasized by Burkhard (2004) and Shahaf et al. (2012), they play a critical role in supporting sense-making and dialogue across user groups. In the OLIVE project, they are co-constructed with stakeholders to ensure alignment with both cognitive ergonomics and institutional needs.

The combination of visual metaphor, participatory design, and semantic modeling underpins OLIVE's ambition to transform educational guidance into an intelligible and empowering experience for all users.

Educational Pathway as Metro Map, presented in Fig. 4, where a simulated learner journey is represented through a metro-style visualization. Lines correspond to thematic learning axes, while stations indicate modular learning blocks or milestones. Branches represent specialization options, and intersections indicate cross-disciplinary equivalences.

The OLIVE project (Optimization and Innovation for Lifelong Learning Experiences) focuses on improving lifelong learning processes through innovative approaches and technological tools. Its structure is divided into three key areas:

- **Line 1: Research** – This line focuses on using methods such as **Design Thinking** and **Data Visualization** to explore new ways of designing and visualizing learning.
- **Line 2: Pedagogical Innovation** – It aims to create new educational strategies, starting with the **Subway Map Metaphor**, exploring **Competencies**, and developing **Training Modules**.
- **Line 3: Decision Support System** – This area is responsible for developing technologies such as search engines and **AI for decision support**, leading to the creation of **Personalized Learning Paths**.

These three areas intersect at a central point: **User-Centered Design**, meaning all innovations and tools are created with users' needs in mind. The project aims to optimize the

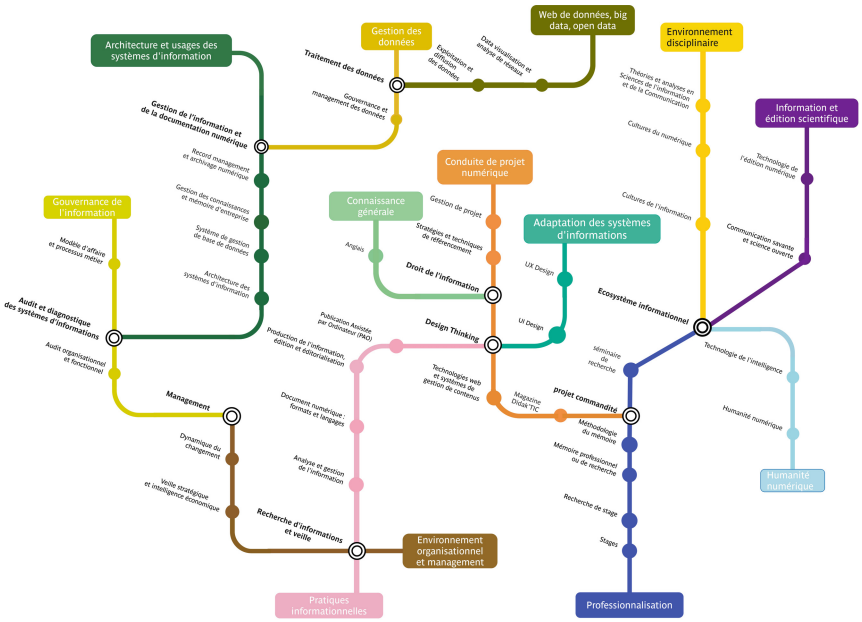

Fig. 4. Educational Pathway as Metro Map.

lifelong learning experience by combining research, innovative pedagogy, and advanced technological systems to support decision-making in learning.

4 Conclusions: Impact, Expected Results and Future Directions

The OLIVE project is expected to generate multidimensional impacts on educational ecosystems, both from pedagogical and technological perspectives. One of its primary contributions lies in enhancing the transparency and intelligibility of competency-based education. By making learning paths visually navigable and semantically coherent, OLIVE promotes learner agency and reduces the cognitive overload often associated with fragmented educational offerings.

Pedagogically, OLIVE supports active learning and self-regulation by enabling learners to visualize their progress and identify relevant trajectories. Instructors and curriculum designers benefit from clearer mappings between competencies, learning outcomes, and training programs. As noted by Gonzalez et al. (2019), *"the visual organization of knowledge and skills facilitates navigation and comprehension, even for non-experts."*

From a technological standpoint, the project integrates AI-driven recommendation systems that adaptively guide learners through personalized itineraries. This approach contributes to the democratization of intelligent tutoring systems by embedding them in intuitive, metaphor-based environments. The integration of open data, ontologies, and interoperable standards further reinforces OLIVE's value as an infrastructure for educational innovation.

At the institutional level, OLIVE supports strategic decision-making by providing visual diagnostics of program coverage, learner mobility, and alignment with professional domains. It offers educational authorities a tool for monitoring competencies and optimizing training offerings.

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Institutionally, OLIVE supports strategic decision-making by offering visual diagnostics of program coverage, learner mobility, and alignment with professional domains. It provides educational authorities with a tool for monitoring competencies and optimizing training offers.

On a broader scale, OLIVE aligns with three Sustainable Development Goals: SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure), and SDG 17 (Partnerships for the Goals). The project's output will be disseminated through open platforms, ensuring accessibility and reusability for future educational projects.

OLIVE represents a conceptual and methodological shift in how educational trajectories are represented and navigated. By merging metaphorical design with semantic modeling and artificial intelligence, it establishes a new paradigm for academic guidance—one that is user-centered, visually intelligible, and contextually adaptive.

The success of this paradigm, however, depends on sustained co-construction with users. As Collard et al. (2012) emphasize, *"la convivialité […] dépend de la capacité de l'interface à refléter les modèles mentaux des usagers"* (p. 476). Future iterations of OLIVE must therefore deepen their engagement with learners and educational staff through participatory workshops, iterative prototyping, and continuous feedback loops.

In terms of research, Fig. 5, OLIVE opens new avenues for studying the cognitive effects of visual metaphors in learning environments. Do metro-style representations improve long-term retention? How do learners interpret and navigate such interfaces across different cultures or disciplines? These questions invite empirical validation.

The project's scalability is another strategic consideration. While initially focused on France and Brazil, OLIVE's modular architecture and reliance on international standards make it adaptable to other national contexts. Its design could be transferred to higher education systems in Europe, Latin America, or Africa—provided that local taxonomies and pedagogical practices are integrated.

Finally, OLIVE contributes to the broader movement for open educational resources and data-driven governance in education. As Szoniecky (2024) argues, *"modéliser des écosystèmes de connaissances permet non seulement de cartographier le savoir, mais d'en favoriser la mise en débat et la régulation collective"* (p. 12). In this spirit, OLIVE's metro map does not merely show the way—it invites all actors to co-design the route.

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Curricular Characterization of Technical Modules to Align Training with Student's Professional Employability

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Abstract. This research aimed to characterise and redesign the didactic modules of the Electronics and Automation Engineering programme at the Universidad Tecnológica Israel. The goal was to meet the practical training needs of students who are already active in the industrial sector and require the rapid acquisition of technical competencies. A mixed-methods approach was adopted, combining a descriptive analysis of the current curriculum with an exploration of the differences between academic content and labour market demands. Data were collected from job platforms such as Infojobs, Kilur Tech, Multitrabajos, Geprom and Tecyges, enabling a detailed mapping of the skills required by industry, such as PLC programming, SCADA integration and industrial network management [1, 2]. Additionally, student surveys and technical meetings with educators revealed limited access to standardised practices and underutilised infrastructure, as well as a lack of ergonomic and safe environments. Based on these findings, a series of modular learning units were designed and simulated using CadeSIMU, incorporating LOGO! PLCs, HMI interfaces and real-time monitoring tools in order to replicate industrial scenarios [3]. Integrating these modules bridges the gap between theory and application, fosters skill development and enhances students' employability within a condensed academic timeframe [4]; Trevelyan, 2019). Implementing this model establishes the institution as a leading provider of technical education aligned with international standards and the evolving needs of the industry.

Keywords: Standardised Didactic Modules · Industrial Automation Training · Technical Employability

1 Introduction

The training of engineers in Electronics and Automation is characterised by the perpetual challenge of adapting its pedagogical methodologies to the technological imperatives of the industry and the labour market. Academic curricula mandate effective practices that facilitate the integration of theoretical knowledge with real-world applications. However, numerous studies have demonstrated that university environments are deficient

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 218–231, 2025.
https://doi.org/10.1007/978-3-032-09080-5_23

in adequate infrastructure and standardised modules that could facilitate such practical learning, thereby impinging upon the professional preparation of future engineers [2, 3]. This situation is particularly evident in the field of automation, where the mastery of control systems, programmable logic controller (PLC) programming and industrial networks necessitates educational environments that are equipped to simulate complex industrial scenarios [5].

At Israel University, the Electronics and Automation programme has identified a significant discrepancy between the theoretical training received by its students and the practical experience they have been able to acquire. This discrepancy can be attributed to the underutilisation of existing laboratories and the absence of standardised modules that facilitate the execution of academic practices aligned with the requirements of the national and international productive sectors [4]. In response to this identified problem, the present study proposes an institutional research project whose purpose is to design and implement automated modules that are capable of strengthening the technical training of students through the implementation of modern and replicable practices that are structured.

The scientific literature acknowledges the pivotal role of standardised modules in university laboratories in enhancing the quality of practical teaching. These modules facilitate the replicability of experiments, ensure the consistency of didactic content, and promote the acquisition of specific technical skills [6, 7]. Aragues et al. emphasise the necessity of integrating specialised software and hardware into academic practices to address contemporary technological challenges [3]. Furthermore, Barashkin et al. posit that the design of efficient laboratories should consider functional, technical and pedagogical aspects to maximize their impact on learning [2].

In this project, an exhaustive analysis of the curriculum of the Electronics and Automation degree programme has been carried out, with the aim of identifying the key subjects that require strengthened practices through the implementation of standardised modules. These subjects include Industrial Networks, SCADA Systems, Industrial Maintenance and PLC Programming. Concurrently, student surveys and technical meetings with specialised educators were conducted to ascertain the prevailing current limitations in the development of laboratory practices. The findings of this investigation indicated a necessity to incorporate more sophisticated practices that facilitate the emulation of the operational reality of industrial systems.

The present study employs a mixed method approach, incorporating documentary analysis, student surveys, an evaluation of existing resources, and technical planning of the module design. An electrical and spatial study of the laboratories was also considered in order to ensure the technical feasibility of the new devices without compromising the operability of the current equipment [8]. The methodological structure is based on international standards for the design of university laboratories [9], seeking to establish standardisation criteria that can be replicated in other subjects or educational institutions.

The results obtained will optimise the use of laboratories, improve the academic experience of students and strengthen their professional profile, responding to the demands of the labour market and the automation industry. In addition, the implementation of these standardised modules will contribute to the consolidation of an institutional culture of

practical learning, technological innovation and links with the productive sector, in line with global trends in technical education and vocational training [1, 5].

2 Methodology

The methodology used in this study is based on a mixed approach that combines quantitative and qualitative research techniques in order to obtain an integral characterisation of the didactic modules related to the subjects of Industrial Automation and Control Systems, Industrial Maintenance and Installations, Industrial Networks and SCADA Systems, and Process Transformation. This methodological approach responds to the need to understand both the demands of the productive sector in terms of professional profiles, as well as the perceptions and experiences of students regarding the development of their practical skills in the laboratories of the Electronics and Automation course [2, 10].

From a quantitative point of view, a descriptive analysis of labour demand was carried out by collecting information from specialised employment platforms such as Infojobs, Kilur Tech, Multitrabajos, Geprom and Tecyges. The search focused on job offers for profiles related to industrial automation, process control, maintenance and industrial network management. The aim was to identify the technical skills most in demand by the business sector, such as PLC programming, SCADA system integration, predictive maintenance and industrial communication network design [1]. This analysis made it possible to identify labour market trends and existing training gaps in graduate profiles.

In addition, structured surveys were carried out among the students who had taken the subjects studied, using validated instruments with closed questions and Likert scales. The surveys made it possible to evaluate aspects related to access, use and usefulness of the laboratories, as well as the level of practical application of the knowledge acquired. Subsequently, specific practical guides were developed for the aforementioned subjects, aimed at strengthening technical skills and the mastery of software and hardware applied to industrial processes, which were evaluated through structured questions focused on their applicability, relevance and transfer to the professional field [7].

From a qualitative point of view, working meetings were held with teachers in charge of laboratories and experts in automation, who provided technical criteria on the current situation of the modules, the need for updating and guidelines for their standardisation. This process made it possible to identify good practices, limitations and possible improvements in the design and implementation of practical activities. In addition, the normative documents and curricular guidelines of the Higher Education Council (CES) [11] were analysed to ensure that the proposed modules correspond to the basic knowledge required in each subject, according to the professional profiles and occupational fields defined for the career.

Finally, a technical field study was carried out, which included an inspection of the physical and technological infrastructure of the laboratories, an analysis of the spatial distribution of equipment, the need to relocate equipment and a review of the operating conditions for the implementation of the new standardised modules. This comprehensive analysis allowed the formulation of recommendations aimed at optimising the use of resources, improving the learning experience of students and ensuring the relevance of

academic content to the needs of the productive sector, within a technical education model that articulates theory, practice and links with the professional environment.

3 Technical-Pedagogical Development to Characterize Standardized Automation Modules in Higher Education.

3.1 Curriculum Review and Professional Alignment

The curriculum analysis of the Electronics and Automation degree programme shows a structure that integrates technical contents progressively distributed over the eight academic periods. Subjects such as Industrial Networks and SCADA Systems, Industrial Automation and Control Systems, and Industrial Maintenance and Installations are fundamental axes of applied training, oriented towards the design, programming and maintenance of automated processes. All subjects with a technical profile define the practical and technological requirements necessary to configure didactic modules that reproduce real industrial situations. From the official micro-curriculum, there is an orientation towards automation as a transversal core of the training.

When these subjects are compared with the requirements of the labour market, it is possible to identify recurring technical competences required by the Infojobs, Kilur Tech, Multitrabajos, Geprom and Tecyges platforms. These include the mastery of PLC programming, HMI management, industrial network configuration and control process analysis. This convergence shows that the contents taught in these subjects should reflect a direct applicability in industrial environments, especially in the areas of remote monitoring, preventive maintenance and programming of SCADA systems. At this stage, it is appropriate to show in Table 1 the comparison of the practical competences required in the professional field with the structured academic contents.

The mapping between the technical competences observed in the job offers and the expected learning outcomes shows a high degree of correspondence, especially for skills such as reading electrical plans, sensor integration, ladder logic programming and interpretation of industrial protocols such as Modbus or Profibus. However, some gaps are related to the lack of standardised practices that articulate these competences in real or simulated environments, where it is observed that the use of technical simulators does not replace the practical experience of the industrial environment. The standardisation of physical modules would make it possible to strengthen these links, ensuring that the acquisition of operational skills, in addition to the strategy of incorporating practical guides with embedded systems, programmable automats and industrial panels, becomes a decisive factor in ensuring effective technical preparation. Where the use of specific application modules, such as those available at the Israel Institute of Technology, does not allow the necessary competencies to be achieved by students who have very little knowledge of the industrial field, since they are process operators and not junior developers.

The review of the guidelines of the Higher Education Council (CES) in relation to the harmonisation of the graduate profile, the curriculum and the relevance to the labour market confirms that the training must be supported by criteria of technical integration, sustainability and employability. The relationship between the required modules and

Table 1. Comparison of minimum competencies with labor demand.

INFOJOBS	**Higher Level Training Cycle/PLC PROGRAMMER**	
	PLC programmer for automation projects in industrial environment..	Specialists in PLC programming with experience in Siemens and Rockwell platforms, with knowledge in other platforms (Schneider, Omron, etc).
KILUR TECH	**Ladder Programming**	
	In the industrial environment, the mastery of AB equipment represents a strategic advantage for professionals, enhancing their competitiveness and performance.	Ladder Programming 1, Communication between PLC and PC 2. Wired Logic (Contacts) 3. LADDER language 4, PLC electrical connections 5, Programming of sequences using the physical inputs and outputs of the PLC.
	PLC Maintenance and Automation Technician	
MULTITRABAJOS	Maintenance and plc automation technician	1. In-depth knowledge of its operation and application, specifically in platforms such as Logo! Soft Comfort. 2. Experience in the configuration and use of virtual machines to integrate and operate industrial automation software. Functional diagrams interpretation: 3. Ability to work with function diagrams and perform configurations directly on PLC equipment, optimizing industrial processes.
	Junior PLC Programmer	

(*continued*)

Table 1. (*continued*)

GEPROM	Technician: Superior Degree in Electricity and Electronics or Electronic Engineering, Electricity, Superior Degree in industrial automation or similar.	1. Knowledge in programming of the main PLC of the market, especially SIEMENS S5-S7-TIA PORTAL, OMRON CX-PROGRAMMER, among others. 2. Programming of the main PLCs in the market, especially SIEMENS S7-TIA PORTAL, OMRON, among others. Programming of HMI screens (TIA PORTAL) / WIN CC.
	Programador PLC Senior	
Tecyges	Development and specification of new software projects, commissioning of the machines we manufacture and their maintenance. .	1. Somachine for M251 / M241 controllers 2, Ethernet / IP communications 3, Lexium 28 servos or similar 4, Serial communication 5. Data acquisition for data base storage 6. Minimum experience of at least 5–10 years in PLC programming.

the above-mentioned subjects is reinforced by the CES regulations, which require the link between professional training and the needs of the productive environment; in this context, the design and implementation of standardised modules not only optimises the academic process, but also ensures correspondence with the professional profile and market requirements.

3.2 Functional Characterization of Module Requirements

The functional characterization of the practical modules must consider both the pedagogical structure and the technical requirements of each learning unit; in this context, the design of modules such as SCADA Module, Motor Control Module, Sensor Module, which correspond to key contents in subjects such as Automation and Industrial Control Systems and Industrial Networks and SCADA Systems. The exercises associated with these modules have been specifically designed to develop the competences required by the working environment, as shown in the analysis of professional needs in Table 1, in order to achieve the required knowledge:

Week 1: Alternating control of two pumps with PLC (handling of digital outputs, inverting logic, motor starting safety).

Week 2: Traffic lights with PC Simu (sequential timing, basic HMI simulation, testing conditional logic).

Week 3: Counters, dynamic timing and alarms in PLCs (up/down counters, use of comparators, alarm management)

Week 4: Evaluation of knowledge and logic applications (integration test of basic LOGO! Soft Comfort concepts)

Week 5: Traffic light design with LOGO WEB EDITOR.

(simple visual interfaces, remote control via browser, mobile application).

Week 6: Master-slave communication (simulation of basic industrial networks, data transmission between PLCs).

Weeks 7 and 8: Final Integration Project (solving an automation case study based on a real technical problem).

The expected functions of these modules include the simulation of industrial processes, real-time monitoring and the interaction between networked devices, through exercises such as the management of counters, dynamic alarms and master-slave configuration, allowing the development of skills in programming, control logic and industrial communication; these exercises are directly related to the performance standards defined in the profile of the graduate of the profession, as can be seen in Table 2 of the bill of materials.

In terms of technological compatibility, the modules have been designed primarily to work with Siemens LOGO! controllers, due to their low cost, ease of configuration and high level of adaptability to the educational environment. This equipment allows the implementation of basic automation functions through a friendly interface, ideal for teaching-learning processes in the first levels of industrial programming. The choice of LOGO! facilitates a progressive learning curve and promotes the development of fundamental skills in programmable logic control.

3.3 Physical and Technological Environment Analysis

The analysis of the physical environment (Fig. 1) showed that the infrastructure of the laboratories has shortcomings that directly affect the quality of the training process; the distribution of the existing modules (Fig. 2) was very grouped by the distribution of 220 V sockets, in addition to the efficient use of space, causing operational interference between workstations. In addition, the current electrical conditions do not meet the minimum safety requirements, since multiple sockets without adequate channeling, lack of differentiated protection and insufficient ventilation in areas where high-demand electronic equipment is used have been identified; these conditions limit both the use of space and the performance and safety of academic practices.

The diagnosis of the current equipment compared to the projected needs allows to identify a growing demand for workstations, especially in technical subjects that require individualized practices or small teams. From the results of the surveys carried out among the students of the profession, it has been established that there is an urgent need to increase the number of functional modules for automation, since the current ones are not sufficient to cover the demand in peak hours and in specialized practices. This gap limits the frequency and depth of practical experience, which affects the development of skills in critical areas such as process control, monitoring of industrial variables and configuration of automated systems (Fig. 3).

Table 2. List of materials of the module.

No.	Component	Technical Specification	Functional Purpose
1	Three-phase breaker	220 VAC, 16 A	Protection for 3-phase power circuits
2	Single-phase breaker	110 VAC, 1 A	Power input protection for the panel
3	Thermal fuse	5–34 VDC, 3 A	Protection for 24–12 VDC circuits
4	Power supply 5VDC	5 V, 500 mA	Powers the network switch
5	Power supply 24VDC	24 V, 16 A	Powers PLC, HMI, and other modules
6	DC-DC Converter LM2596	Input: 24 VDC; Output: 12–10 VDC	Voltage adjustment for control systems
7	Ethernet switch	5-port gigabit	Establishes network communication
8	Contactor	3 kW or 9 A, 110 VAC	Actuation of 3-phase power circuits
9	Relay	24 VDC	Controls the contactor coil at 110 V
10	HMI Wecon 7”	RS-232/422/485, Ethernet, Wi-Fi, 24 VDC	User interface for system control
11	Analog input module	0–10 VDC, 4–20 mA	Acquires analog signals for processing
12	LOGO! PLC 8.4	12–24 VDC, 8 DI, 2 AI, 4 DO, Modbus TCP/IP	Main controller for automation tasks
13	Potentiometer	10 kΩ	Voltage modulation for analog input
14	Banana plug jack	4 mm female	Connection for cables and circuits
15	NO push button	10 A	Manual activation for various uses
16	NC push button	10 A	Manual deactivation or interruptor function
17	2-position selector switch	NO contact, 10 A	Selection between two states
18	3-position selector switch	Double NO contact, 10 A	Selection between three modes

(*continued*)

Table 2. (*continued*)

No.	Component	Technical Specification	Functional Purpose
19	Emergency stop	Retained closed contact, 10 A	Safety shutdown of the system
20	Pilot light	24 VDC	Visual signaling indicator

Fig. 1. Reconfiguration of the electronics and automation laboratory space

3.4 Modular Implementation Plan Preliminary Design

In terms of constraints on the implementation of new modules, limitations were identified in terms of both technical aspects and ergonomic criteria. The existing workstations did not consider basic principles of comfort, proper posture or accessibility for students, which led to discomfort and physical risks during prolonged sessions. This situation affected concentration, use of exercises and safe handling of equipment. In view of this, it was necessary to redesign the laboratory layout with a focus on ergonomics, prioritizing functional workflows, adequate distances between modules, orderly arrangement of cabling, cross ventilation and work surfaces at appropriate heights. This redesign aims to create an environment that promotes active and safe learning, facilitating constant interaction between students and technological resources (Table 3).

As part of the preliminary design, a detailed simulation of the functional module was developed in the CadeSIMU platform, allowing the system behaviour to be validated prior to physical implementation. The schematic shows a Siemens LOGO! controller connected to a system of digital inputs and outputs, pushbuttons, indicator lights and a three-phase motor controlled by contactors. A Wecon type HMI (simulated) interface is also incorporated for variable monitoring and status display. This simulation makes it possible to verify the programming logic, the operation of the thermal protections and the interaction between the components, ensuring that the module meets the technical and pedagogical requirements defined for academic practice.

The results of the student survey reflect a clear perception of the inadequacy of the equipment available for practical laboratory work. As shown in Fig. 5, 54.5% of

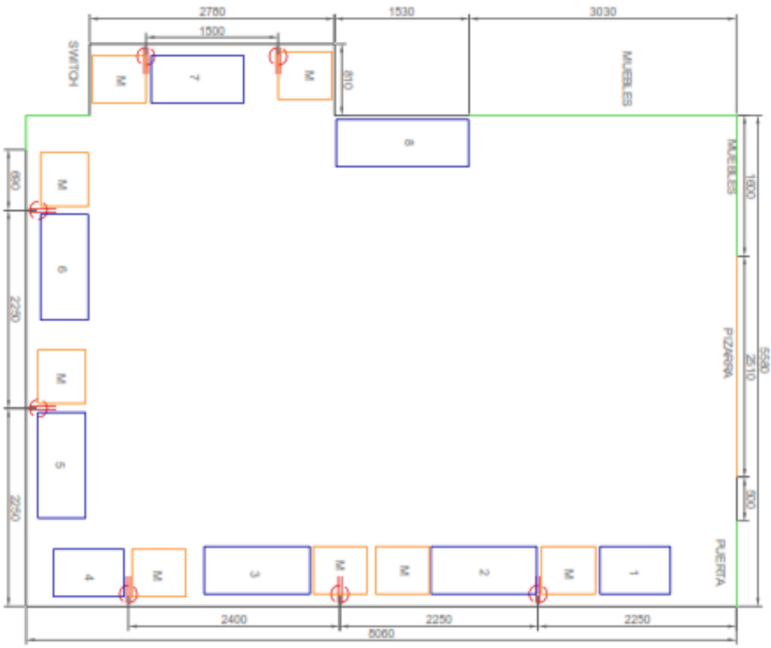

Fig. 2. Redistribution of modules in the laboratory

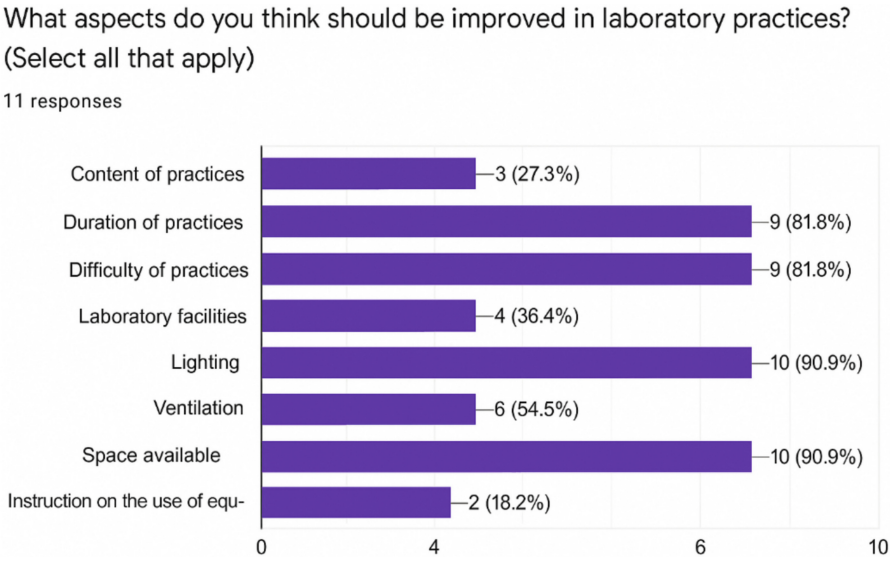

Fig. 3. Survey on laboratory practices in Industrial Networks and SCADA Systems

respondents felt that the amount of equipment was sufficient but with limitations, while 45.5% felt that it was insufficient. This trend demonstrates the urgent need to improve the

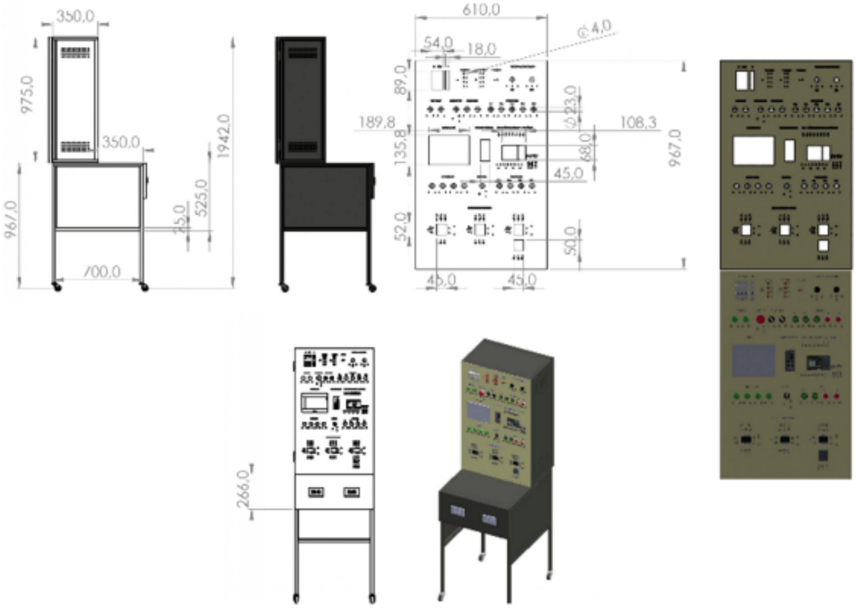

Fig. 4. Design scheme of the didactic module

Table 3. Design and ergonomics parameters

• ERGONOMIC APPEARANCE	• DESCRIPTION
Height:	• The proposed height is 1.94 m and 70 cm wide, which allows the users to have a correct posture during the start-up during the elaboration of practices.
Body posture:	• According to the position of the display and control system, users can manipulate the controls and components without adopting incorrect postures while working on the module.
Accessibility of controls:	• As for the maneuverability of the emergency stop, it has been strategically placed for quick response and safe operation of the system. (Galván Sánchez, 2012).
Visibility:	• Design and implementation of a didactic module for the elaboration of practices oriented to industrial processes with emphasis on electro-pneumatic and pneumatic systems, plc-hmi interface (Fig. 4).

operational capacity of the laboratory by incorporating new practical modules that ensure equitable access to resources for all students. Increasing the number of workstations will not only optimise usage time, but also improve the quality of technical learning by avoiding equipment saturation at peak times (Fig. 6).

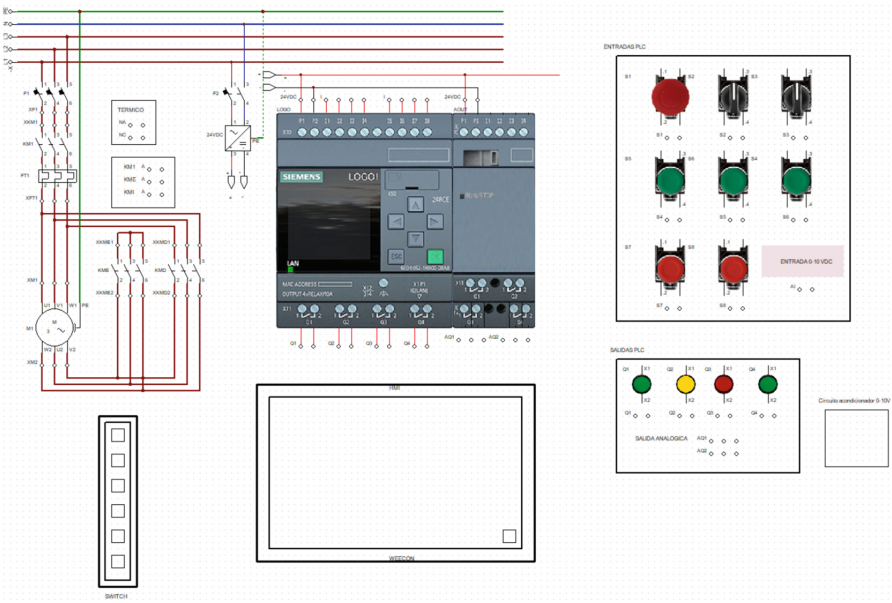

Fig. 5. Proposed schematic of the module in CadeSIMU

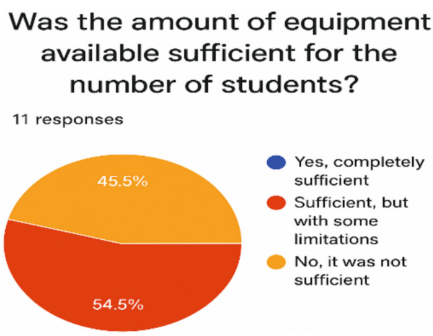

Fig. 6. Student responses on the sufficiency of laboratory equipment

4 Discussion of Results

The development of standardised didactic modules addresses the specific requirements of students at the Universidad Tecnológica Israel, many of whom are already employed in industrial settings. Such learners require intensive, targeted training strategies that bridge

the gap between theory and practice in a short period. Modular systems provide a flexible, replicable approach to acquiring skills, enabling students to simulate real industrial processes in a controlled academic environment. Unlike traditional learning methods, this model enables immediate immersion in automation practices. This approach aligns with the accelerated learning goals of working professionals seeking to complete their engineering degree efficiently.

Furthermore, integrating hands-on modules that are tailored to industrial technologies enables students to enhance their technical competence while fulfilling their professional obligations. The proposed structure includes modules on PLC programming, HMI interfaces and SCADA systems to foster autonomy and problem-solving, which are key competencies in modern automation roles. These modules are pedagogically and technically effective, offering a high degree of transferability to the workplace. By adapting to the temporal and cognitive demands of adult learners, the institution establishes itself as a leader in applied technical education. This practical focus sets the programme apart from traditional academic models, which often lack industrial relevance.

5 Conclusions

The integral analysis of the curriculum, the requirements of the professional profile and the physical conditions of the laboratory showed the need to incorporate standardised modules in the academic practices of the Electronics and Automation programme. The functional characterisation and preliminary design developed in platforms such as CadeSIMU allowed the technical validation of the proposals, demonstrating their viability and relevance in terms of learning objectives and the requirements of the working environment.

As a result of the study, the Israel Technological University formally implemented the modules designed in the P4–10 laboratory, setting an institutional precedent in the strengthening of practical training spaces. This action guarantees a significant improvement in the quality of the teaching-learning processes by providing students with access to ergonomic environments that are technically adequate and aligned with current industrial technologies, thus promoting the training of highly competent professionals.

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Perceptions of Interculturality in Higher Education

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Abstract. This research seeks to construct a scale of perceptions on interculturality among higher education stakeholders by reviewing, adapting, and reconstructing the instruments used in the publications analyzed between 2020 and 2025. The inclusion criteria for selecting publications contemplate that the subjects studied be represented by university professors, lecturers, and students, in the year of publication, covering the period between 2020 and 2025, with a minimum of 18 citations. The databases of the scientific journals consulted include Scielo and Google Scholar. Among the results, the coincidence in the use of the Likert-type scale in the reviewed articles stands out, covering both even and odd-numbered scales. The importance of the most widely used pioneering instruments is highlighted: The Questionnaire of Attitudes Toward Interculturality (CAI), the Scale of Attitudes Toward Cultural Diversity (EADC), the Fantini Intercultural Competence Scale, and the Scale of Attitudes Toward Intercultural Edu- cation (EAEI). The construction of the "Perceptions towards Interculturality in Higher Education", composed of seven dimensions: Negative Intentions, Positive Intentions, Positive Beliefs, Negative Beliefs, Negative Emotions, Positive Behaviors and Support Capacity, of 3 items each, totaling 21 in the instrument. The neutral wording of each item seeks to avoid bias in the responses.

Keywords: perception · interculturality · higher education

1 Introduction

The term "interculturality" first emerged around the 1990s, in the context of debates related to human rights, education, and cultural diversity.

Thus, UNESCO [1], in the Universal Declaration on Cultural Diversity, highlighted the importance of cultural pluralism and, consequently, fostered the understanding of cultural dialogue as an instrument for peace reconciliation and sustainable development.

It is worth noting that the term "interculturality" already existed in social and academic circles, but it is precisely beginning to be used and formally adopted due to its relevance to the coexistence and development of culturally diverse societies.

In this context, it is important to highlight that the indigenous population represents approximately 6% of the world's population, a figure presented by organizations such as the United Nations and the World Bank for the year 2025.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 232–237, 2025.
https://doi.org/10.1007/978-3-032-09080-5_24

In Ecuador, this percentage reaches approximately 7.69% of the total national population, according to figures obtained from the National Institute of Statistics and Censuses (INEC) [2] collected in the Population and Housing Census.

In this sense, it is imperative to recognize the diversity of groups from diverse cultures that coexist in Ecuadorian territory, represented not only by the different nationalities, nations, and Indigenous peoples of the nation, but also by those present as a result of regional and global human mobility. This invites us to reflect on the im- portance of incorporating these representative populations into social dynamics, respecting their educational rights.

As Ecuador is a multiethnic country, it has a set of government instruments that guarantee that the groups it represents receive education in their own language. These include the Constitution of the Republic (National Assembly) [3], the National Development Plan [4], the Law on Intercultural Higher Education (SENPLADES) [5], the Higher Education Law of the National Assembly [5], and the Organic Law on Intercultural Higher Education (National Assembly) [6].

In this regard, Corbeta [7] asserts that it is precisely in Latin America where the concept of interculturality in the educational field emerges; hence the relationship between interculturality and education, based on the assertion that a group of countries in the region is considered multiethnic, with their own languages and the cultural diversity that characterizes them.

Understanding multiculturalism as a process that revolves around social reality and, therefore, education, which is imbued with and subject to being experienced and given meaning by the perceptions, beliefs, and feelings of each of its participants. Therefore, it is important to review some concepts related to perception, given that it involves the way human beings understand and make sense of their interactions with their environment.

From this perspective, it can be understood that perceptions, in one way or another, influence the way individuals express their feelings, behaviors, and conceptualization of diverse social reality.

In this sense, Vargas [8] states that “in the process of perception, ideological and cultural references come into play that reproduce and explain reality, and are applied to different everyday experiences to organize and transform them” (p. 49).

Therefore, understanding that perceptions not only direct but also condition people’s behavior is an important element to take into account. In the field of psychology, the concept of perception is defined as a cognitive process that involves recognizing, interpreting, and giving meaning to form judgments about the sensations we obtain from the physical and social environment.

Allport [9] explains perception as an element that includes the understanding of environmental circumstances, as well as the ability to perceive each of the objects that constitute them.

In this context, the literature review allows us to affirm that perception can be defined as a biocultural concept, given that it is determined both by the physical stimuli and sensations involved, as well as by the organization of these stimuli and sensations, upon which sensory experiences depend, which are interpreted and assigned meaning to interactions. These experiences are conditioned by cultural and ideological patterns learned from the earliest years of life.

Thus, Vargas et al. [9] affirm that perception is a dynamic process involving a set of elements that remain in constant interaction, in which not only society, but also the individual themselves, play a significant role in shaping the individual's particular perceptions of each social group, which implies a set of prejudices and stereotypes that shape their opinions about people.

Auzmendi [10] argues that attitudes can be defined as elements provoked by beliefs, feelings, and predispositions that manifest in behaviors oriented toward a specific element. Sales and García [11] assert that attitudes range from positive to negative, thus influencing our actions toward people or social situations. Gómez expands on the idea that attitudes can be considered not only positive and negative predispositions but can also be translated into personal aspirations that influence behavior.

According to Baron and Byrne [12], an attitude involves an affective reaction, positive or negative, directed toward an object, and they argue that attitudes are learned and remain stable over time.

From the perspective of the traditional model, attitude is conceptualized through three components: Cognitive, affective, and behavioral, also known as the tendency to action (Morales [13]). This holistic approach recognizes that attitude involves not only thoughts and feelings, but also an inclination toward a specific action.

The cognitive component refers to facts, opinions, beliefs, thoughts, values, knowledge, and expectations related to the object in question. In this sense, Urbay [14] states that the disposition toward an object is conditioned by the level of knowledge one has about it. Generally, this component is related to a person's beliefs and values, while Morales et al. [13] assert that the attitude toward an object is linked to the person's beliefs about that object.

Understand that beliefs are related to affective, evaluative, and social elements, associated with cognitive structures that allow the individual to organize and filter the information received. The affective component is presented below. Some authors, such as Fishben and Raven (1962), cited by Hogg [15], consider it the only distinctive feature of attitudes. Others, such as Mann (1972), cited by Hogg et al. [15], con- sider it the most deeply rooted and resistant to change. This component encompasses feelings, emotions, moods, and preferences, which manifest physically and emotionally toward the object of the attitude. Therefore, one may experience tension, anxiety, worry, or happiness in response to the object.

On the other hand, the conative or behavioral component refers to actions, behaviors, or responses for or against the object. Thus, positive feelings provoke closeness to the object of the attitude, while negative ones incite avoidance. Gómez Chacón [17] defines it as "the tendency toward a certain type of behavior" (p. 23), classifying it as "tendential," given that the action is not always carried out.

These three components constitute the so-called pedagogical components according to Eagly [17], so named because they operate in educational settings.

This brief approach to perceptions and their transformation into attitudes and their components, which significantly influence the educational field, invites reflection on interculturality. In particular, it invites us to understand how perceptions of interculturality are constructed in higher education.

2 Material and Methods

This product was developed through quantitative research based on documentary analysis. A descriptive scope was adopted, according to Hernández [18]. Regarding article selection, inclusion and exclusion criteria were established based on the year of publication, covering the period from 2019 to 2025, with a minimum of 18 citations.

This review was based on consulting scientific journal databases, including sources such as Scielo and Google Scholar.

The research process was developed in three main, interrelated phases, which ensured reliable and conclusive results.

The first phase consisted of an exhaustive bibliographic search in recognized scientific journals and academic databases. The search considered the terms "perceptions," "interculturality, "and "higher education." This exhaustive analysis allowed for the compilation of various publications relevant to the topic.

In the second stage, the information was filtered to refine the results and ensure the inclusion of the most relevant articles. Strict criteria were established, including the presence of key terms such as "perceptions," "interculturality, "and "attitudes." Likewise, time constraints were considered to ensure that the selected articles were contemporary and representative of the most recent advances in the field of social psychology and interculturality, as well as the language used.

After selecting the relevant articles, a thorough analysis of each one was conducted, obtaining data on the perceptions of educators, teachers, and students regarding interculturality in education. During this process, attention was focused on the methodologies and instruments used to collect the information, as well as the results obtained from each study reviewed. This analysis allowed for the identification of concurrent bibliographic references and the characterization of the research instruments used.

In summary, the implementation of a strict and organized methodology allowed for a systematic investigation of the conceptualizations, characterizations, and instruments used to understand perceptions of interculturality in higher education. The results obtained from this research offer an updated perspective on the topic, allowing for the construction of an instrument, the Intercultural Perceptions Scale. This scale, therefore, represents a substantive contribution to future research.

The validity of this scale was developed using the expert judgment validity criterion, in which three (3) PhDs in educational sciences participated. Content validity modalties were applied to ensure that the instrument adequately addressed the relevant aspects of perceptions of interculturality, thus guaranteeing its robustness and reliability as a measurement tool in subsequent research.

3 Results

The analysis of the selected articles allowed for the development of the table, which systematizes significant elements regarding the most commonly used instruments. To this end, elements such as dimensions, types of scales used, and their intended uses will be considered.

The articles reviewed consistently use Likert-type scales, both even and odd, with four or five response options. Furthermore, the dimensions addressed allow us to infer a certain relationship with the components of attitudes.

In conclusion, the references consulted offer information on interculturality, multiculturalism, perceptions, attitudes, and their components, which represent the key terms of this research.

4 Discussion

The review and analysis of the articles consulted allowed for the construction of the Perceptions of Interculturality in Higher Education scale. It began with determining the purpose, followed by a conceptualization of perceptions and interculturality, as well as its dimensions. Three items were written for each dimension, completing a total of 21 items in the instrument. The wording of each item is neutral to avoid any bias in the responses.

The Perceptions of Interculturality in Higher Education instrument adopts the categories or dimensions of the instrument (Llorent and Álamo, 2016a). Therefore, it was structured into seven dimensions: Negative Intentions, Positive Intentions, Positive Beliefs, Negative Beliefs, Negative Emotions, Positive Behaviors, and Support. These are consistent with the attitudinal components and conceptualizations of perceptions.

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Application of Augmented Reality in the Practical Teaching of Electrical Machines and Industrial Control

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Abstract. The objective of this study was to develop a mobile Augmented Reality (AR) application as a didactic tool for the Electrical Machines and Industrial Control course in the Electronics program at the Instituto Superior Tecnológico Tungurahua, aiming to improve student learning outcomes in virtual mode. Using the Design Thinking methodology, an interactive solution was designed and prototyped that allows students to visualize and manipulate 3D models of electrical components, enhancing their understanding of complex concepts and facilitating autonomous practice. The application development was based on software such as Blender 3D, Unity, and Visual Studio, and it was evaluated through integration and usability testing. As a result, a 6.1% improvement in academic performance was observed in the students who used the tool compared to the group that used traditional methods, demonstrating the effectiveness of AR in distance technical education.

Keywords: Mobile application · Augmented Reality · Didactic tool

1 Introduction

In recent years, virtual education has gained ground over face-to-face education, driven by advances in teaching methodologies that promote autonomous and collaborative student work through internet-based educational platforms [1]. This modality has not only improved access to knowledge but also enabled teachers to integrate emerging technologies that enhance the learning experience, generating hybrid models that have proven highly effective in academic training [2]. The coexistence of face-to-face and virtual education has led to broader use of technological tools for teaching and interaction, thereby strengthening instruction and encouraging collaborative learning [3]. However, despite its promise, virtual education faces several challenges, including the initial financial investments required by institutions, connectivity limitations, lack of familiarity with Information and Communication Technologies (ICT) among educational actors, and the psychological effects of limited social interaction in digital environments [4].

In Ecuador, face-to-face education has been repeatedly disrupted by events such as social protests and, more recently, the COVID-19 pandemic, which forced a rapid

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 238–248, 2025.
https://doi.org/10.1007/978-3-032-09080-5_25

and often improvised shift to virtual education. While necessary, this transition posed difficulties, particularly for technical and technological programs where hands-on, experimental training is essential [4]. At the Instituto Superior Tecnológico Tungurahua (IST Tungurahua), located in Ambato, Ecuador, these challenges are especially evident in its Higher Technology in Electronics program, where over 70% of curricular hours are devoted to practical learning. During the virtual teaching periods, students in this program showed a significant decline in academic performance compared to face-to-face instruction, underscoring the need for innovative solutions to enhance remote practical education.

This issue is clearly reflected in the academic results of Electronics students at IST Tungurahua during the 2020 I and 2020 II terms, both conducted virtually. During these periods, learning outcomes were noticeably lower than in the 2019 II term, which was delivered face-to-face. As shown in Table 1, the average academic performance in the 2019 II term was 6.94/10, dropping to 6.83/10 in 2020 I and to 6.17/10 in 2020 II. This decrease highlights the challenges of virtual education in technical and technological fields, where practical instruction plays a crucial role.

Table 1. Comparative table of learning outcomes compliance

Academic period	**2019 II**	**2020 I**	**2020 II**
Subjet	Industrial Machines and Control		
Number of students	20	17	23
Average academic performance	6.94/10	6.83/10	6.17/10
Students passed	17 (85.0%)	14 (82.4%)	17 (73.9%)
Students failed	3 (15.0%)	3 (17.6%)	6 (26.1%)

These results highlight a particular situation in technical and/or technological training programs, where most courses include a significant practical-experimental learning component. The data reveal how the lack of in-person interaction and the limitations of virtual instruction affected students' academic performance.

Augmented Reality (AR) is defined as a system that, in real-time, combines virtual elements with reality in the same interactive environment, enriching users' sensory and perceptual experience through the inclusion of additional information [5]. According to [6], AR is characterized by the real-time integration of physical and digital information using technological devices that create an altered reality where both sources are relevant. Similarly [7], emphasizes that AR visually enhances a real environment by overlaying information and virtual elements, allowing for interaction between them.

Numerous studies have underscored the pedagogical value of virtual environments, as they enable students to interact with three-dimensional representations of real systems. This interaction not only facilitates a deeper understanding of the content but also promotes autonomous learning. Simulations offer students the opportunity to engage in controlled and safe environments, thereby enhancing key skills such as problem-solving, decision-making, and critical thinking. Consequently, simulation technology has become

a fundamental teaching tool, optimizing the teaching-learning process and encouraging the use of active methodologies, particularly in technical fields such as automation and pneumatic systems control [8]. A study conducted by [9] examined the role of AR as an innovative educational tool, focusing on its potential to improve teaching processes by fostering student interaction, engagement, and motivation. Using documentary, analytical, and field methods, the researchers developed an educational application based on multi-level markers. Results indicated a significant increase in student interest and motivation, highlighting AR as an effective alternative to traditional methodologies.

In [10], the use of augmented and virtual reality in higher technical education was analyzed. The study reviewed documented applications of these technologies, focusing on their impact on organizational and educational processes. A methodology was proposed to integrate AR into the academic environment of technical universities, using the EV Toolbox constructor to explore 3D models through paper markers. The study identified several opportunities to enhance educational and organizational processes in technical education institutions. In the educational field, Unity 3D has proven to be a valuable tool for improving the understanding of complex concepts. In areas such as electrical engineering and industrial control, AR allows students to dynamically interact with models of systems and components such as electric motors and industrial circuits. Recent studies show that virtual environments created with Unity allow students to carry out practices without physical equipment, reducing costs and providing a safe space for experimentation [11]. Additionally, [12] illustrates the use of AR and Unity 3D in developing a sign language translation system using an electronic glove that detects hand gestures and converts them into text or audio. Although focused on accessibility, this application demonstrates AR's potential to support the teaching of practical skills through interactive simulations, enabling more dynamic and effective learning environments.

The inclusion of AR in learning strategies is important due to its ability to address deficiencies in traditional educational models such as the inability to carry out experimental practices due to lack of materials, safety concerns, or limited access to facilities and physical spaces [13]. However, AR should not be implemented in a radical manner but rather as a complement to traditional methodologies outlined in curricular design, especially when students are already proficient in using digital technologies, the internet, and social media.

In this context, AR is particularly relevant in subjects such as Electrical Machines and Industrial Control, part of the Electronics program curriculum, where 73.3% of the content is practical-experimental. The aim of this article is to explore the implementation of AR in teaching this subject through a mobile application, allowing students at IST Tungurahua to interact with 3D models of electrical and electronic components without the need for physical equipment. This proposal seeks to develop a specific educational tool tailored to the institution, aligned with the learning objectives of the course, and capable of being effectively integrated into the academic environment.

This article is structured into four sections: Introduction, materials and methods, analysis of results, and conclusions and future work.

2 Materials and Methods

The methodology used to design the proposal was Design Thinking, which allows for understanding people's needs and establishing real solutions supported by technological feasibility and the correct application of business strategies. Design Thinking is presented as a user-centered approach to solving complex problems through a creative and iterative process. It is linked to collaborative learning, promoting a deep understanding of users' needs and teamwork in interdisciplinary groups. This approach encourages collaboration, critical thinking, and flexibility, using prototypes and testing to adjust solutions. It is especially useful in education, as it facilitates the creation of collaborative tools that help students work together and develop social and teamwork skills [14]. In the educational context, Design Thinking has proven to be effective for designing interactive tools that enhance the learning experience, such as mobile applications and simulation platforms, which allow students to interact with content in an immersive way [15].

In the creation of educational technology tools, especially in the teaching of technical disciplines, Design Thinking has been used to design Augmented Reality (AR) applications, which enhance the understanding of complex concepts. These tools allow students to visualize and manipulate three-dimensional models, facilitating more active and autonomous learning. The use of Design Thinking in education allows solutions to be adapted to the needs of the student, promoting interaction and collaboration within a technological learning environment [16].

The methodology follows a five-phase process: Empathy, definition, ideation, prototyping, and testing, ensuring that each phase is adjusted to the specific needs of the students, generating effective solutions that facilitate the understanding of technical subjects. In the development of the AR application for the Electrical Machines and Industrial Control course, this process was followed, allowing the tool to be specifically adapted to the practical and experimental content of the course [17].

2.1 Needs and Difficulties Identified

The Electrical Machines and Industrial Control subject, corresponding to the second semester of the Electronics program, is part of the Professional Training Unit and has a total of 120 h, distributed into 32 h of direct contact learning with the instructor and 88 h of practical, experimental, and autonomous learning. The academic content of this subject is organized into four main units: Unit 1: Components of industrial electrical installations; Unit 2: Automation schematics and industrial control circuits; Unit 3: Rotating electrical machines for alternating current (AC) and direct current (DC); and Unit 4: Electronic devices for electric motor control.

The Instituto Superior Tecnológico Tungurahua (IST Tungurahua) has three classrooms and four laboratories equipped to deliver both basic and professional training courses for the Electronics program. These laboratories are equipped with the necessary tools to cover the practical content of the subject. However, there are a number of issues arising from the number of parallel courses and students in each module, which make optimal use of these resources difficult. For example, at times, a specific laboratory is not

assigned to the subject during the corresponding schedule, which prevents proper planning of practical activities. Additionally, sometimes the practical sessions are conducted in groups of five or more students per module, making it challenging to ensure active and equitable participation from all members, especially in such a technical environment where hands-on work is essential for learning.

In addition to these challenges, interruptions in face-to-face classes have been recurrent, which has considerably affected the full coverage of the academic content of the subject, particularly the practical-experimental component. The suspensions of face-to-face classes are largely due to external factors, such as social protests that have occurred in Ecuador, including the October 2019 protests, the national strikes of June 2022, and the March 2023 mobilizations, which at times have forced the suspension of academic activities. These interruptions, along with logistical challenges related to access and availability of spaces, have created a gap in the complete development of practical activities, which directly affects student performance in the subject.

The convergence of the components and technologies used in the development of the mobile Augmented Reality application prototype is shown in Fig. 1 In this figure, the teacher, based on the required learning outcomes, idealizes the teaching process through the visualization of 3D objects. These objects are designed and modeled in CAD software and then loaded into the application development tool containing the Augmented Reality app. The students install the app and can navigate through the application environment. Depending on whether the mobile device has internet connectivity, the designs are updated automatically; otherwise, only the pre-loaded designs are available.

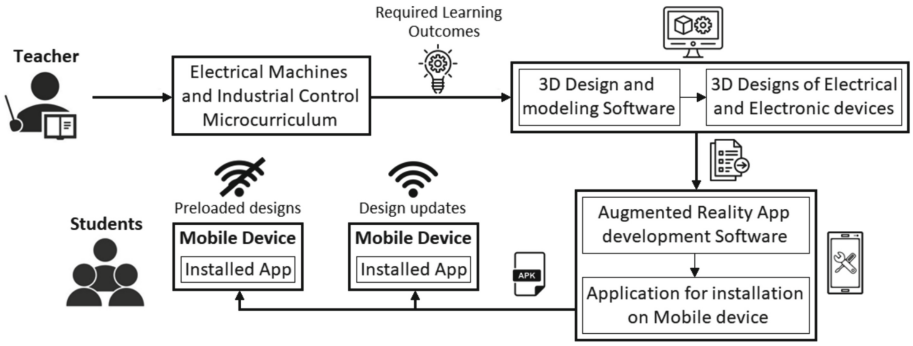

Fig. 1. Technology integration diagram

2.2 Ideation and Low-Fidelity Prototype

Before proceeding with the development of the application, it was necessary to define its minimum functionality requirements, so that its inclusion in the current curriculum model would help mitigate the limitations and issues described earlier. The application prototype must be installable on the students' mobile devices via an executable file provided by the instructor in charge. Additionally, it must offer a user-friendly and intuitive navigation environment, using icons that clearly represent the actions to be performed, with figures or images related to electrical and electronic components, making it easier

to understand. The application should include at least three interactive three-dimensional models of key elements in industrial control systems, such as components for switching, protection, measurement, and actuators. These models should be manipulable by the students, allowing them to add, move, rotate, and delete objects within a real environment captured by the mobile device's camera. In this way, the tool will provide a practical and visual learning experience that complements the students' academic activities, enabling them to perform virtual practices autonomously, thus enriching their practical and experimental training, despite the restrictions on access to physical laboratories or interruptions in face-to-face education.

In order to meet the outlined requirements, the application was structured and built according to the flowchart presented in Fig. 2, which was developed based on the expected interaction process between the Augmented Reality application and the student, always with the mindset that it could positively impact the learning of the Electrical Machines and Industrial Control subject.

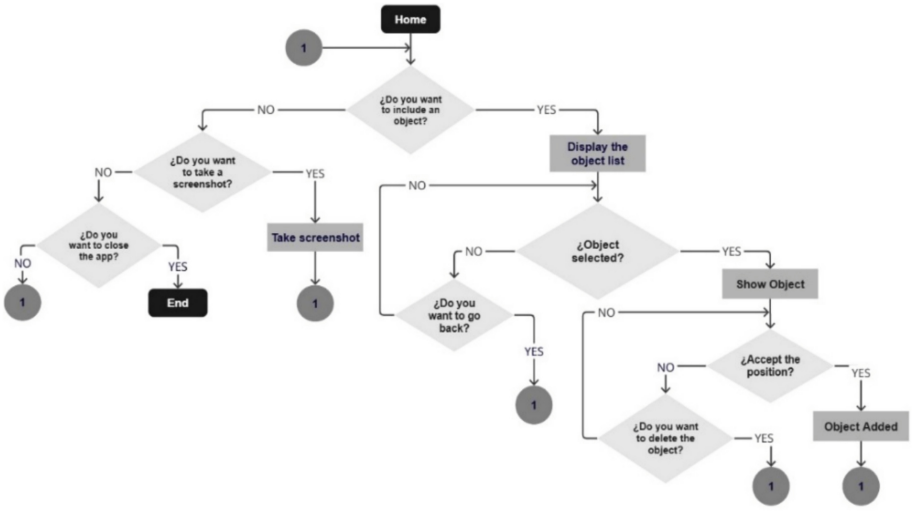

Fig. 2. Flowchart of the expected interaction process

Next, a low-fidelity sketch was designed to graphically represent the structure, functionality, and possible interactions between the elements that make up the graphical interface of the Augmented Reality application. This design was created through sketches that illustrate the different states of the application, including the available menus and the actions that the navigation buttons allow. The goal of this exercise was to solidify the functionality ideas described in the flowchart, ensuring that the interface is intuitive and functional. Figure 3 presents some of the designed sketches, which visualize how the elements of the application integrate into its operational structure.

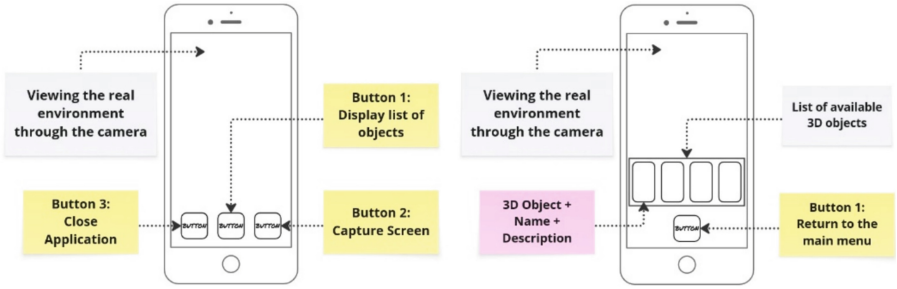

Fig. 3. a) Sketch of the main menu of the mobile application, b) Sketch of the objects menu of the mobile application

2.3 Application Design

In an initial version of the application, four specific elements were worked with: A three-phase asynchronous motor, a differential circuit breaker, a three-pole contactor, and a thermal or overload relay, as shown in Fig. 4.

Fig. 4. a) Model of a residual current device, b) Model of a contactor, c) Model of an overload relay.

The design of the Augmented Reality application involves developing an environment where the elements can be visualized, defining their characteristics and possible interactions. The interactions that govern the user experience during the use of the application were developed in C# scripts using Visual Studio software. These scripts contain code to create, edit, call, and execute the different functions associated with the logical architecture of the application.

2.4 Functionality Testing

The following functionality tests were conducted using two approaches. The first was an integration test, aimed at ensuring that all states and interactions of the application functioned correctly. The second was a usability test, focused on evaluating the application directly with Electronics program students to analyze their experience and the tool's effectiveness in a real-use environment.

Integration Test This test required a mobile device with Android 8.0 or higher, compatible with the version of Google Play Services for AR that supports ARCore. To install the app, it was necessary to enable the option to allow installations from external sources in the device's security settings, as it was recognized as an unknown source.

When launched, the application starts at the main menu. Pressing the central button leads to the object menu, displaying a content bar with the available 3D models. Selecting any element overlays the corresponding 3D model onto the real environment, which can be placed on a horizontal surface detected by the camera.

After confirming the object's position, the app returns to the main menu. From there, the same interactions can be repeated to add more models in the same environment, even duplicating objects if desired. Figure 5 shows screenshots captured during the test execution.

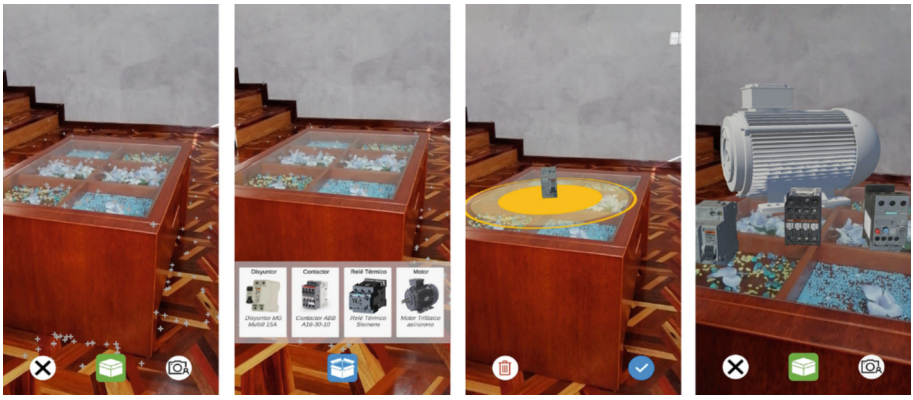

Fig. 5. a) Main menu of the application, b) Objects menu of the application, c) Positioning menu of the application, d) Objects anchored to the environment in the integration test.

Usability Test The objective of this test is to identify potential difficulties users may experience when interacting with the application. To achieve this, the test was conducted with an experimental group composed of 21 students, where all participants successfully placed virtual objects on environmental surfaces without requiring any assistance to operate the application.

3 Results and Discussion

To quantify the impact of the application on learning outcomes, it was used as a teaching tool during the topic Components of Industrial Electrical Installations from Unit 1 of the Electrical Machines and Industrial Control subject. Two groups with similar characteristics were involved: The first group, with 21 students, served as the control group, and the second group, also with 21 students, was the experimental group. Both received classes in the same week under a similar teaching plan. The control group used traditional methodologies and available institutional equipment, while the experimental

group followed a hybrid methodology that included the Augmented Reality application as a teaching tool.

Using the same evaluation method, both the developed activities and the knowledge acquired were assessed. Table 2 shows the evaluation results of both groups, revealing that the experimental group outperformed the control group by 6.1%. This difference could be greater once a more complete version of the application is available.

Table 2. Descriptive measures

	Control Group	Experimental Group
N	21	21
Mean	7.33	7.81
Standard deviation	2.20	1.81
Minumun	2.00	4.00
Maximun	10.0	10.0

The experimental group has a slightly higher average, suggesting better overall performance compared to the control group. The experimental group has a lower standard deviation (1.81 vs. 2.20), indicating that the results are more consistent and homogeneous compared to the control group. The results in the experimental group have a higher minimum (4.00 vs. 2.00), indicating that there are no such low scores in this group. However, both groups have the same maximum score (10.0), suggesting that both groups have reached the highest score available.

4 Conclusions

The project aimed to address learning deficits observed in students from the Electronics program at the Instituto Superior Tecnológico Tungurahua (IST Tungurahua) during virtual education. This issue is especially relevant for technical and technological programs, where practical and experimental content outweighs theoretical learning. In Ecuador, the problem has worsened in recent years due to frequent shifts between in-person and virtual modalities, which have negatively impacted the teaching-learning process.

To tackle this challenge, a mobile Augmented Reality (AR) application was developed for the Electrical Machines and Industrial Control subject. Used as a didactic tool, the application contributed positively by offering an innovative, engaging, and interactive approach to learning. The application was developed using the Design Thinking methodology, focusing on the subject's practical content. The five phases empathy, definition, ideation, prototyping, and testing ensured the solution met the academic needs of Electronics students.

Regarding hardware and software, the project identified the optimal tools to develop and operate the application. These included ARCore-compatible mobile devices and platforms such as Blender 3D, Unity Hub, and Visual Studio 2022, which facilitated efficient development.

Evaluation results showed a clear improvement in learning outcomes. A comparative assessment indicated that the experimental group using the AR application achieved an average performance 6.1% higher than the control group, which used traditional methods. This demonstrates the potential of AR to enhance learning, particularly in programs emphasizing hands-on activities.

The implementation of Augmented Reality not only improved student engagement but also offered an effective solution to the limitations of virtual education in technical subjects. Future versions of the application could further boost results by adding more interactive features, expanding available models, and enhancing the user experience. These findings suggest that Augmented Reality is a powerful tool for modernizing education and overcoming challenges related to distance learning. Moreover, the project's success offers a valuable model for applying emerging technologies in education, particularly in fields where practical learning is essential.

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Computational Thinking in Primary School Students Using Scratch

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Abstract. This article presents the results of an exploratory study aimed at identifying computational thinking skills in 11- and 12-year-old students when solving two non-routine problems using SCRATCH, both in connected and unplugged modalities. Using a mixed-methods approach, the study relied on a case study and implicative statistics for data collection and analysis. The main findings indicate that students are capable of following routines, formulating problems, and demonstrating logical thinking, but face challenges in formulating conjectures and discovering arithmetic patterns or relationships.

Keywords: Computational thinking · Non-routine problems · Scratch programming

1 Introduction

Currently, Computational Thinking (CT) is increasingly permeating the mathematics curriculum particularly in primary education with the aim of developing the ability to approach complex problems, structure them, decompose them, and solve them efficiently [2, 14]. In this regard, CT emerges as a tool for systematizing thinking skills related to logical reasoning and structured problem solving, with or without technological mediation [2, 14]. It encompasses competencies such as abstraction, decomposition, algorithm design, and automation [4], all of which are relevant to mathematics education from an early age. Abstraction supports the identification of a problem's essential elements [12, 13], while decomposition enables the division of complex problems into manageable parts. The creation of algorithms and their automation enhance mathematical reasoning and creativity. The development of CT in various school contexts including those with limited access to digital resources not only poses a challenge but also represents

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 249–259, 2025.
https://doi.org/10.1007/978-3-032-09080-5_26

an educational opportunity to bridge cognitive and digital divides [3, 5]. Furthermore, unplugged activities—those that do not require digital devices are valuable in contexts with technological limitations [6, 13]. On the other hand, studies have shown that the use of programming environments such as Scratch can improve CT skills and specific aspects of mathematical reasoning [7, 15].

2 Relative Work

Considering recent advances in digital education, tools such as Scratch constitute an excellent platform for the development of CT, thanks to their visual interface and playful orientation, which foster autonomous learning and the visualization of mathematical processes. However, there is limited evidence regarding the specific impact of Scratch on the development of CT, particularly in relation to non-routine mathematical tasks, as understood by [11].

It is worth noting that CT has been identified as an essential competence for solving complex problems [2, 14]. Skills such as decomposition, abstraction, and algorithmic thinking are crucial for organizing and solving mathematical problems efficiently [9]. In this sense, Scratch is presented as an effective tool to promote such skills through a visual, accessible, and exploratory approach [8].

The use of this environment not only promotes active learning, but also enables students to construct and manipulate logical representations, formulate conjectures, and apply algorithmic solutions to contextualized problems [2]. However, there remains a gap in the literature regarding how these practices impact the simultaneous development of CT and problem solving (PS) when applied to non-routine mathematical tasks.

This study examines primary school students' CT skills when engaging with non-routine mathematical problems, through both connected activities using Scratch software and unplugged activities. The objective is to understand how these methodologies contribute to the development of abstraction, logical-mathematical thinking, and generalization skills identified as fundamental in recent research [2, 4, 15]. We explore how Scratch, in both modalities, can foster problem-solving and CT, providing empirical evidence to inform curriculum design and pedagogical practices. Furthermore, we set out to fill the research gap on the use of Scratch to simultaneously develop these competencies in primary school students.

Based on the elements presented, our research question is: How does the use of block-based software such as SCRATCH facilitate the development of CT skills and the resolution of non-routine mathematical problems in students aged 10 to 12?

2.1 Theoretical Framework

CT refers to a set of cognitive skills that employ logic and abstraction to understand and solve complex problems. CT includes key practices such as: (1) Decomposition, which breaks down a problem into more manageable parts; (2) Abstraction, which simplifies and represents problems in a meaningful way; (3) Algorithmic Thinking, which involves designing sequences of logical steps to solve a problem; and (4) Generalization, which transfers solutions to similar problems [2, 14, 15]. These skills are crucial for the

development of mathematical competencies, as they allow for the systematic structuring and tackling of complex problems. By fostering the decomposition of mathematical problems and the creation of algorithms to solve them, CT becomes a valuable tool to enhance problem solving (PS). This is particularly effective when supported by technological tools that facilitate the practical application of these competencies, such as SCRATCH.

Developed by the MIT Media Lab, SCRATCH is an environment that enables students to create interactive projects by programming with code blocks, thereby facilitating the understanding of mathematical and computational concepts in a visual and accessible manner [10]. Through stories, games, and animations, students apply CT to solve mathematical problems, promoting active learning. According to [8], such tools foster logical thinking and transform learning into a fun and meaningful experience.

In this study, CT is understood as an essential competence for developing mathematical skills at the primary level [15]. Scratch is presented as a tool that supports the resolution of non-routine mathematical problems by activating algorithmic thinking and generalization in educational contexts [2, 15]. Its accessible interface and its capacity to enhance fundamental cognitive skills in young students are particularly noteworthy. Unlike tools such as Python, Scratch allows learners to focus on the logic of the problem rather than on the syntax, thus promoting abstraction.

3 Methodology

In this study, two non-routine problems were presented to 35 students (S1, S2,...S35) aged 10 to 12 from a public school in Valparaíso, Chile, in order to document their CT skills. The problems were designed to assess various dimensions of CT. A mixed-methods approach was employed descriptive and non-correlational framed within an instrumental case study. Implicative statistics were used to detect patterns among the observed CT skills. A co-design model was adopted in collaboration with the classroom teacher, who implemented the problems during regular lessons.

The analysis was based on three data sources: Classroom video recordings, written records from the resolution of Problem 1, and programming files from Problem 2. This multi-source strategy enabled the collection of direct evidence regarding students' CT-related interactions and skills.

To operationalize CT, six analytical categories previously defined in the literature were employed, specifically drawing on the work of [1] and the rubric indicators proposed by [9]. These categories were adapted by incorporating observable indicators for each, in order to identify and assess the different manifestations of CT during the problem-solving process. Table 1 presents the categories along with their corresponding indicators.

3.1 A Priori Analysis

Problem 1: Unplugged Programming

In Problem 1, which involved unplugged programming, the software was used to explore and verify the resulting figures. To do this, students selected three natural numbers between 0 and 7, each corresponding to the length of a line segment. Upon entering

Table 1. Categories of CT according to the literature (adapted from [9]).

CT Category	Characteristics	Indicators
Problem Formulation (PF)	Decomposition of the problem into steps or subproblems.	Focuses on specific features of the problem, simplifies it, and acts through an inductive or exploratory process in search of a conjecture.
Abstraction (AB)	Representation of data through models or abstract sequences of steps.	Communicates conjectures, hypotheses, judgments, or examples, potentially accompanied by simulation proposals.
Logical Thinking (LT)	Logical organization of data and structured analysis.	Expresses the position, orientation, or path of objects through oral, written, gestural, or symbolic language, sequencing actions or linking them to programming.
Using Algorithms or Programming (AP)	Automated solutions through algorithms or programming.	Applies operations using algorithms (a series of ordered steps) or programming sequences.
Implementation and Solution Analysis (IS)	Identification, testing, and optimization of solutions.	Coherently explains problem solutions, including proposals for debugging and process optimization.
Generalization (G)	Pattern recognition and the transfer of solutions to new problems.	Uses natural or gestural language to communicate verifiable patterns or transfer solutions to similar problems.

the values, the interface drew the segments in a clockwise direction with 90° turns, generating a closed figure. For example, using the numbers 1, 2, and 3 produces a "spiral" shape, as shown in Fig. 1.

Fig. 1. Figure formed with the numbers 1, 2 and 3 called a whirlpool.

Table 2 presents the expected observable indicators for CT skills during the resolution of Problem 1.

Problem 2: Plugged-in Programming

Table 2. Indicators for CT Skills in the Resolution of Problem 1.

CT Skill	Code	Indicator
Problem Formulation (PF)	p1	Proposes different number triplets to generate a figure.
Abstraction (AB)	p2	Labels the figures with words referring to everyday objects.
Logical Thinking (LT) **Logical Thinking (LT)**	p3 p4	Fixes at most two numbers in a given triplet. Reverses the order of the numbers in a triplet.
Abstraction (AB)	p5	Describes with keywords the pattern of the strokes that form a figure.
Algorithms and Programming (AP)	p6	Relates the numbers in a triplet through an arithmetic operation.
Implementation of Solutions (IS) **Implementation of Solutions (IS)**	p7 p8	Identifies number triplets associated with the same type of figure. Relates the change in figure size to the idea of a multiple.
Generalization (G)	p9	Communicates different arithmetic relationships along with their corresponding figures.

In Problem 2, students are asked to observe a sequence of code blocks in the SCRATCH software and then formulate hypotheses about what will be generated in the interface. Subsequently, they must propose changes to the block sequence in order to produce a polygon. The purpose of this activity is to generate a specific polygonal shape, as illustrated in Fig. 2.

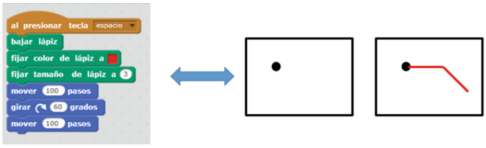

Fig. 2. Purpose of problem 2, generate a polygonal.

Table 3 outlines the indicators of CT skills that were expected to be observed during the resolution of Problem 2. These indicators reflect students' interactions with the software and their ability to understand, manipulate, and apply programming blocks to successfully close the figure.

To analyze students' task responses, Implicative Statistical Analysis (ISA) was applied using the CHIC software (v7.0) [3]. ISA combines cluster analysis and association rule analysis to identify probabilistic relationships between variables based on co-occurrences and counterexamples [3]. The dendrogram groups variables with strong associations, while the implicative graph visualizes these relationships and their strength

Table 3. Indicators for CT Skills in the resolution of Problem 2.

CT Skill	Code	Indicator
Problem Formulation (PF)	p10	Identifies the role of each block.
Abstraction (AB) **Abstraction (AB)**	p11 p12	Draws figures using only strokes. Modifies parameters of a block based on a given figure.
Logical Thinking (LT) **Logical Thinking (LT)**	p13 p14	Relates the turning angle to a supplementary angle. Discovers the turning angle required to form an equilateral triangle.
Algorithms and Programming (AP)	p15	Proposes a sequence of blocks to create a rectangle.
Implementation of Solutions (IS)	p16	Creates new figures by modifying block parameters.
Generalization (G)	p17	Proposes sequences of blocks to construct a regular polygon.

through confidence indices. This approach highlights significant patterns expected or emergent supporting interpretation and hypothesis generation.

4 Results

Problem 1 encouraged the exploration of numerical combinations that led to the construction of diverse figures, to which students assigned representative names. This activity activated key CT skills such as problem formulation, abstraction, and generalization. The analysis revealed the use of logical reasoning and pattern recognition, thus validating the analytical categories employed.

Table 4 reflects the diversity in figure naming, revealing different visual interpretations and varying levels of abstraction. Cases such as those of Student 1 (“Fan”) and Student 11 (“Propeller”) demonstrate direct visual associations, whereas the response from Student 23 (“Large Spiral”) incorporates the attribute of size, suggesting a progression toward conjecture-building that links shape, scale, and numerical structure. These interpretations reflect not only perceptual processes but also complex cognitive reasoning, connecting geometric representations with mathematical attributes.

These observations highlight the potential of the activity to foster complex CT processes, as evidenced by the connections made between geometric representations and underlying mathematical structures.

Figure 3 presents S6 response regarding the “spiral” figure. This student identifies that permuting the numbers within a given triple does not alter the resulting shape—An observation replicated by 57% of the participants. This finding points to an intuitive understanding of the commutative property, although it is not explicitly named. Additionally, Student 6 hypothesizes that the triple [5 1 6] generates a spiral, without explicitly

Table 4. Names assigned by students to the figures.

Student	Figure name	Triplet	Figure
S22	Daisy	[3, 2, 3]	
S1	Fan	[5, 4, 1]	
S23	Big Spiral	[1, 5, 6]	
S35	Flower	[3, 4, 5]	
S15	Sun	[6, 1, 3]	
S11	Propeller	[3, 5, 2]	

recognizing the underlying mathematical regularity: The sum of the two smaller numbers equals the largest. This omission highlights a pedagogical opportunity to deepen the connection between numerical structures and their geometric representations.

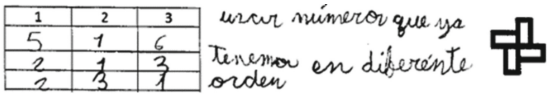

Fig. 3. Part of the S6 response to indicate triplets associated with the whirlpool.

In later attempts, S6 adopts an exploratory strategy by fixing the first number of the triple to analyze how the figures vary. While this action promotes logical thinking and systematization, it was not replicated by other students suggesting a need for more guided interventions to encourage the broader adoption of such strategies.

It is worth noting that, when students were asked to propose new triples associated with other figures they had identified, S6 experimented with different combinations using the SCRATCH software. In this case, they tested triples composed of the same number, which resulted in square-shaped figures, as shown in Fig. 4. However, S6 was not able to verbally express the regularity underlying this pattern, nor to accurately reproduce the figure on the grid.

Regarding the analysis enabled by Implicative Statistical Analysis (ISA) and the tools provided by CHIC 7.0 software, it is possible to contrast various aspects of the

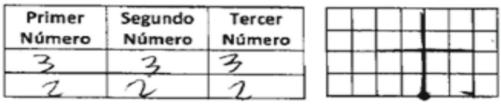

Fig. 4. Part of the S6 response to indicate triplets associated with the whirlpool figure.

results presented in the previous section. Figure 5 presents the Similarity Tree obtained by processing the data matrix based on the presence (1) or absence (0) of the categories defined in the a priori analysis using CHIC 7.0.

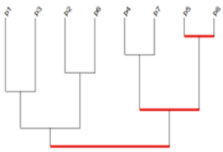

Fig. 5. Similarity tree over the a priori categories of problem 1.

In this tree, three significant classes are identified, highlighted in red. Class 1 stands out with a similarity index of 0.999104. The other two classes have a similarity index that is too low to be included in this particular analysis.

In the significant class (p5 p8), the importance of following the sequence of strokes and reversing the order of the numbers in a triplet is highlighted as a strategy for associating different triplets with the same figure, as illustrated in S27 response in Fig. 6.

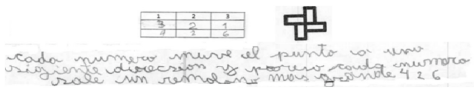

Fig. 6. Part of S27 answer to indicate triplets associated with the whirlpool figure. "Each number moves the dot to the next direction, and so each number produces a larger whirlpool [4 2 6]."

On the other hand, S22 was able to identify two triplets that correspond to the same figure, similar to the whirlwind, as shown in Fig. 7.

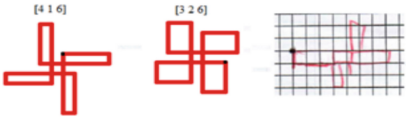

Fig. 7. Part of S22 answer to show triplets associated with a figure other than a whirlpool.

Figure 8 presents the implicative graph for Problem 1. The graph shows the implication relationships between the analytical categories, with an implication index set at 75% or higher. A chain of implications stands out in the visualization.

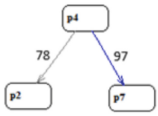

Fig. 8. Implicative graph of the a priori analysis categories of Problem 1.

From this chain of implications, the pair p4 → p7 stands out with an implication index of 97%, highlighting a strategy that may be representative of the typical reasoning used by this group of students. It shows that reordering the numbers in a triplet is one of the first strategies students employ to associate different triplets with the same figure, as observed in the response of E6 (Fig. 4). This does not exclude other strategies, such as repeating a number in each triplet (Fig. 5), or using the idea of multiples, as suggested by E27 (Fig. 7). Additionally, the implication p4 → p2 indicates that changing the order of numbers in a triplet leads students to classify figures based on their shape and size.

On the other hand, Table 5 provides an overview of how students approached Problem 2. Based on this data, we can associate their actions with specific CT skills, using the a priori analysis categories defined earlier in the methodology.

Table 5. Student actions during the task and associated CT skills.

Student Actions During the Lesson	CT Skills
1 min–13 min: The teacher presents students with ideas and examples of open and closed figures to recall prior knowledge. Then, they show what the block sequence generates in the software interface, repeating the same action up to three times.	AB (Abstraction)
14 min–19 min: Students describe the geometric elements of a figure that changes as they activate the block sequence. First, they observe a corner, two lines, one angle. Then three angles, four lines, an open figure. Finally, five angles, six lines—Still an open figure. They notice that the starting point does not match the last stroke, prompting doubt and the realization that there are now eight strokes.	PF (Problem Formulation), AB (Abstraction)
20 min–55 min: Students open the file for Problem 2. Using a new block that allows repetition, they begin experimenting with parameters to generate a closed figure.	IS (Implementation of Solutions)
56 min onward: Students organize the blocks into four sequences to generate a square, a rectangle, an equilateral triangle, and a regular polygon with five or more sides.	IS (Implementation of Solutions), LT (Logical Thinking)

It is important to note that the data could not be organized for statistical analysis, since the task required drawing, modifying parameters, and programming with the software. However, students did not name their programming files as planned, making it difficult to assign the presence or absence of CT categories in that dimension.

The implementation of both unplugged and plugged programming activities revealed progress in the development of CT, particularly in students' understanding of geometric patterns and strategy use in problem-solving. However, limitations emerged in the formulation and communication of conjectures, as well as technical challenges related to parameter manipulation in visual programming environments. While the transition between activities supported students' understanding, the lack of a systematic trial-and-error approach and insufficient promotion of autonomy hindered the development of more advanced skills. It is concluded that a redesign of the instructional sequence is necessary, incorporating teaching strategies that foster exploration, critical thinking, and mathematical communication within a supportive environment for the effective use of tools such as SCRATCH.

5 Conclusions

This study offers empirical insights into the development of CT in primary school students, evidencing their capacity to activate core CT dimensions such as problem formulation, abstraction, logical reasoning, algorithmic processes, and generalization through the resolution of non-routine mathematical problems mediated by both unplugged and digital programming environments.

Findings from the unplugged task (Problem 1) illustrate that students engage in inductive reasoning and exploratory practices, notably through the construction of numerical triplets and the identification of geometric patterns. These actions reveal an incipient, albeit intuitive, appropriation of structural properties such as symmetry and commutativity. The ISA revealed significant cognitive patterns and strategy clusters, particularly those associated with figure recognition, parameter manipulation, and relational reasoning.

The digitally mediated task (Problem 2) further demonstrated students' ability to transfer and operationalize geometric and algorithmic reasoning within a block-based programming interface. While students successfully engaged in problem structuring and iterative testing of block sequences, the limited articulation of conjectures and the absence of explicit generalization processes suggest a need for pedagogical scaffolding that fosters higher-order reasoning and mathematical communication.

These results highlight the pedagogical potential of Scratch as a mediational tool for fostering CT in primary mathematics. However, they also point to the need for intentional instructional design that supports metacognition, structured exploration, and mathematical verbalization. Future research should explore longitudinal interventions with scaffolding strategies to enhance the transfer of CT skills across broader mathematical contexts and consolidate CT as a foundational competence in mathematics education.

Acknowledgments. This work was supported by the project CEDAI 07-2024, within the Plan for the Strengthening of State Universities, Ministry of Education of Chile, under the agreement UPA 1999.

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Empowering Tomorrow's Marketers: Required Digital and Sustainability Skills

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Abstract. The development of green skills is essential due to the pressing environmental, social, and economic challenges faced today. Issues such as biodiversity loss, climate change, and social inequality demand integrated and sustainable solutions. Businesses play a crucial role in addressing environmental and social issues by adopting responsible practices, with marketing influencing consumer behavior and promoting sustainability. Integrating sustainability into marketing education provides students with the necessary skills to tackle these challenges effectively. Additionally, digital transformation is revolutionising marketing, offering unprecedented opportunities through technologies such as social media, Big Data, IoT, and AI. Developing digital skills in higher education is crucial for students to excel in this rapidly evolving landscape. Through an Erasmus+ project, a study was designed to identify which competencies from GreenComp and DigiComp are considered most important by stakeholders in the marketing field. Consequently, a survey was disseminated at the beginning of 2024 to understand the significance of these competencies for the future of marketing professionals. Green skills aligned with business-driven initiatives and consumer-driven actions are highly valued. From DigiComp, competencies in Safety stand out the most.

Keywords: Digital Skills · Green skills · Sustainability Skills · Digital Marketing · Higher Education · Digistainability

1 Introduction

The development of sustainability competencies is crucial today due to the environmental, social, and economic challenges we face. Biodiversity loss, climate change, and social inequality are severe issues that require an integrated and sustainable approach [1]. Businesses play a significant role in perpetuating these problems, and it is essential that they adopt practices to mitigate the negative impacts of their activities.

Marketing plays a crucial role in developing sustainability competencies by influencing consumer behavior and promoting responsible business practices. Integrating sustainability into marketing education equips students with essential skills to address

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 260–269, 2025.
https://doi.org/10.1007/978-3-032-09080-5_27

environmental, social, and economic challenges [1]. According to a report by the European Union, a universal competence framework is necessary to guide educators and policymakers in promoting sustainability competences [2]. This need was met through the publication of GreenComp: The European Sustainability Competence Framework in 2022 [3]. It aims to integrate sustainability into education and training systems, ensuring that individuals are equipped to contribute to a sustainable future.

Digital transformation is also revolutionising the marketing landscape, offering unprecedented opportunities for businesses to enhance their strategies and operations. The integration of digital technologies such as social media, Big Data, mobile marketing, the Internet of Things (IoT), and Artificial Intelligence (AI) is reshaping how companies interact with customers, manage internal processes, and measure performance. One of the key benefits of digital in marketing is the ability to gain deeper insights into customer behavior and preferences. Through advanced data analytics, businesses can personalise their marketing efforts, creating more targeted and effective campaigns. This not only improves customer satisfaction but also drives higher engagement and loyalty [4].

Digital technologies enable real-time communication and interaction with customers, fostering stronger relationships and enhancing the overall customer experience. Social media platforms, for instance, allow companies to engage directly with their audience, respond to feedback promptly, and build a community around their brand. Developing digital skills in higher education is crucial for marketing students to thrive in the digital transformation era. Integrating these skills into curricula, offering practical projects, and fostering industry partnerships are essential strategies for effective digital education [4].

In 2022, the framework "DigComp 2.2: The Digital Competence Framework for Citizens—With new examples of knowledge, skills and attitudes" [5] was published, highlighting the importance of digital competencies. This framework provides updated examples of the knowledge, skills, and attitudes necessary for citizens to thrive in a digital society. It emphasises the need for individuals to develop competencies in areas such as information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. By fostering these skills, the framework aims to empower citizens to effectively navigate and utilise digital technologies in their personal and professional lives [5].

In this context, at the end of 2023, the "DIGISTAINABILITY—Digital and Sustainable Marketing Skill for European Students and Workforce" project began, aiming to prepare marketing professionals with essential digital and sustainability skills for the rapidly evolving job market. This Erasmus + project brings together seven European partners, including both associations and higher education institutions. Its aim is to identify the competencies required by marketing professionals in the coming years, considering diverse perspectives from across European labour markets. The aim is to improve the quality of education and training systems, promoting relevant competencies and contributing to a more sustainable future.

This paper aims to present the results obtained from a survey conducted across the partner countries involved in the project, focusing on identifying the sustainability and digital skills viewed as most important by students, professionals, and educators in the field of digital marketing. The research seeks to pinpoint the essential competencies for success in the current and future job market, highlighting the needs and expectations of

the different stakeholder groups. The findings will provide a robust foundation for developing training materials and courses that meet market demands and promote education aligned with contemporary requirements.

2 Sustainability and Digital Skills

The evolution of sustainability in marketing has followed distinct phases. Initially, Ecological Marketing emerged in the late 1960s and 1970s due to environmental concerns, leading to the creation of regulatory bodies. In the 1980s and 1990s, Environmental or "green marketing" focused on products with better socio-environmental performance and responded to growing green consumer demand. The 2000s introduced Sustainable Marketing, integrating social and environmental costs, emphasising long-term value and supporting sustainable development goals [6].

Currently, sustainability marketing addresses broader topics such as the circular economy, waste reduction, carbon emissions, and innovation. Future directions involve systemic changes, business-led initiatives, and consumer-driven actions, all aiming for greater sustainability [6].

Sustainability education in business schools is essential for preparing future marketing professionals. Key competencies include systems thinking, strategic thinking, and interpersonal skills, fostering a holistic and long-term approach. Integrating the Sustainable Development Goals into curricula ensures that economic, social, and environmental aspects are addressed [1]. Higher education institutions must promote global collaboration and interdisciplinary initiatives, transforming educational practices to fully incorporate sustainability. Such changes are vital for preparing graduates to contribute meaningfully to a sustainable future and to challenge traditional growth assumptions.

From a European Commission initiative, sustainability skills, also known as green skills, are defined as technical skills, knowledge, values, and attitudes needed to support sustainable outcomes in business and industry [2]. A framework was designed to integrate sustainability into education and training systems across Europe [3]. The framework is divided into four main competence areas, each with three specific competences:

- Embodying Sustainability Values: Valuing Sustainability; Reflecting on personal values and aligning them with sustainability. Supporting Fairness; Promoting equity and justice for current and future generations. Promoting Nature; Recognising humans as part of nature and respecting the needs of other species.
- Embracing Complexity in Sustainability: Systems Thinking; Understanding the interconnectedness of systems and their impacts. Critical Thinking; Assessing information and arguments critically. Problem Framing; Defining and structuring sustainability problems to find suitable solutions.
- Envisioning Sustainable Futures: Futures Literacy; Imagining and developing scenarios for sustainable futures. Adaptability; Managing transitions and challenges in complex situations. Exploratory Thinking; Using creativity and experimentation to find new solutions.
- Acting for Sustainability: Political Agency; Navigating political systems to advocate for sustainability. Collective Action; Collaborating with others to achieve sustainable change. Individual Initiative; Taking personal responsibility and action for sustainability.

This framework is crucial for higher education institutions as it helps learners develop the knowledge, skills, and attitudes necessary to think, plan, and act sustainably [2]. Courses should be revised to incorporate green skills, thereby preparing students for future professional challenges.

On the other hand, digital marketing has evolved significantly since its establishment. In the 1990s, the advent of the Internet introduced email marketing and basic online advertising. The 2000s saw the rise of search engines and the emergence of social media platforms like Facebook and Twitter, revolutionising how businesses engage with customers. From 2010 onwards, mobile marketing and the use of Big Data became crucial, enabling personalised marketing strategies. The integration of technologies such as IoT and AI has further transformed the landscape, allowing for real-time customer interactions and automated processes [7].

The Digital Competence Framework for Citizens, known as DigiComp, is an initiative by the European Commission to provide a common understanding of digital competence. It aims to support individuals in developing the necessary skills to engage confidently, critically, and safely with digital technologies [5]. DigiComp is structured around five key competence areas:

- Information and Data Literacy: The ability to browse, search, filter, evaluate, and manage data, information, and digital content.
- Communication and Collaboration: Interacting through digital technologies, sharing data and content, engaging in citizenship through digital technologies, collaborating, understanding netiquette, and managing digital identity.
- Digital Content Creation: Developing, integrating, and re-elaborating digital content, understanding copyright and licences, and programming.
- Safety: Protecting devices, personal data and privacy, health and well-being, and the environment.
- Problem Solving: Solving technical problems, identifying needs and technological responses, creatively using digital technology, and identifying digital competence gaps.

DigiComp provides a detailed framework with proficiency levels ranging from foundation to highly specialised, offering examples of knowledge, skills, and attitudes to help citizens navigate the digital world effectively [5].

Developing sustainability and digital skills in higher education courses in digital marketing is essential for preparing professionals to tackle contemporary challenges. Integrating sustainable practices in marketing promotes long-term value creation and socio-environmental responsibility. Additionally, digital literacy enables professionals to utilise emerging technologies for effective and innovative marketing strategies. These combined competencies empower students to develop creative and sustainable solutions, contributing to a greener and digitally advanced future. Therefore, higher education must adapt to include these crucial skills in the curriculum.

3 Digistainability Projet

The Erasmus+ DIGISTAINABILITY project, which began in December 2023, in-volves seven partners: HETEL (Spain), NAZARET FUNDAZIOA (Spain), Universi-tà degli Studi di Urbino Carlo Bo (Italy), Ilmiolavoro srl (Italy), Polytechnic Universi-ty of Tomar (Portugal), ACEEU GmbH (Germany), and Fondatsiya na Biznesa za Obrazovani (Bulgaria). This project, submitted under the action type KA220-HED - Cooperation Partnerships in Higher Education, aims to identify the digital and sustainability skills essential for marketing professionals in the coming years. It seeks to propose adaptations to the curricula of vocational and higher education degrees in marketing and business to align with the new realities of the job market. By addressing these needs, the project aims to ensure that graduates are equipped with the necessary competences to thrive in a rapidly evolving professional landscape.

The second work package (WP), which ran until the end of 2024, aimed to identify the digital and sustainability skills required by marketing professionals and evaluate current curricula in vocational and higher education. By doing so, the partners hoped to identify gaps and determine where improvements were needed. This process led to the creation of a proposed framework, which will guide the development of content that promotes these essential skills.

4 Methodology

To achieve these objectives, we first identified stakeholders for our research, distributed a survey, and invited select individuals to participate in focus groups in each country. The survey was developed between January and February 2024, tested with a pilot group, translated into the respective languages by each partner, and disseminated in March 2024.

The survey is divided into four sections. The first section focuses on the demographic information of the respondents, asking about their gender, age, country of residence, and current occupation. The second section contains specific questions tailored to each respondent's occupation. Students are asked about their experience with internships or Erasmus programmers. Teachers are asked about the duration of their teaching experience in digital marketing courses or subjects. Professionals in the labour market are asked about their length of service, job position, economic sector, and company size. The final two sections assess the importance of the competencies identified in GreenComp [3] and DigiComp [5] for the marketing sector, using different Likert scales: for GreenComp, a 5-point scale ranging from 1 (Decrease) to 5 (Increase) is used; for DigiComp, a 5-point scale ranging from 1 (Not important) to 5 (Extremely important) is applied.

Most questions are multiple-choice to facilitate ease of response. This approach was considered practical for both respondents and the subsequent analysis phase. Internationally defined lists were utilised for the multiple-choice items, like International Standard Classification of Occupations (ISCO), Business economy by sector - NACE Rev. 2 and Scientific Fields.

A total of 256 respondents from the partner countries participated in the survey. Table 1 provides a summary of the group's demographics and characteristics.

Table 1. Characterisation of responses by partners.

Partner	Country	Age Average	Students	Employed	Teacher	Answers
Hetel	Spain	32	14 (41.2%)	17 (50.0%)	3 (8.8%)	34 (13.3%)
Nazaret Fundazioa		26	35 (72.9%)	5 (10.4%)	8 (16.7%)	48 (18.8%)
University of Urbino "Carlo Bo"	Italy	28	40 (80.0%)	4 (8.0%)	6 (12.0%)	50 (19.5%)
Ilmiofuturo		34	26 (46.4%)	16 (28.6%)	14 (25.0%)	56 (21.9%)
Polytechnic University of Tomar	Portugal	25	24 (68.6%)	7 (20.0%)	4 (11.4%)	35 (13.7%)
ACEEU	Germany	33	3 (50.0%)	2 (33.3%)	1 (16.7%)	6 (2.3%)
Fondatsiya Na Biznesa Za Obrazovani	Bulgaria	41	3 (11.1%)	22 (81.5%)	2 (7.4%)	27 (10.5%)
Total		31	145 (56.6%)	73 (28.5%)	38 (14.8%)	256 (100.0%)

The average age of respondents is 31, with the majority being students (56.6%). The partners' average ages vary according to the respondents' status, with the universities (Polytechnic University of Tomar and Nazaret Fundazioa) showing the lowest average ages: 25 and 26 years old.

Regarding gender, there is a predominance of female respondents (60.2%). Only 18 individuals (7.0%) identified as belonging to a minority group, selecting physical disabilities, immigrant status, or religion.

The educational level distribution indicates that most respondents have completed Vocational Education and Training (33.2%), followed by bachelor's degrees (27.7%) and master's degrees (24.2).

In terms of occupation, students are the largest group with 145 respondents (56.6%), followed by teachers with 38 respondents (14.8%). The remaining respondents are distributed among employers (11.7%), job seekers (4.3%), and workers seeking improvement (12.5%).

Most respondents are associated with the Social Sciences (80.0%), which is expected given the focus on marketing. Additionally, 36 respondents (14.1%) are linked to engineering and technology.

Among the 145 students, 18 have participated in an Erasmus programme (12.4%), and 75 have completed internships (51.7%), providing them with practical work experience.

The teachers who responded have an average of 19 years of service, ranging from one to 35 years. Of the 38 teachers, 24 (63.2%) teach marketing courses or subjects in the field.

5 Results

5.1 GreenComp Competences

Analysis of the response distribution regarding the importance of each GreenComp competence for the future revealed that the highest average score, on a scale from 0 to 5, was 4.27, and the lowest was 3.91. This indicates that all the listed competences are considered important or very important by most respondents, with only slight variations in their perceived significance.

By examining the competences with the highest and lowest averages (Table 2), one area clearly stands out. The competences within the domain of "3.3 Exploratory Thinking Skills—Importance in the Future" have values ranging from 4.26 to 4.20. This includes Innovative Sustainability, Material and Consumption Innovation, and Consumer-Centric Design.

Table 2. GreenComp competences with the highest and lowest average (Scale importance: 1-Decrease to 5-Increase).

GreenComp Areas	Skills	Average
1.1 Valuing sustainability Skills	Strategic communication	4.24
1.2 Supporting fairness Skills	Sustainability Certification and Strategic Application	4.24
1.3 Promoting nature	Sustainable Marketing Integration	4.24
	Circular Economy and Resource Stewardship	4.27
2.3 Problem framing skills	Systemic Thinking and Product Innovation	4.20
3.3 Exploratory thinking skills	Innovative Sustainability	4.20
	Material and Consumption Innovation	4.26
	Consumer-Centric Design	4.25
4.2 Collective action skills	Sustainability Advocacy	4.20
4.3 Individual initiative skills	Sustainability Communication and Engagement	4.21
	Personal Growth and Action	4.25

The competence with the highest average is Circular Economy and Resource Stewardship, scoring 4.27, within the domain of Promoting Nature - Importance in the Future.

While competences related to regulations or policies have lower averages, ranging from 3.91 to 3.99, they are still considered important.

5.2 DigiComp Competences

Regarding the DigiComp competences, those in the "Safety" competence stand out significantly (Table 3). More than 50% of respondents rated them as 5—Extremely important, with the following values: Protecting personal data and privacy (71.0%, average of 4.60), Protecting health and well-being (69.0% average of 4.56), Protecting the environment (62.3% average of 4.48), and Protecting devices (54.4%, average of 4.34).

Table 3. DigiComp Competences with the highest average (Scale of importance in the future: 1-Not important to 5-Extremely important).

DigiComp	Skills	Average
Safety	Protecting personal data and privacy	4.60
	Protecting health and well-being	4.56
	Protecting the environment	4.48
	Protecting devices	4.34

All the competences have an importance level above 3.96, indicating that they are all significant and should not be overlooked. The competence with the lowest value is Problem Solving - Solving Technical Problems, with a score of 3.96. This may be because there are specialised support technicians available, making its importance relatively lower.

6 Discussion

The GreenComp [3] and DigiComp [6] frameworks highlight the growing importance of sustainability and digital skills across domains. Survey data reveals key trends and competencies expected to shape the future of digital marketing. All skills received high ratings (all above 3.91 on a 0–5 scale), with respondents indicating their importance will increase. This broad consensus underscores sustainability and digital literacy as core elements for future marketing professionals.

GreenComp [3] competencies like Strategic Communication and Practical Implementation received top ratings, suggesting professionals must understand sustainability strategies and communicate them effectively both internally and externally. Skills related to ethical business practices, such as Sustainability Certification and Strategic Application (4.27), were also highly valued, indicating organisations will prioritise ethics and social responsibility in strategic decisions. Circular Economy and Resource Stewardship (4.27) further show the need for efficient resource use and waste reduction, requiring marketing professionals to be prepared for these challenges.

The findings emphasise the importance of Lifecycle and Systems Integration, Risk Management, Collaborative Insight, and Holistic Communication Strategies in tackling complex sustainability issues. These competencies highlight the need to understand interconnected systems and make informed, long-term decisions. Innovative and flexible

solutions are also needed; skills such as Strategic and Climate Adaptability, Innovative Sustainability, and Consumer-Centric Design are increasingly valued, reflecting the need to anticipate trends and develop creative solutions aligned with sustainability and digital goals. As Nguyen et al. note, project-based learning and real-world application enhance critical thinking and problem-solving.

These results align with Nguyen et al. [1], who emphasise systems and strategic thinking as crucial for promoting sustainable business practices and addressing complex challenges, preparing marketing professionals to drive positive change.

For DigiComp [5], respondents highlighted the importance of digital collaboration and communication. Skills such as Interacting, Sharing, and Collaborating through Digital Technologies (all above 4.20), as well as developing digital content (4.23) and understanding Copyright and Licences (4.19), are increasingly significant. The highest-rated skills relate to safety, including protecting personal data and privacy (4.60), health and well-being (4.56), the environment (4.48), and devices (4.38), underlining the importance of cybersecurity knowledge for digital marketing professionals.

According to [4], practical skills like extracting insights from Big Data, using social media, and managing customer relationships are key, but our findings show safety is given even greater importance.

Overall, the survey results on GreenComp [3] and DigiComp [5] competencies reinforce the increasing relevance of sustainability and digital skills. Organisations must prioritise sustainability communication, ethical engagement, systemic thinking, adaptability, digital collaboration, cybersecurity, and policy advocacy to address future challenges, as also noted in other studies [6]. Developing these skills will be vital for professionals aiming to contribute to a more sustainable and digitally literate world.

7 Conclusion

Sustainability marketing has evolved from addressing specific environmental issues to a comprehensive approach that integrates social, ethical, and environmental considerations into marketing practices [6].

Future directions for sustainability in marketing focus on three main areas: System-driven changes (infrastructure and regulatory policies), business-driven initiatives (integrating sustainability in the process), and consumer-driven actions (high-impact behaviours). These combined efforts aim to create a holistic approach to sustainability in marketing [6]. For all this, marketing significantly contributes to the development of sustainability competencies by providing students with the knowledge, skills, and practical experience needed to promote sustainable business practices. This prepares future marketing professionals to address complex sustainability challenges and create positive change in their organisations and communities [1].

From our study, all GreenComp and DigiComp listed skills are considered important or very important for future, with scores ranging from 3.91 to 4.60. The highest average score GreenComp is 4.27 for “Circular Economy and Resource Stewardship, “ while the lowest is 3.91 for competences related to regulations or policies. Competences within “Exploratory Thinking Skills” also stand out, with values between 4.26 and 4.20. These

more important skills are more align with business-driven initiatives and consumer-driven actions [6] perhaps because they are more directly related to the tasks performed by marketing professionals.

Regarding DigiComp skills, those in the "Safety" category are highly rated, with over 50% of respondents considering them extremely important. Cybersecurity is something that concerns the stakeholders in digital marketing.

Consequently, it is considered that the integration of sustainable and digital skills should be holistic, involving all aspects of the curriculum and institutional practices, to promote meaningful change and prepare marketing professionals to address the sustainability and digital challenges of the 21st century [1, 4].

In addition to the survey results, Focus Groups were also conducted to better understand the different perceptions of stakeholders. Comparing these data will allow for a deeper understanding of the importance attributed to the different GreenComp and DigiComp skills, helping to identify which should be integrated into digital marketing courses by European higher education institutions.

Acknowledgements. This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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Evolution of Artificial Intelligence Initiatives Implementation Through Macro Policies in Latin America in 2022 and 2025

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Abstract. The aim of this article is to analyze the evolution of macro-policy recommendations on artificial intelligence and their coverage and implementation in Latin America, through a comparative case study analysis of eight countries (N = 8) in the years 2022 and 2025. The results show that the number of initiatives in this area has increased between 2022 and 2025, and this difference is statistically significant with $p < .001$. Furthermore, there has been a clear growing interest in public governance, science and technology and Economy and Digital Economy through. However, it is still necessary to expand coverage in sectors such as employment, investment, finance, health, and education.

Keywords: Artificial Intelligence · Policy · International Policy · Government Policy · Latin America

1 Introduction

Artificial Intelligence (AI) has evolved over the past seventy years into one of the most impactful technologies in contemporary society. It has even been suggested that we are currently experiencing the "AI Spring" [10 , p.25]. Ultimately, the implementation of AI presents both substantial benefits and considerable risks and has become a pivotal technology in the ongoing technological revolution shaping modern society. Consequently, various international organizations engaged in the formulation of supranational policies—Including the Organisation for Economic Co-operation and Development (OECD), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the European Union (EU), and the Organization of American States (OAS), among others have developed principles and recommendations aimed at facilitating the integration of AI into society in a manner that is efficient and respectful of fundamental human rights. These initiatives aim to assist states worldwide in the development of public policies.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 270–279, 2025.
https://doi.org/10.1007/978-3-032-09080-5_28

1.1 Definition of AI in Macro-Policies

Defining the concept of Artificial Intelligence (AI) proves to be a complex task. As Berryhill et al. aptly state, "AI means different things to different people" [1 , p.11]. From a technical perspective, the OECD defines AI as "a machine-based system that can make predictions, recommendations, or decisions, influencing real or virtual environments, for specific objectives defined by humans" [5 , p.20]. This definition is later complemented with a broader perspective "a general-purpose technology with the potential to enhance the well-being of individuals, to contribute to positive and sustainable global economic activity, to foster innovation and productivity, and to help address major global challenges" [11 , p.3].

Similarly, UNESCO defines AI as: "An information-processing system that integrates models and algorithms capable of learning and performing cognitive tasks, leading to outcomes such as prediction and decision-making in both material and virtual environments." [15 , p.4]. Along the same lines, the European Union (EU) conceptualizes AI as: "A system of software (and possibly also hardware) designed by humans that, given a complex objective, acts in the physical or digital dimension by perceiving its environment through the acquisition of data, interpreting structured or unstructured data, reasoning on the knowledge or processing information derived from this data, and deciding on the best actions to take in order to achieve the established objective." [14 , p.20].

2 Method

The methodology employed in this study is a multiple-case study approach [8, 16]. This approach is chosen because it enables the description and comparison of various subjects, objects, or situations from both quantitative and qualitative perspectives, providing a more comprehensive understanding and interpretation of the studied phenomenon. Additionally, this method allows for the use of documentary analysis as a valid technique for this process, using data available from the OECD AI Policy Observatory website. The population consisted of 13 Latin American countries. However, to determine the sample, $n = 8$ countries were selected and characterized by their participation in the OECD AI Policy Observatory and their initiatives in public policy in this area, according to the initiatives declared at two observation periods: 2022 and March 2025.

To determine the degree of policy coverage of state initiatives on AI, a comparative technique was used [13]. This technique is characterized by seeking similarities and differences among the study subjects [12]. Additionally, Fideli states that 'the comparative technique serves to compare two or more properties stated in two or more objects, at a specific moment or over an extensive period [3 , p.18].

Statistically, the absolute frequency of 11 policy coverage indicators proposed by the OECD AI Policy Observatory was determined and can be seen on Table 1. A Chi-Square test was conducted to examine the relationship between the number of initiatives by dimension and the year in which they were reported, as this technique allows for the study of frequency similarities between groups of variables [9], setting as Hypothesis that the distribution of policy implementation has varied significantly between both years studied.

Table 1. Distribution of AI initiatives in 8 Latin American countries, by dimensions, in 2022 and 2025. Source: Own elaboration.

Public Coverage Indicator	Year 2022	Year 2025	Chi-Squared test
Innovation and Development	33	34	0,0070
Economy and Digital Economy	36	54	2,7534
Education and Skills	23	18	0,8876
Industry and Entrepreneurship	28	24	0,5420
Science and Technology	32	40	0,5324
Social Issues and Well-being	22	15	1,7008
Public Governance	34	57	4,7170
Investment	15	5	5,5190
Finance and Insurance	10	1	7,8281
Employment	11	8	0,6369
Health	8	9	0,0192
		Sum of Chi Squared	25,1439
		p value	0,00180

Additionally, the Global Government AI Readiness Index [7, 8] was used as a comparative measure at the global level, according to their results exposed in 2021 and 2024.

3 Results

In 2022, the countries consulted combined declared 63 initiatives, increasing to 113 at March 2025. Each of these policies corresponds to one or more of the indicated dimensions, distributed as follows:

As can be appreciated in Table 1, to study the independence between the number of declared initiatives and the observation year, a Chi-Square test was conducted. The distribution of policy implementation has varied significantly between 2022 and march 2025. For a total of 517 observations across both years, setting a significance level of.05 and 10° of freedom, a p-value of 0.0018 was obtained. This result allows us to conclude that the relationship between the variables is statistically significant.

To further explore the behavior observed in the number of initiatives, the cases for each of the studied countries were reviewed.

3.1 Argentina

Argentina reported a total of nine AI-related initiatives in 2022. Among the most noteworthy are a) the National AI Plan, and b) the Big Data Observatory. These initiatives are aligned with the supranational policies previously discussed, which recommend the

design and implementation of AI policies that actively promote data collection, analysis, and knowledge generation, all from a perspective that prioritizes citizen protection and integrity. By March 2025, Argentina reported an increase to twelve initiatives, maintaining the nine declared in 2022 while adding the establishment of an AI Center and new mechanisms aimed at reinforcing the ethical and trustworthy use of AI.

In terms of policy coverage, the 2022 initiatives were primarily focused on production-related domains, particularly emphasizing Innovation and Development projects, Industry and Entrepreneurship, followed by Investment and Science and Technology. However, even though a greater number of initiatives declared by 2025, their scope became more narrowly distributed, concentrating efforts in the areas of Economy and Digital Economy, Science and Technology, and Public Governance.

3.2 Brazil

Brazil also reported nine AI-related initiatives in 2022, increasing to twelve by March 2025, a trend like that observed in Argentina. Among the most relevant initiatives declared in 2022 were: a) the Brazilian AI Law, b) the General Data Protection Law, c) the National Internet of Things (IoT) Plan, and d) the Applied AI Research Centers.

A significant increase was observed in initiatives linked to Public Governance around 2025, rising to seven. Notable among these are: a) the use of AI in public sector cases, b) the Brazilian Strategy for Artificial Intelligence, c) the Brazilian Strategy for Digital Transformation, d) the General Data Protection Law, and e) the Governance Committee for the Brazilian AI Strategy.

The establishment of legislation promoting the integration of AI-based technologies provided a solid foundation for Brazil's social and economic progress. These laws are fully consistent with the recommendations of supranational AI policy guidelines, particularly the OECD [6] regarding AI system development and UNESCO [15] concerning data protection and security.

In 2025, these guidelines had materialized into concrete initiatives, with a strong focus on governance, reflecting the general trend observed across Latin America. This development was accompanied by a notable increase in initiatives related to Innovation and Development, which grew from four to nine initiatives explicitly linked to this dimension. Conversely, the country reported at least one initiative linked to finance and investment in 2022, a figure that dropped to zero.

3.3 Chile

In 2022, Chile reported nine initiatives related to the adoption of Artificial Intelligence. Among these, the following stood out: a) the National AI Policy, b) various educational initiatives, and c) the Data Observatory. By 2025, the country reported two additional initiatives, notably including the establishment of the AI Research Center. Policy coverage was clearly geared toward the creation of a system in which citizens are placed at the center of the deployment of AI-based technologies. Educational promotion and skills development emerged as fundamental pillars, as evidenced by the large number of initiatives dedicated to this area, including a) the National Digital Languages Plan,

b) the Doctoral Scholarship System for AI studies, and c) collaborations with private companies for the identification and development of digital AI talent, among others.

The system also actively encouraged Innovation and Development initiatives and the generation of AI knowledge and technological solutions. Lastly, the creation of AI-based jobs was another key element complementing the system. Looking forward, policy coverage must expand to focus on generating AI-driven solutions in areas such as health, investment, and industry and entrepreneurship. It is also worth noting that Chile was the only country in this study to declare fewer initiatives linked to Public Governance in 2025 compared to 2022, and the only country to consistently report initiatives addressing the Employment dimension in both years.

3.4 Colombia

Colombia stands out as the country that reported the highest number of AI-related initiatives in both study periods. In 2022, the most significant initiatives included: a) the Law for the Promotion of AI Technology and Entrepreneurship, b) the National Artificial Intelligence Strategy, c) the Big Data Policy—Data Governance Framework, d) the Ethical Framework for Artificial Intelligence. Colombia's early emphasis on drafting legislation to facilitate the deployment of AI technologies was a key driver for systematic growth in this area. This approach materialized in a notable increase from 20 to 35 initiatives declared by March 2025, with a strong focus on the dimensions of Innovation and Development, Economy and Digital Economy, Science and Technology, and Public Governance. In fact, of the 35 initiatives declared in 2025, 17 directly address this last dimension.

This trend demonstrates Colombia's clear intent to position itself as a regional leader in AI policy within Latin America. However, it also reveals gaps in areas such as Education, Employment, Finance, and Investment, where the number of initiatives remained almost unchanged across both periods. Colombia's approach is well-aligned with supranational policy recommendations, incorporating diverse strategies that address core themes proposed by the [6] and UNESCO [15]—Including the promotion of AI, responsible data use, and ethical AI development through its National Artificial Intelligence Strategy.

3.5 Costa Rica

In 2022, Costa Rica reported three initiatives related to the implementation of Artificial Intelligence, notably including: a) the Digital Transformation Strategy for Costa Rica's Bicentennial 4.0, and b) the National Artificial Intelligence Laboratory. By 2025, the number of initiatives rose to seven, with five of them specifically contributing to the Public Governance dimension.

Although it would be premature to speak of an integrated AI system encompassing various sectors of society, the country has demonstrated a genuine interest in ensuring it is not excluded from the benefits offered by emerging technologies—Particularly AI. However, no clear regulatory framework regarding data usage or ethical guidelines for the development of AI-based solutions could be identified. In terms of policy coverage, Costa Rica's initiatives have mainly focused on two areas: the development of Innovation

and development projects and the application of AI in the public sector. These two domains represented most initiatives both in 2022 and 2025, with a strong emphasis on governance-related dynamics.

Nevertheless, the country still needs to develop new AI-related initiatives and public policies that address other sectors, including health, education, employment, and investment, among others. This gap also presents an opportunity for Costa Rica to strategically direct its future efforts in these areas.

3.6 México

Mexico presented, in 2022, 5 initiatives related to the incorporation of AI, of which the following stand out: a) National AI Agenda in Mexico, b) Principles and impact analysis guide for the development and use of AI-based systems in federal public administration, and c) National Open Innovation Ecosystem. By 2025, the number of declared initiatives increased to 15, including: a) Cases for the use of AI in the Public Sector, b) National Artificial Intelligence Alliance. In this context, there is a strong focus on Governance, Industry, and Economy, to the detriment of areas such as Health, Education, Finance, Employment, and Investment, which have no recorded initiatives.

Like other nations, Mexico, despite having fewer initiatives, maintains a strong interest in developing actions related to governance, with policies that aim to promote the development of AI in the country. These are embodied in nascent initiatives seeking to create an integrated system capable of addressing the diverse actors in society. It is important to highlight that, within the initiatives, there is a marked interest in the development of comprehensive AI policies that ensure the protection of personal data use. This presents an opportunity to advance towards a deeper and broader AI system, also considering the ethical background regarding the generation, collection, and analysis of data, in line with the fundamental principles proposed in the OECD [6] and UNESCO [15] recommendations.

3.7 Peru

Peru presented 5 initiatives in 2022, increasing to 17 by 2025, reflecting a significant rise, which, like other nations, is concentrated in Governance and Economy, and Digital Economy. By 2022, Peru highlighted the following initiatives: a) National Artificial Intelligence Strategy, b) National Open Data Platform, and c) AI Initiative for Covid-19, incorporating by 2025 new legal frameworks and specific AI applications, such as: a) Check your Plan, or b) PUNKU, both tools for data collection and analysis of the telecommunications market.

The political coverage mainly focuses on the development of AI initiatives in Public Governance, knowledge management through the development of science and technology, and promoting AI skills among its citizens. On the other hand, there are no recorded initiatives in areas such as health, employment, finance, investment, and Innovation and Development project management. As can be seen, Peru values the attention given to data as a key input for knowledge management, consolidating the nascent establishment of an AI system in society, incorporating regulatory and ethical regulations in this regard, marking a significant advancement compared to the original initiatives declared in 2022

3.8 Uruguay

Finally, Uruguay presented a total of 3 initiatives related to the incorporation of AI in 2022, of which the following stand out: a) AI Strategy for Digital Government, and b) Data Policy and Strategy for Digital Transformation. By 2025, it had incorporated only one more, named AI Use Cases in the Public Sector, making it the country with the fewest declared initiatives in both studied periods. There is a noticeable lack of development in terms of a greater number of initiatives and state policies addressing other sectors. Additionally, fundamental initiatives such as those proposed by the [6] and UNESCO [15], mentioned earlier, are not evident. However, these deficiencies present an opportunity for improvement and social development in AI.

The areas of political coverage are quite like those of Costa Rica, with most initiatives focused on sectors such as Innovation and Development and public governance. There is a clear desire to promote knowledge through initiatives that encourage science and technology.

The challenges of new AI initiatives in Uruguay should be centered on health, employment, finance, investment, economy, education, social issues, industry, and entrepreneurship. Additionally, it is worth noting that for the last studied period, the initiatives reported even fewer dimensions, making Uruguay the only country whose distribution in 2025 is lower than in 2022, showing a trend of maintaining a focus on Governance and Science and Technology.

3.9 Global Government AI Readiness Index

To contextualize the results in an international context, the Ranking prepared by The Global Index on Responsible AI was reviewed, comparing the reports from the two periods immediately preceding the studied years (Table 2):

Table 2. Global ranking of Latin American governments' readiness for AI incorporation in 2021 and 2024 (Source: Own elaboration)

Indicators	Country							
	A	B	C	D	E	F	G	H
Average Index 2022 [7]	54,4	60,6	60,4	58,9	46,2	52,6	40,6	57,9
Average Index 2024 [8]	36,1	65,9	63,2	59,3	56,9	53,3	57,1	62,2
Global Index Position 2022 [7]	54	40	41	45	74	60	91	48
Global Index Position 2024 [8]	54	18	23	48	44	64	61	19

Note: 1) The average index indicator is calculated based on a total of 100 points. 2) The global position is calculated based on a total of 160 countries, 3) Nomenclature: A) Argentina, B) Brazil, C) Chile, D) Colombia, E) Costa Rica, F) México, G) Peru, H) Uruguay.

When analyzing the behavior in 2021, according to the AI Government Readiness Index [7], Latin America averaged a total of 41.26 points. "It is considered the third lowest globally, after the Middle East and North Africa and Sub-Saharan Africa. Latin

America is comparable to South and Central Asia, both in terms of average score and the disparity between countries" [7 , p.24].

By end 2024, the average indexes of Latin America and the Caribbean saw a significant increase, with Brazil, Chile, and Uruguay standing out, yet remaining below the global average [8, p.16–17]. In any case, the global positioning of the studied countries shows an upward trend in the ranking, except for Argentina, Colombia, and Mexico. The case of Uruguay is particularly noteworthy, as, despite having very few declared initiatives in the case review, these reflect robust government support, combined with a remarkable update strategy [8 , p.17].

4 Discussion

The OECD [6] proposes five recommendations for the development of state AI policies: 1) investing in AI research and development; 2) fostering a digital ecosystem for AI; 3) shaping a favorable political environment for AI; 4) developing AI-related skills in citizens by preparing them for the transformation of the labor market; and 5) international cooperation for trustworthy AI.

Regarding the first recommendation, the findings indicate that, in general, by 2025 the countries studied have consolidated strategies with AI initiatives aimed at the generation of Science and Technologies projects. However, to advance social development, it is necessary to invest more resources in Innovation and Development. According to the report Innovation for Development by the Economic Commission for Latin America and the Caribbean, the situation in Latin America and the Caribbean is quite the opposite, as "in recent years there has been a reduction in investment and expenditure on Innovation and Development projects, decreasing from 0.65% of GDP in 2013 to 0.56% in 2019" [2 , p.19].

In the second and third recommendations, it can be seen that, by 2025, the creation of a large-scale AI system has been addressed with a strong concentration of initiatives focused on governance, through the implementation of regulations and legislation that, in 2022, appeared to be at an early stage but now reflect applied strategies in their use, as is the case in Peru and Costa Rica. This is mainly evident through the effort to publish AI policies that ensure the development of technology.

The fourth recommendation is a fundamental pillar for advancing the development of this type of technology. However, it has not been sufficiently implemented in the various AI initiatives and policies. Only Chile has made education and the development of AI skills a clear priority. This is demonstrated through the multiple initiatives it has launched, as well as the conservative behavior of its declared initiatives, which have remained consistent in their scope between 2021 and 2025. According to the Government AI Readiness Index, Chile stands out as the most prominent Latin American country in this area [7], maintaining its leading position through 2024, closely followed by Uruguay.

Finally, the fifth recommendation refers to international cooperation to foster trustworthy AI. Only one country (Chile) has introduced an international linkage initiative in this area, present in both periods analyzed. The main objective of this initiative is to promote transparent and reliable digital trade with nations such as Singapore and New Zealand. Regarding AI, this initiative aims for technology to explore new topics

of innovation and competition in the digital economy. In addition, it seeks to promote financial technology and the development of regulatory frameworks to support the safe and responsible use of such technologies [4, 8].

5 Conclusion

The eight Latin American countries analyzed in this study present different initiatives and/or state policies to develop AI in their countries. The most relevant ones are the creation of AI Laws (Brazil and Colombia) and National AI Policies, Plans, and/or strategies, observed in all studied countries by 2025. In relation to the OECD [6] recommendations for generating state AI policies, between 2022 and 2025, there is a trend on the incorporation of initiatives focused on governance and economic development, which is consistent with what was proposed by Reis et al., who as early as 2019 identified these dimensions as priorities, emphasizing how the structure of AI design and application shapes public initiatives [9].

At the political coverage level, it is evident that most of the countries analyzed do not present, in their different AI initiatives and/or state policies, the incorporation of these technologies in key areas such as employment, investment, finance, health, and education. Thus, it can be stated that the eight Latin American countries analyzed in this study are generating and preparing their initiatives and/or state policies following the recommendations and guidelines of various international organizations. Each country does this at a different level depending on its individual factors. However, there is a widespread desire among the largest Latin American powers to make a serious effort to develop AI in their countries to harness all the benefits it brings in the future.

In conclusion, considering the OECD's five recommendations, Latin America reveals as region in transition, marked by both progress and persistent challenges. Moving forward, it is imperative to adopt a more balanced approach that not only fosters AI infrastructure and governance but also actively invests in human capital and cross-border partnerships to ensure inclusive and trustworthy AI development.

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Models of Environmental Sustainability in Universities: A literature Review

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Abstract. This article presents a comprehensive review of the extant literature on environmental sustainability models developed within academic institutions. A qualitative approach was employed because it is a descriptive, non-experimental research using methodologies validated by authors to identify the benefits and opportunities related to environmental sustainability. This was achieved through a literature review of various studies, theories, and successful practices. The findings indicate a marked interest in environmental sustainability among institutions of higher education. These institutions, in their capacity to train professionals who contribute to development and progress, serve as strategic partners in environmental management and the implementation of sustainable practices on university campuses. It is recommended that this partnership be evaluated. The present systematic literature review contributes to the advancement of the discourse on environmental sustainability in higher education by identifying current trends, challenges, and best practices in the implementation of sustainable policies at the university level. The results indicate a mounting commitment on the part of universities to contribute to sustainability in areas such as environmental education, curriculum, and various strategies to make visible this contribution to the environment from the academy.

Keywords: environmental sustainability · universities · education

1 Introduction

The issue of environmental sustainability has attracted considerable global interest, this has prompted higher education institutions, which play a fundamental role in society by training professionals, to undertake a thorough examination of their responsibility to the environment and natural resources. Consequently, these institutions have adopted various strategies and sustainable practices on university campuses to enhance their environmental performance and to assess it through models.

A paradigm shift is imperative to address the untenable status quo, marked by the incompatibility between the pursuit of continuous production, energy consumption, and the necessity of environmental sustainability. This transition demands a fundamental

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 280–289, 2025.
https://doi.org/10.1007/978-3-032-09080-5_29

transformation in the prevailing development paradigm, one that fosters inclusive and sustainable growth while anchoring our vision in a long-term perspective (CEPAL,2018).

According to the United Nations (2022), the Brundtland Commission's 1987 definition of sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" entails a significant responsibility for the current generation, as it places the future of society in the context of its present actions and decisions.

Environmental sustainability is defined as "the capacity to maintain certain processes or states over time, balancing the production and consumption of natural resources." As stated in the Program of the United Nations for the Environment (PNUMA, 2004).

The concept of environmental sustainability encompasses the responsibility of preserving resources for future generations. According to Goodland (1995), environmental sustainability involves the integration of development practices that preserve biodiversity, ecosystems, and natural resources for the benefit of future generations (p. 8).

The model of environmental sustainability in universities is defined as an integral approach that seeks to implement sustainable practices in institutional management, research, and teaching. The objective of this implementation is to generate a positive impact on the environment and the university community (Ceballos, and López, 2020).

In this regard, the United Nations (UN) has asserted that education serves as a pivotal catalyst for achieving numerous Sustainable Development Goals (SDGs). The UN has identified education as a crucial factor in enabling individuals worldwide to lead healthier and more sustainable lives. Moreover, education has been identified as a means of fostering tolerance among individuals and contributing to the development of more peaceful societies. This is likely due to the fact that maintaining adequate resources in good condition and ensuring sufficient supplies to meet the population's needs can prevent the emergence of pressures and conflicts over access to these resources.

According to Torres Ortega et al. (2024), "Universities have the capacity to develop interdisciplinary programs that address critical issues such as climate change, social justice, and conservation of natural resources" The success of sustainability models in higher education institutions will depend on their ability to adapt and evolve. (p. 128).

1.1 The Importance of Environment Sustainability and ODS

The present study explores the state of sustainability and its compliance in Ecuadorian universities, examining its integration within the broader institutional evaluation framework. This analysis delves into the challenges and opportunities confronting higher education institutions in their efforts to innovate and enhance environmental decision-making processes within the context of the educational model. The study calls for a re-evaluation of existing practices and a proactive approach to address the pressing issues of sustainability, performance, and decision-making in the Ecuadorian higher education sector.

In relation to this topic, it can be mentioned that environmental sustainability is related to various Sustainable Development Goals (SDGs), including SDG 4: Quality Education. Academia can contribute greatly to educational quality, within which the environment and sustainability represent a fundamental element. Another SDG that is

essential to comply with at the university is the one referred to recycling and proper waste management, such as SDG 12: Responsible production and consumption by reducing paper consumption (United Nations, 2020).

2 Development

2.1 Method

The qualitative approach was implemented due to the descriptive, non-experimental nature of the research.

In this research, the literature review was conducted using the approach proposed by Khan et al. (2003, pp. 118–121). This approach consists of a systematic review of five steps, which are outlined below:

1. The following questions have been identified for the purpose of review: In this phase, the following key questions were established: Which researchers have previously addressed the field of environmental sustainability in universities? What were the primary conclusions of the study? Have models or strategies for environmental sustainability been developed?
2. The identification of relevant work is the first step in this process. The relevance of the research in the scientific field was determined by applying selection criteria, including the languages in which it was written (Spanish and English), the year of publication, and the indexed database. The present process is intended to guarantee the relevance of the articles selected, thereby serving to strengthen the current research.
3. The quality of the studies must be evaluated. It is imperative to ensure rigor in order to determine the impact and veracity of the number of citations, the scientific database, the relevance of the author, and the contribution to the topic of environmental sustainability in universities.

4. The following is a synopsis of the extant evidence: Following the identification of pertinent research, a meticulous and comprehensive analysis of each study was conducted, resulting in the creation of summaries and syntheses that underscore the fundamental concepts and their potential relevance to the study of environmental sustainability.

5. Interpretation of the Results: The most suitable and representative research was analyzed and interpreted so that its findings could be incorporated into the current study.

2.2 Results

3 Literature Review

The bibliographic search criteria considered for the topic of “Environmental Sustainability Model” in universities are presented below (Table 1):

Table 1. Bibliographic search criteria-environmental sustainability models in universities

Criteria	Description of the criterion
Content in the works	Models of Environmental Sustainability in Universities / Sos-tenibilidad Ambiental / Sustainability in Universities
Works related to Higher Education	Journals of Higher Education Institutions (HEI)
Year of publication	2010 to 2024
Relevance of the publication	SciElo, Redalyc, Researchgate, Dialnet, Risti, IEEE Xplore, E-libro y Science Direct.
Lenguage	Spanish—English

The results of the literature review on "Models of Environmental Sustainability in Universities" indicate that academic institutions play a pivotal role in promoting environmental sustainability. They function as agents of change by integrating sustainable practices into their operations, teaching, and research. To address this need, several models have been developed to guide universities in this process, covering dimensions such as environmental management, social responsibility, economic viability, and institutional relevance. These models aim to reduce the environmental impact on university campuses and to cultivate a culture of sustainability among students, faculty, and administrative staff (Table 2).

Table 2. Search results for research papers

Journals / Libraries	Selected
Science Direct	25
SciElo, Redalyc, Researchgate, Dialnet y Risti	15
E-libro (virtual library)	3
IEEE Xplore	4
Total	47

The selection of these 47 research papers was conducted in accordance with the second step of the literature review methodology, which pertains to the identification of relevant papers. Subsequently, an evaluation was conducted to ascertain the quality and contribution of the studies. This evaluation resulted in the selection of the following 15 research papers as the most significant (Table 3).

Table 3. Detail of research on models of environment sustainability in universities

No	Author (s)	Year	Title
1	Gabriel Estuardo Cevallos Uve	2015	Environmental management models: Comparative analysis from multidimensionality and local context.
2	Edgar J. González Gaudiano, Pablo Á. Meira-Cartea y Cynthia N. Martínez-Fernández	2015	Sustentabilidad y Universidad: Retos, ritos y posibles rutas
3	Tom Murphy y Will O'Brien	2014	A strategic decision model for evaluating college and university sustainability investments
4	Rodrigo Lozano et al.	2022	Adopting sustainability competence-based education in academic disciplines: Insights from 13 higher education institutions
5	Ayotunde Dawodu	2022	Research in campus sustainability: Indicators and dimensions to consider for the design and evaluation of a sustainable campus.
6	Walter Leal Filho, Chris Shiel, & Arminda Maria Finisterra do Paço	2015	Integrative approaches to environmental sustainability at universities: An overview of challenges and priorities
7	Edna Cristina Figueroa García, Manuel Alejandro, Gutiérrez González, Luis Leonel Heath Moncada	2023	Sustainability Model for Higher Education Institutions: A self-diagnostic strategy for the transition to sustainability. Case Study
8	Miranda, Luis Francisco, Sánchez Buitrago, Jorge Oswaldo, & Viloria Escobar, Javier de Jesús.	2021	Environmental sustainability in higher education: A review of the field.
9	Pilly Constanza Monroy Abril, William Fernando Castrillón Cardona, Diana del Socorro Daza Ardila	2016	Review of environmental management models in institutions of higher education.
10	Silvia Fissi, Alberto Romolini, Elena Gori, Marco Contri	2021	The path toward a sustainable green university: The case of the University of Florence
11	Bifeng Zhu, Jing Feng, Chaoyang Sun3 & Zhekai Wang	2024	Characteristics and affordability of American universities with a willingness to invest in Sustainability

(*continued*)

Table 3. (*continued*)

No	Author (s)	Year	Title
12	Mohammed Maatallah, Sidamar Lamsadfa, Abdelhak Guennoun	2024	The role of the University in sustainable development: A statistical analysis of student and faculty trends at the University of Tamanrasset
13	Tennakoon, W. D. N. M. S., Janadari, M. P. N., & Wattuhewa, I. D.	2024	Environmental sustainability practices: A systematic literature review
14	Rodrigo Lozano, Michelle Y. Merrill, Kaisu Sammalisto, Kim CeulemansID and Francisco J. Lozano	2017	Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal
15	Alok Bihari Singh, Himanshu Kumar Meena Chandni Khandelwal, Govind Sharan Dangayach	2023	Sustainability Assessment of Higher Education Institutions: A Systematic Literature Review

The following is a literature review on recent advances and applications of environmental sustainability in this context.

Cevallos (2015) explores the consequences of the influence of environmental management at the local level on the dimensions of development as a fundamental tool to advance on the path of sustainability, where environmental management should respond more to models associated with quality and excellence than to costs.

Dwodu (2023) posits that assessment tools have emerged as the prevailing approach for addressing sustainability concerns within the built environment.

González et al. (2015) thoroughly delineate the challenges encountered during the integration of sustainability principles within Latin American universities. Their study addresses the multifaceted demands imposed by societal, governmental, and global market pressures, offering a comprehensive analysis of the obstacles and opportunities that arise from these pressures.

Murphy, and O'Brien, (2014) found that the strategic decision model provides a broader framework for decisions, i.e., qualitative and quantitative in terms of university sustainability. This reinforces the concept that sustainability must be properly planned to avoid subjectivity and lack of resources.

A significant aspect that has garnered considerable attention from universities is the curriculum. In this regard, Lozano et al. (2022) have noted that higher education institutions (HEIs) have incorporated sustainability into education and curricula, emphasizing sustainability competencies, pedagogical approaches, and their interconnection. The integration of sustainability in education, as elucidated through curricular evaluation,

has been facilitated by the adoption of innovations and possesses the capacity to elucidate the development of competencies through pedagogical approaches.This approach equips students with a more transdisciplinary set of skills, thereby contributing to the realization of more sustainable societies.

In the context of higher education institutions and the integration of sustainability in academic programs, it is noteworthy to consider the example of the Israel Technological University of Ecuador. Despite its status as a relatively recent institution, with a foundation of 25 years, the university has demonstrated a profound commitment to sustainability. This commitment is exemplified by numerous strategic initiatives, primarily as follows: The Strategic Development Plan includes an exclusive objective pertaining to sustainability that is transversal to the university's substantive functions. Furthermore, the Sustainable Development Goals have been incorporated into the syllabus, and a subject entitled "Sustainability and Corporate Responsibility" has been included in the Business Administration curriculum (Fig. 1).

FUNCIÓN SUSTANTIVA	OBJETIVO ESTRATÉGICO	INICIATIVAS ESTRATEGICAS
DOCENCIA/ INVESTIGACIÓN/ VINCULACIÓN CON LA SOCIEDAD /GESTIÓN	**OE5.** Potenciar la sostenibilidad en la docencia, investigación, vinculación con la sociedad y gestión universitaria	5.1 Trabajar en equipo hacia el desarrollo sostenible promoviendo la inclusión de los ODS en las funciones sustantivas universitarias
		5.2 Promover una cultura de consumo responsable de recursos a través de la potenciación de buenas prácticas ambientales
		5.3 Promover el sentido de pertenencia a través de actividades de responsabilidad ambiental

Fig. 1. Detail of UISRAEL's strategic objective about sustainability included in the institutional strategic plan PEDI 2023–2027

Figueroa García et al. (2023) present a strategy for the transition to sustainability of a university in the state of Querétaro. In this strategy, a Sustainability Model was applied, consisting of four areas: Environmental sustainability, social responsibility, economic viability, and institutional relevance. This model was used to quantify the university's sustainability actions (Fig. 2).

In the context of evaluating and qualifying sustainability (Singh et al., 2023), the extant literature was analyzed to compile a list of SATs (Sustainability Assessment Tools). These tools were classified into three categories: Qualitative, quantitative, and mixed techniques.

In relation to this subject, Filho et al. (2015) expound on the principles of sustainable development and their growing pertinence to organizations capable of serving as conduits in the dissemination of these principles within society. Consequently, Miranda et al. (2021) identified three primary domains that provide a foundation for research

Fig. 2. Virtual classroom of the sustainability and corporate responsibility course

on environmental sustainability in academic institutions: Environmental education, the integration of environmental sustainability and environmental protection.

In their research, Monroy Abril et al. (2016) examined the application of consolidated models in select universities. These models were found to address the identified needs and demands of stakeholders. The study recommended the utilization of established models, with modifications to align with the requirements of the specific context. This approach was deemed essential for the development of environmental management systems within educational institutions.

The establishment and adaptation of models to suit the requirements of the context can be utilized to develop the environmental management of an educational institution. These models can also guide the institution in achieving sustainability for its teaching, research, and service processes in the near future.

4 Conclusions

The extant literature on the subject indicates that, despite the presence of certain advances in the realm of environmental sustainability within university campuses, a more systematic and collaborative approach is necessary to maximize impact. It is imperative that higher education institutions adopt a proactive role in the formation of a sustainable society, ensuring the integration of sustainability across all its dimensions. The integration of environmental sustainability in education represents a moral obligation of universities, given that it constitutes a cross-cutting issue to the substantive functions of teaching, research and liaison with society. In this regard, it is important to note that processes generated by academic activities result in the use of natural resources and

environmental impacts. The effective implementation of environmental sustainability models for universities necessitates a holistic approach that considers the particularities of each institution and its socioeconomic environment, thereby ensuring more effective results. Institutions that adopt a sustainable approach realize a variety of benefits, both in terms of the environment and motivation. The establishment of an environmental consciousness within the community is one such benefit, as is the implementation of effective environmental practices. Furthermore, energy, water, and material savings are generated, thereby reinforcing university welfare.

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Intelligent Tutor for Tasks in The Domain of Linear Algebra

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Abstract. Difficulties in learning linear algebra are well-documented and arise from epistemological, didactic, and instructional factors. This study presents the design of an affective intelligent tutor focused on the mathematical object known as systems of linear equations (SLE). The tutor provides adaptive feedback and was developed using an iterative methodology that combines design, internal validation, and continuous improvement. It integrates several components: A didactic knowledge module, a model of ideal student behavior, a pedagogical tutoring module, a graphical interface, and an affective module based on computer vision. This affective component employs the DeepFace library, integrated with OpenCV and PyQt6, to detect emotions in real time through facial expressions. Emotional inputs are processed to compute a stress index, which triggers adaptive, affective feedback during task execution. The current version includes one task designed to help students coordinate the seven different representations of a 3×2 SLE, thereby enhancing their understanding of the solution set. To date, expert and functional validation has been conducted. The tutor shows potential as a support tool for autonomous learning and as a training resource for future mathematics teachers. Preliminary testing with experts revealed challenges such as redundant emotion detection and visual overlap of interface elements. These findings have informed subsequent redesign efforts. Although still in the prototype phase, the system shows promise in supporting representational coordination in tasks involving SLE.

Keywords: Linear algebra · Systems of linear equations · Affective computing · Intelligent tutor · Feedback

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 290–300, 2025.
https://doi.org/10.1007/978-3-032-09080-5_30

1 Introduction

The Babylonian, Greek, and Chinese civilizations addressed practical problems in trade and land surveying using SLE [1, 9], leading to methods like the Fangcheng shu—Structurally similar to the Gauss-Jordan method [9]. In the 17^{th} and 18^{th} centuries, SLE were applied to curve fitting, and by the end of that period, Euler studied them as autonomous mathematical objects, showing that the nature of their solutions depends on the relationships among the equations [6]. This formalization process faced challenges: The dominance of algebraic methods often obscured the geometric aspects of solving SLE. Still, it marked the emergence of the concept of linear dependence, later formalized and extended beyond the context of SLE [6, 8].

On the other hand, from an educational perspective, considering that the processes of abstraction, generalization, and axiomatization that took place in mathematics to shape the fundamental concepts leading to what we now know as Linear Algebra (LA) took centuries and faced many difficulties. This inevitably creates difficulties for students learning these topics in university, preventing them from fully understanding the meaning and scope of this new knowledge [6]. In particular, this has been evidenced in research related to the understanding of SLE, and more specifically 3×2 systems, as this requires a complex articulation between different mathematical representations—Algebraic, graphical, and structural that students do not always manage to establish fluently [14, 15].

In relation to the above, research in mathematics education has shown that students' difficulties in this domain of mathematics do not stem solely from procedural shortcomings, but also from epistemological obstacles related to the very nature of the mathematical object [6]. Added to this are difficulties inherent in traditional teaching, which often prioritizes algorithmic methods over conceptual understanding and geometric visualization [12, 13].

In response to this scenario, the development of an intelligent tutor with affective feedback is proposed. Its purpose is to guide the student in the active exploration of the seven possible geometric configurations of a 3×2 SLE, in order to support the cognitive construction of the solution set of this mathematical object [15].

The design of this tool is based on a dual inspiration: On the one hand, the classical theoretical frameworks of ITS, and on the other, didactic research addressing the learning difficulties associated with SLE, from perspectives such as APOS theory [2] (Action, Process, Object, Schema) and modes of mathematical thinking. This article presents the design foundations of the tutor, its architecture, the tasks it proposes to students, and the preliminary results obtained in the early stages of development.

Despite the historical evolution of linear algebra and the depth of its conceptual structure, few educational technologies explicitly integrate affective and didactic components to address learning obstacles in SLE. This project responds to this gap by proposing an intelligent tutor that not only supports problem solving but also incorporates pedagogical principles and real-time emotional feedback to foster deeper conceptual understanding. As highlighted by [18], the integration of affective computing in ITS enables these tools to detect and respond to learners' emotional states, significantly enhancing engagement and conceptual comprehension in cognitively demanding tasks. This approach aligns with recent innovations in educational technology, where emotion-aware ITS are being

designed to personalize instruction based on learners' affective and cognitive profiles, offering a more holistic and responsive learning environment. Furthermore, [19] demonstrated that combining peer instruction with seminar strategies and didactic engineering in linear algebra courses fosters active learning, enhances motivation, and improves conceptual mastery, suggesting that integrating such pedagogical strategies into intelligent tutors could further support students in overcoming learning obstacles in SLE.

2 Related Work

2.1 Intelligent Tutoring Systems (ITS)

ITS represent a convergence of artificial intelligence, learning theory, and educational technologies aimed at providing personalized teaching experiences. Unlike traditional computer-assisted instruction systems, ITS explicitly integrate structured domain knowledge, a student model, pedagogical strategies, and an adaptive interface [14]. This modular architecture enables the diagnosis of errors, the generation of meaningful feedback, and the dynamic adjustment of instruction according to the learner's cognitive and emotional needs.

According to [4, 10], an ITS is structured around four core components: (1) an expert knowledge module, (2) a student model, (3) a tutoring module, and (4) a user interface. These modules work together to provide an educational experience capable of diagnosing errors, proposing corrective strategies, and adapting to the learner's individual needs. Our tutor is based on this architecture and additionally incorporates an affective module, which responds to the student's emotional state through motivational feedback.

Recent developments in the field of ITS highlight the increasing integration of affective computing to enhance learning personalization and engagement. In [18] it is emphasized that systems capable of detecting and responding to students' emotional states can significantly improve motivation and cognitive performance. In mathematics education, [17] provides a comprehensive review of ITS implementations using the SAMR model and notes that most systems remain at the augmentation stage, with few achieving deep transformations in pedagogical practices. Affective feedback mechanisms, as examined by [20], offer new pathways to emotional self-regulation in learners, especially in tasks with high epistemic demand. Furthermore, a recent review by [7] underlines the importance of designing affect-aware educational technologies that go beyond task completion, focusing instead on conceptual understanding and student autonomy.

In comparison to widely used systems such as ALEKS and ASSISTments, which primarily focus on adaptive sequencing and procedural accuracy, our proposal incorporates emotional monitoring, conceptual scaffolding, and active manipulation of mathematical objects. This positions our tutor within a new generation of ITS that combine domain-specific didactic knowledge, real-time affective feedback, and exploratory environments to support the construction of meaning in advanced mathematical tasks such as SLE.

2.2 Affective Tutoring and Emotional Feedback

Recent studies, as synthesized by [4], have highlighted the crucial role that emotions play in learning processes, particularly in contexts mediated by intelligent technologies. The integration of an affective module in an ITS enables the detection of students' emotional states—such as frustration, confusion, or lack of motivation—and the activation of adaptive responses aimed at sustaining engagement and promoting both emotional and cognitive self-regulation. In this study, emotional classification is based on the dimensions of valence and arousal, allowing for the selection of motivational phrases that are contextually relevant and tailored to the user's affective profile.

Affective feedback has proven especially effective in learning environments where cognitive challenge can lead to blockage or disengagement. Its implementation in this tutor seeks not only to support students in solving mathematical tasks, but also to provide emotional scaffolding at critical moments of the learning process.

2.3 Epistemological Difficulties in Learning SLE

Learning SLE, particularly in the 3×2 case, presents challenges that go beyond procedural aspects. Research based on the APOS theory has shown that many students fail to construct a coherent schema of the "system" object or to connect algebraic solutions with their geometric representations [15].

Likewise, from the perspective of modes of thinking (synthetic-geometric, analytic-arithmetic, and analytic-structural), it has been shown that students tend to operate within a single mode without being able to shift between them, which limits their overall understanding. These difficulties, documented in both secondary and university students, justify the choice of a task that requires coordinating representations and reflecting on the structure of the SLE [12].

The tutor presented in this work seeks to address these issues not only through technological support, but also through a didactic proposal that is mindful of the epistemological complexity of the mathematical object in question.

3 Methodology

The proposed model consists of three interconnected modules, whose interaction simulates the dynamics between a student and a teacher in an educational setting. This architecture, based on a generic model proposed by [10], aims to computationally represent the relationships established during the resolution of a test situation, as shown in Fig. 1.

The core of the system is a playground-type interactive environment, in which the student can engage with a series of problems that allow for a hands-on approach to a specific content area. In this work, that environment consists of a visual representation of a Cartesian plane, where the student can manipulate lines to solve exercises related to collinearity. This module incorporates an emotional sensing system based on computer vision, which detects the student's facial expressions to infer their emotional state during problem-solving, as shown in Fig. 2.

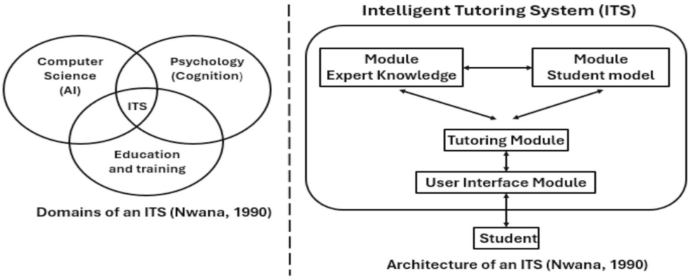

Fig. 1. Structural elements of the intelligent tutor.

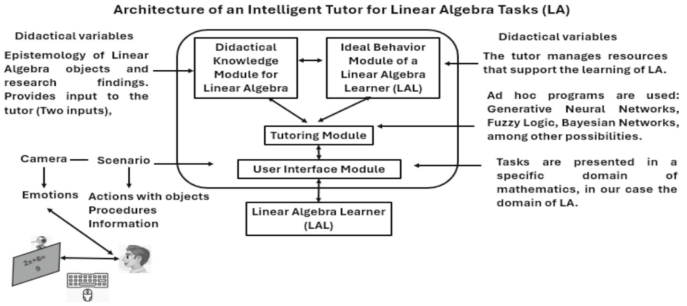

Fig. 2. Intelligent tutor architecture.

Additionally, the system integrates an intelligent tutor module, which processes the stimuli collected from the student and provides adaptive feedback. This tutor is structured into three distinct submodules:

1. **Knowledge base:** Contains the theory associated with the teaching content, including a searchable repository of frequently asked questions, solved problems, and conceptual explanations. It can be based on an encyclopedia-style model or be accessible via an LLM to facilitate interaction.
2. **Student mode:** Estimates the student's level of conceptual mastery, problem-solving strategy, and emotional response based on the context. It can learn from the student's interaction with the interface via reinforcement learning to enable adversarial training with the tutor module.
3. **Tutor mode:** Generates instructional stimuli and specific guidance based on the estimated student profile. It can learn from interaction with a real tutor via reinforcement learning, although it would initially be based on a rule-based logic.

Both the student model and the tutor module can be trained using data generated from the interaction between the user and the environment, as well as through teacher interventions.

During the experience, the student interacts with a set of prototypical problems in the playground, facing varying degrees of familiarity with the tasks presented. This process leads to particular emotional responses (e.g., stress or frustration), variable cognitive

strategies, and possible queries directed to the tutor, all of which are collected for the system's adaptive feedback.

3.1 General Design Approach

The intelligent tutor developed in this work was designed based on the classic principles of ITS, also integrating an emotional module that provides affective feedback during the resolution of a complex mathematical task. The proposal was conceived as a support tool for students who face difficulties in the structural understanding of 3×2 linear equation systems.

The design is based on an iterative methodology, coordinated between a team of researchers in mathematics education and a software developer. The first functional version of the system has been evaluated through internal review sessions, focusing on pedagogical coherence, the quality of the interface, and the tutor's behavior with different user profiles.

The first iteration was evaluated by a team of mathematics education researchers through internal expert reviews. These sessions provided insights into graphical usability, emotional feedback accuracy, and pedagogical coherence. No student data was collected at this stage.

3.2 System Architecture

The affective module of the tutor is based on the premise that emotions significantly influence cognitive processes and, therefore, learning [5, 11]. With the goal of emotionally supporting the student during the resolution of complex mathematical tasks, a real-time facial recognition system was integrated to infer the user's emotional state and activate personalized affective feedback. This system was implemented using the DeepFace library, a deep learning-based facial analysis tool [16], complemented with OpenCV for continuous image capture from the device's camera. Every two seconds, the system captures an image of the student's face and performs an inference that returns the predominant emotion. The emotions considered include: happy, sad, fear, angry, neutral, surprise, and disgust.

Following the affective valence model described in [3], which classifies emotions based on their positive or negative charge, a subjective scoring scale was defined for each emotion recognized by the system. This scale allows the student's recent emotional state to be quantitatively represented through a normalized stress index. Negative emotions such as *sad*, *fear*, and *angry* are assigned a score of $+1$, while positive emotions like *happy* receive a score of -1. Ambiguous emotions such as *surprise* and *disgust* are assigned a score of 0.5, and *neutral* is considered the midpoint with a value of 0. This index is calculated using the following expression:

$$\text{Stress Index} = \frac{1}{2}\left(\sum_{i=1}^{n} score(\text{emotion}_i)\right)$$

Where n is the number of emotions recorded during the analysis interval, and $\text{score}(\text{emotion}_i)$ represents the score assigned to the emotion at instant i. The formula normalizes the weighted average to the interval [0, 1], where values close to 1 reflect high-stress states, and values near 0 indicate emotionally positive or regulated states. Table 1 presents a summary of the emotional scoring system used.

Table 1. Scores assigned to each emotion.

Emotion	Score assigned
happy	-1
sad, fear, angry	+1
neutral	0
surprise, disgust	0.5

Based on this index, the system deploys three types of affective interventions, according to predefined temporal and emotional criteria:

- **High stress:** If the index exceeds 0.6 and at least 30 s have passed since the last alert, a message is displayed acknowledging the emotional load and offering explicit support.
- **Distraction or moderate stress:** If the value falls between 0.4 and 0.6, and at least 5 min have passed, a notification is triggered suggesting a break or redirection.
- **Sustained positive emotional state:** If the index remains below 0.4 for at least 10 min, the system issues a positive reinforcement message.

The integrated timers ensure that affective interventions are neither intrusive nor redundant, respecting the student's pace and autonomy. This emotional feedback mechanism, far from being a merely decorative feature, represents a critical functional layer for the tutor's adaptability, as it modulates the user experience based on dynamic affective variables. In doing so, the system moves toward a truly learner-sensitive tutoring model, integrating cognition and emotion within a unified pedagogical flow. The system consists of five main modules:

- **Didactic knowledge module:** Incorporates the theoretical and didactic foundations of the addressed topic, based on previous research.
- **Ideal student behavior model:** Contains the expected actions and responses for each of the proposed tasks.
- **Tutoring module:** Manages system interventions in response to errors, stagnation, or task deviations.
- **Affective module:** Detects emotions through facial recognition and activates relevant emotional phrases.
- **Graphical interface:** Allows the student to construct and manipulate geometric representations of systems of equations.

The architecture follows the classic framework of [10], enriched with features typical of mixed tutors (shared control between the system and the student).

Although a formal accuracy validation of the emotion recognition system has not yet been conducted, controlled testing with the DeepFace + OpenCV integration confirmed reliable basic performance. Future empirical phases will incorporate user consent protocols to address privacy concerns.

3.3 Description of The Mathematical Task

The proposed task consists of graphically modeling the seven possible configurations of a 3×2 SLE by representing three lines in the plane. The key point is for the student to understand what a solution is and what can happen with the solution set of a $3\ x2$ linear system.

The interface allows the student to draw, label, move, and analyze the lines, as well as identify common points and record conclusions. This activity aims to promote the coordination of algebraic and geometric representations, in addition to stimulating transitions in the way of visualizing the objects.

4 Results

4.1 Preliminary Observations of The Prototype

The first functional version of the tutor was subjected to a series of internal testing sessions, focused on analyzing technical performance, pedagogical coherence, and user experience quality. These tests allowed the identification of strengths as well as areas for improvement. Among the most relevant observations are the following:

- **Early presentation of the solution:** In the introduction of the task, the system shows an image with all possible configurations of the 3×2 system, which contradicts the proposed exploratory approach. It has been decided to remove this image in future versions.
- **Rigid graphical interface:** The equations of the lines overlap and cannot be relocated, making it difficult to clearly visualize the student's work. It is proposed to separate the visualization of the lines and their equations and allow manual editing.
- **Repetition of emotional states:** The system constantly detects and reports the same emotional state (for example, "neutral"), leading to irrelevant emotional interventions. This suggests the need to refine the recognition model and enrich the available phrase base.
- **Lack of adaptive help:** Currently, the tutor does not offer specific support when the student gets stuck or makes errors. It is proposed to implement a decision tree-based system to generate contextual interventions based on the student's actions.

During testing, several recurring behaviors were noted. For instance, the system repeatedly detected the same emotion ("neutral") without adjusting, and students found it difficult to distinguish overlapping lines. These findings informed decisions to improve emotional sensitivity and graphical clarity.

4.2 Adjustments in Development

Based on these observations, several lines of improvement have been defined, which are currently in the implementation stage:

- Redesign of the interface with more precise graphical tools and dynamic labels (L1, L2, L3).

- Expansion of the emotional recognition system with higher levels of sensitivity and customization.
- Incorporation of a strategic help module based on interaction patterns and common errors.
- Optimization of traceability logging for subsequent analysis of the resolution process.

These advances will allow for the evaluation, in a second stage, of the tutor's instructional effectiveness with real students, both in terms of mathematical performance and emotional experience during the task.

5 Conclusions

The intelligent tutor presented in this work constitutes a didactic and technological proposal aimed at supporting the understanding of 3×2 SLE, through the integration of graphical tools, an intelligent architecture, and an adaptive affective component. Its design is grounded in a review of the epistemological difficulties commonly faced by students in this domain, as well as in well-established principles of ITS.

Preliminary results suggest that the system may provide a suitable foundation for fostering transitions between representations and modes of thinking. However, several key areas for improvement have been identified, particularly regarding the graphical interface, emotion recognition, and the timely activation of contextual support.

Looking ahead, empirical validation of the tutor is planned in real educational settings, which will enable the assessment of its potential impact on conceptual understanding, motivation, and learning autonomy. Additionally, the architecture is expected to be adapted to address other complex topics in Linear Algebra, maintaining the focus on the articulation between representations and the consideration of emotional aspects in mathematical learning.

The intelligent tutor presented here represents a didactic-technological innovation that integrates graphical modeling, real-time emotion detection, and conceptual feedback grounded in mathematics education research. Future empirical validation will evaluate its effectiveness in enhancing students' understanding of SLE and regulating their emotional responses. Furthermore, the architecture is designed to be scalable and adaptable to other topics in linear algebra, such as vector spaces and linear transformations, always maintaining its emphasis on the coordination of representations and emotional engagement.

Acknowledgments. This work is supported by: The Call for Technical Support for R + D + i and Creation Functional Units, UPLA, 2024/2025 Edition, and by the Fondecyt Initiation Project No. 11190152.

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A Reference Framework for a Media Literacy Indicator in Brazil

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Abstract. This article presents the development of a reference framework intended to support the future construction of a national media literacy indicator in Brazil. The proposal emerges from the growing need to understand and measure the level of media literacy within the population, especially in the face of intensifying disinformation and the rapid expansion of digital platforms and artificial intelligence (AI) tools. The uncritical reproduction of unbalanced content and misinformation can lead to a variety of societal issues. From the creation of fake profiles to the massive dissemination of false or misinformation—Often spreading so rapidly that mitigation becomes unfeasible—These challenges also raise deeper concerns related to inclusion, equity and human rights. In this context, media literacy stands as a key of contemporary society, promoting citizens social, emotional and productive integration. Media literacy endows individuals with the necessary skills and competencies to critically engage with contemporary media ecosystems. It also functions as a foundational element in the exercise of democratic participation. Thus, this article aims to: (1) examine the core concepts and contextual dynamics surrounding media literacy and (2) develop a reference framework to guide the future creation of a Brazilian media literacy indicator. Through the Design Science Research (DSR) methodology, the study proposes a structured framework that synthesizes key theories and concepts into a unified artifact, designed to support future empirical studies and policy development.

Keywords: media literacy · media education · information consumption · misinformation

1 Media Literacy in Brazil: Concept, Relevance and The Challenges of The Absence of National Indicators

Media literacy comprises multiple competencies that enable individuals to access, understand, critically engage and create media content. Access refers to the skills and abilities necessary to locate media content using available technologies and software. Understanding includes the ability to decode or interpret media, for example, through awareness of formal and generic conventions, design elements, and rhetorical devices. It also involves

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 301–313, 2025.
https://doi.org/10.1007/978-3-032-09080-5_31

critical use of media and an understanding of production processes and institutional control patterns, as well as the ability to evaluate the truthfulness and reliability of media representations of the real world. Finally, creating involves the ability to use media to produce and communicate one's own messages, as a form of self-expression aimed at influencing or interacting with others (Buckingham, 2007, p. 44).

In times of *infodemic* - defined as the overwhelming flow of information from various sources (Rothkopf, 2003) - critical access to content becomes a major challenge. The infodemic is a complex phenomenon marked by the spread of false and misleading information. Although the term has gained relevance in recent years, it was coined in 2003 by David J. Rothkopf to describe a situation like the SARS epidemic, with "its own identifiable symptoms" and the "near-instantaneous velocity of information spread." The term was widely used during the COVID-19 pandemic (Melo, 2020).

Media literacy is particularly relevant in Brazil given its vast geographical extension, cultural diversity and multiple economic layers, as well as the increasing access to the internet and social media platforms, where citizens are exposed to vast amounts of information but, paradoxically, may lack knowledge (Almeida, 2007). In this context, it is essential for citizens to develop critical reading, writing, and comprehension skills to act consciously and actively in the digital world (Almeida, 2007; Castells, 1996; EducaMídia, 2018). Unlike traditional literacy, media literacy requires the development of specific competencies and mastery of information search and curation techniques to critically evaluate the intention and quality of information, understand the role of media and communication rights, and reflect on what is left unsaid (EducaMídia, 2018).

In the field of information consumption, media literacy also helps individuals understand marketing strategies and consumer relations. Thus, effective media education can support the identification of greenwashing strategies and encourage more conscious consumer decision-making, contributing to a more just, equitable and sustainable society.

Media literacy extends the democratic experience into the digital environment (Lewis et al., 1998), where critical interpretation is increasingly necessary for informed decision-making. Data from Melo (2020) show that WhatsApp is one of the main sources of information acquisition among Brazilians. Studies also indicate that trust in news shared by family and friends remains very high (Ideia Big Data, 2019). In sum, media literacy promotes social and productive inclusion, mental health, influences consumer behavior, enhances employability, impacts financial decision-making, and fosters civic engagement (Spinelli, 2021). UNESCO recognizes media and information literacy (MIL) as essential for meaningful media engagement, equipping citizens with critical thinking skills (UNESCO, 2016; Wilson et al., 2016).

Despite efforts by schools, governments, businesses and civil society, there remains a lack of tools for measuring media literacy in Brazil. This gap is attributed to various factors, including the complexity of the concept, the country's territorial extension, cultural diversity and the multiple economic layers that result in highly unequal standards and access to educational opportunities. The absence of such tools hinders an accurate understanding of the population's media literacy levels and complicates the development of effective action plans - such as public policies and large-scale educational programs - to mitigate the negative impacts associated with the lack of media literacy development.

2 Objective of The Study

This article has two main objectives. The first is to understand the media literacy landscape in Brazil through an analysis of information consumption. The second is to develop a reference framework for the future creation of a media literacy indicator that can support policymaking and the evaluation of existing media literacy programs in the country. The motivation for this study lies in the authors' understanding of the gap between published information and consumers' actual comprehension or interpretation of that information and its intent, as well as the widespread circulation of misinformation and its negative societal impacts.

Accordingly, the article presents a literature review aimed at understanding the key concepts and current landscape of media literacy in Brazil; it explores the consequences of limited development of media literacy skills (Almeida, 2007; Hobbs and Jensen, 2013), the need for measurement to enable effective policies, the role of technology companies (Smith and Browne, 2020) and the relationship with information consumption. It then discusses existing frameworks for media literacy competencies and, finally, outlines through the Design Science Research (DSR) methodology the development of an artifact (in this case, the reference framework) that can serve as a foundation for building a national media literacy indicator in the future.

3 Literature Review

3.1 Key Concepts and The Media Literacy Scenario in Brazil

Over the past decades, the concept of media literacy has undergone significant evolution, reflecting changes in communication technologies and patterns of information consumption. The classical definition established by Aufderheide (1993), still widely referenced today, defines media literacy as the "ability to access, analyze, evaluate, and communicate messages in a variety of forms," offering a foundation for the critical understanding of media content. Later, researchers such as Potter (2013) expanded this definition by emphasizing that a media-literate individual is someone who understands how words, images, and sounds influence the creation and sharing of meaning in society, and is equipped to assign value and critically interpret the messages conveyed by media.

This conceptual expansion also gives rise to important distinctions between related terms such as *literacy*, *media literacy*, and *media education.* Fernandes and Alexandre, (2023) define *literacy* as the state resulting from the individual's appropriation of writing, with a focus on the social practices of reading and writing. Fantin (2007) and Goodfellow (2011) argue that *media literacy* involves broader, contextual competencies that encompass communicative practices specific to fields and disciplines. In the field of media education, the national program EducaMídia (n.d.) synthesizes this understanding by defining it as the set of skills needed to access, analyze, create, and critically engage in the informational environment across multiple formats - from print to digital.

The complexity of media literacy lies in its multidimensional and multiplatform nature. As Spinelli and Santos, (2020) highlight, it is an interdisciplinary field that bridges communication, consumption and education, and whose pedagogical practice must go beyond the literal reading of media messages. Media literacy involves recognizing the

power structures embedded in the production and dissemination of content, critically understanding the technologies involved, and ethically producing media. In this regard, Wilson et al. (2016) reinforce that media literacy encompasses the ability to interpret, produce, and critically analyze texts and images, with direct implications for freedom of expression, democracy, and everyday perceptions of events.

Finally, it is essential to recognize that media literacy also includes practical, everyday dimensions, as emphasized by Livingstone et al. (2005), who views information consumption as part of contemporary social choices and values that impact society.

Individuals with well-developed media literacy skills can discern and assign meaning to the messages they consume and produce, positioning themselves as active agents within the communication ecosystem. Potter (2010) adds that media literacy enables individuals to understand the intentions of media producers and to strategically use media to pursue their own objectives, while Kellner and Share, (2005) and Lewis and Jhally (1998) advocate for a dialectical and critical approach that acknowledges both the emancipatory potential and the risks of manipulation and misinformation in digital environments. These authors converge in viewing media literacy as an essential field for civic education and for strengthening democratic societies.

3.2 Critical Discussion on The Adaptation to The Brazilian Context

The Brazilian context presents a paradoxical scenario regarding internet access and digital information consumption. On the one hand, data indicate widespread internet penetration across the country: Approximately 90% of Brazilian households have some form of internet connection, with mobile phones serving as the primary access device. Brazil ranks among the countries with the highest daily internet usage, and its citizens engage with media content frequently throughout the day. However, this access is far from equitable. A study by PWC and Instituto Locomotiva (2022) reveals that fewer than one-third of the population can be considered fully connected - a privilege predominantly concentrated among privileged individuals in socioeconomic classes A and B—While the rest face intermittent connectivity, particularly among those in classes C, D, and E. The predominance of mobile access and the poor quality of connections in many regions further deepen these inequalities, limiting internet use for educational or developmental purposes.

These digital inequalities are directly reflected in the country's educational indicators. Brazil performs among the lowest in reading and text interpretation among OECD countries. The PISA Report shows that most 15-year-old students are unable to identify the main idea in moderately complex texts or distinguish between facts and opinions skills that are fundamental to exercising critical citizenship and navigating an information-rich, and often manipulative, media environment. This deficiency seriously undermines the development of media literacy skills and exposes a structural gap within the Brazilian educational system, which remains unprepared to train students to critically and autonomously engage with the daily influx of digital content.

This issue becomes even more critical given the proliferation of misinformation on social media and the growing public skepticism in journalistic institutions. According to the "Trust Barometer 2022," an annual global report by Edelman based on a sample of nearly 30,000 people, 72% of respondents tend to withhold trust until they see evidence to support the information presented.

Such perceptions create fertile ground for the spread of false news, rumors, and emotionally charged viral content, which intensify social polarization and weaken public debate. The absence of a culture of fact-checking and information curation in people's daily practices underscores the urgency of incorporating media literacy programs into public education policies. These programs must go beyond basic content interpretation to promote autonomy, critical thinking, and responsibility in how information is used and shared.

Considering this scenario, it is essential to recognize that strengthening media literacy in Brazil cannot occur in isolation from the population's social and economic materiality. Unequal access to the internet and basic education must be addressed through intersectoral strategies that combine quality connectivity, teacher training, and the integration of media literacy into school curriculum.

Furthermore, it is crucial to promote public awareness campaigns that encourage fact-checking practices, critical reflection on media content, and the diversification of information sources. These actions are indispensable for empowering citizens to navigate a complex information ecosystem, resist the influence of misinformation, and participate consciously in a democracy increasingly mediated by digital platforms.

3.3 International Models of Indicators (e.g., Media Literacy Index, European Union Indicators)

According to UNESCO (2013), media literacy consists of three core components: Access and retrieval of information, comprehension and critical evaluation, and the creation and sharing of media content. This approach integrates the technical and cognitive skills required for individuals to fully participate in social, political, and cultural life within digital and informational environments. By proposing a Global Assessment Framework, UNESCO establishes 113 performance criteria distributed across these competencies, offering a structured basis for guiding educational policies and assessing media literacy proficiency in different countries, particularly among teachers and students.

Complementing this perspective, Celot and Tornero (2009) propose a conceptual model based on two interdependent dimensions: Individual competencies (such as media access, analysis, and communication) and environmental factors (including the social, economic, and political conditions that influence the development of media literacy). The authors conceptualize media literacy as a pyramid, where foundational criteria - such as media availability and institutional initiatives - serve as requirements for the development of personal competencies. Without these structural conditions, media literacy cannot be sustained.

The study by Schilder et al. (2016) reinforces the conceptual and methodological challenges of measuring media literacy, noting that there is still significant disagreement among experts regarding which dimensions should be assessed. The research identifies three main types of measurement: Occasional (focused on isolated knowledge or

attitudes), component-based (such as bias perception and realism), and holistic (centered on specific media or genres). These diverse approaches highlight the complexity of the concept and the importance of aligning pedagogical objectives with assessment instruments.

Spinelli (2021), in examining the intersections of communication, consumption, and education, proposes media literacy competency indicators aimed at fostering participatory civic identity. These indicators are organized into three dimensions - access, evaluation, and creation - aligned with UNESCO's framework, and are intended to support media literacy initiatives in both formal and informal learning environments. The author emphasizes that the development of media literacy must consider sociocultural contexts and existing inequalities, as it is essential for promoting critical information consumption and strengthening digital citizenship.

4 Methodology

There is currently no standardized framework or indicator for assessing media literacy in Brazil, which reveals a research gap that justifies the present study. As previously stated, this research pursues two central objectives: (1) to understand the media literacy scenario in Brazil through the lens of information consumption and its impacts; and (2) to develop a reference framework for the future creation of a media literacy indicator that can support policy development and the evaluation of existing media education programs.

To construct a reference framework for measuring media literacy, the study draws from four initial sources: (1) the Media Literacy Evaluation Model proposed by Celot and Pérez-Tornero (2009); (2) the competency framework developed by Spinelli (2021); (3) the "New Media Literacy" (NML) theory by Chen et al. (2011) and (4) a case analysis of the EducaMídia Media Literacy Program.

To achieve these objectives, two methodological approaches were used: (1) the case study method, which is widely used in the social sciences (including psychology, sociology, anthropology, and economics) as well as in practice-oriented fields such as organizational, business, environmental, and social work studies (Johansson, 2007); and (2) Design Science Research (DSR). This methodology is appropriate for the development of an artifact - in this case, the reference framework which may serve as the foundation for a future national media literacy indicator. The development of the artifact is understood as a research process grounded in existing theories and knowledge to address a defined problem (Peffers et al., 2007) (Fig. 1).

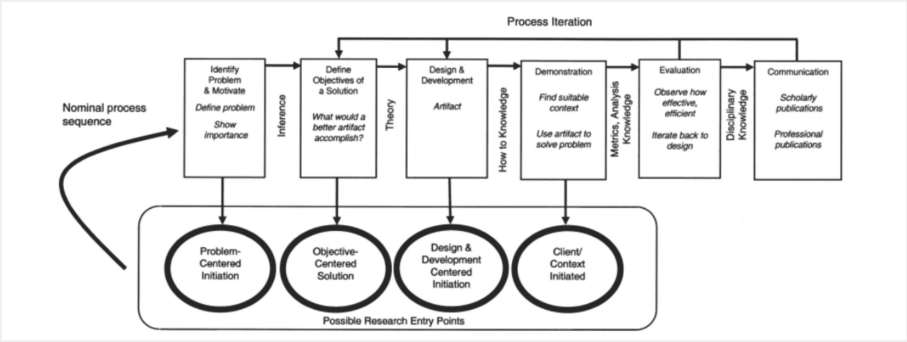

Fig. 1. Source: Peffers et al.,2007.

5 Results and Discussion

According to Yin (2002), the case study serves as a logical structure that connects collected data to the research questions being investigated. It is particularly useful for examining events within real-life contemporary contexts, enabling a deep understanding of ongoing situations. Based on Creswell's (2014) methodological approach, inspired by Stake (1995), the present study adopts an instrumental case study design (Yazan and Ivar, 2016), aiming to explore a specific case to develop a reference framework that may inform the future construction of a Brazilian media literacy indicator.

The selected case was the "Media Education Program" developed by EducaMídia, the media literacy arm of Instituto Palavra Aberta, a nationally recognized organization for its work in teacher training, policy advocacy, and the production of educational materials in the field of media education. The case was chosen for its relevance, structure, and broad reach, and was analyzed using public documents, educational materials, social media content, and institutional data. The analysis followed an embedded case approach, focusing on the program's goals and practices while connecting its findings to the methodological scope of the study.

EducaMídia operates along three core areas: Teacher training, public policy advocacy and public awareness. It has developed a robust educational pathway that includes structured learning tracks, student workbooks, self-paced courses, and an open-resource platform focused on media literacy. Among its goals are the development of competencies such as critical reading of information, responsible content production, and civic engagement in digital environments. As of 2023, the program has trained over 17,000 teachers and reached an estimated 3.2 million students, establishing partnerships with state and municipal governments to expand its impact.

Analysis of public data reinforces EducaMídia's visibility and legitimacy as a national reference. With an active presence on multiple social media platforms, over 1,400 media mentions, 15,000 downloads of its Reference Guide, and a network of ambassadors spread across more than 500 Brazilian cities, the program demonstrates both reach and relevance. The sharp increase in searches for "media education" on Google Trends (from 25 to 94 points between 2019 and 2023) also signals growing societal demand for this kind of training. These elements validate the selection of EducaMídia as the central case study and support its use in the construction of the reference framework presented in this research.

Following the case analysis, the construction of the framework was initiated, initially structured around macro-competencies widely discussed in studies by Spinelli (2021) and aligned with the dimensions proposed by Celot and Tornero (2009). The artifact was divided into three major dimensions: Access, Critical Evaluation and Interpretation, and Responsible Creation. Each dimension was broken down into specific competencies, described using observable descriptors that integrate technical skills, attitudes, and behaviors.

Following the DSR structure of Peffers et al. (2007), the framework organizes these competencies along two central axes: (i) technical and functional skills related to the operation and use of media, and (ii) experiential and interpretive attributes involving critical content analysis and civic participation within informational ecosystems. Its formulation also considers Brazil's sociocultural contexts and the need for a tool adaptable to the country's diverse realities.

The conceptual choice for this arrangement is justified by the need to align assessment practices with the competencies required by contemporary digital society. The identified macro-competencies are grounded in the intersection of three key references: The media education framework proposed by EducaMídia (n.d.); the critical competencies outlined by Spinelli (2021); and the methodological assessment structure developed by Celot and Tornero (2009), which connects individual competencies to contextual (material) factors, inspired by the model of Chen et al. (2011).

Based on the conceptual framework presented in Table 1, it is possible to develop the framework as a potential starting point for the creation of assessment tools capable of identifying different levels of media literacy proficiency. This, in turn, may inform more targeted actions and educational policies aimed at strengthening media literacy as a transversal competency (Fig. 2).

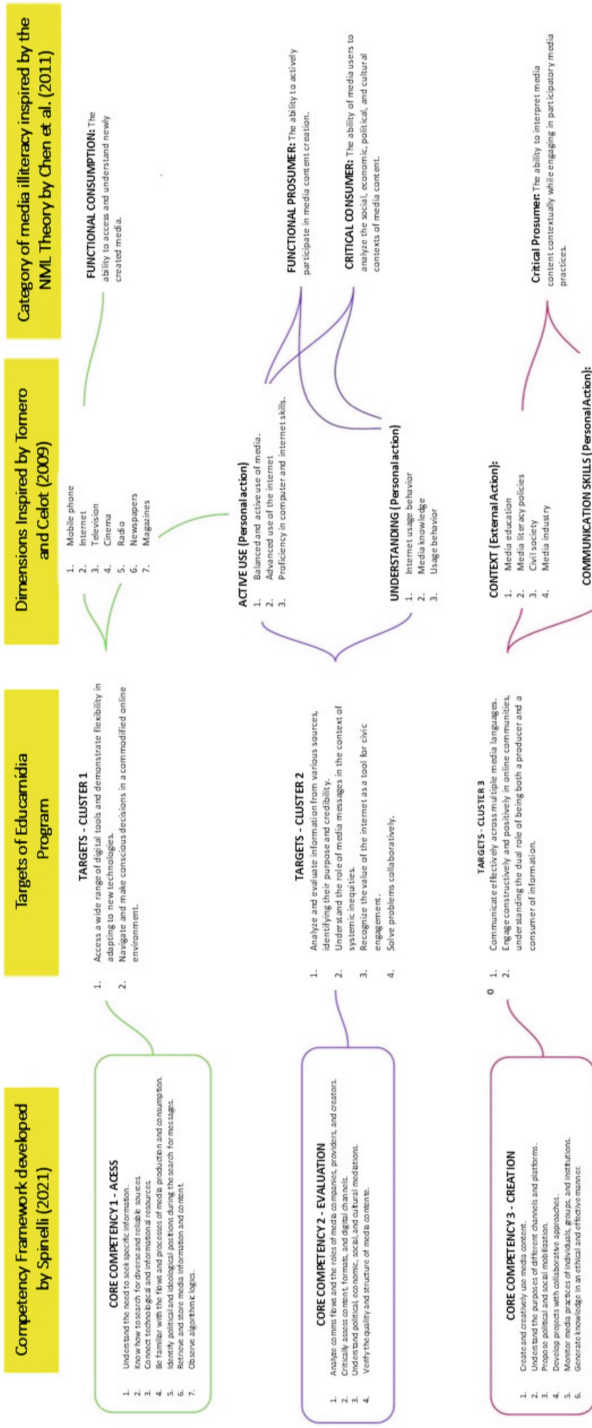

Fig. 2. Reference framework for the Future Development of a Media Literacy Indicator Developed by the authors

Table 1. Source: Developed by the authors.

REFERENCE	REASONING
Media Literacy Evaluation Map by Celot and Tornero (2009)	The study proposed by Celot and Tornero (2009) identified two key dimensions of media literacy that help inform the design of the artifact: (1) the preconditions necessary for the development of media literacy and the factors that either facilitate or hinder it; and (2) personal competencies that enhance technical and cognitive skills as well as engagement with media processes.
Competency Framework developed by Spinelli (2021)	The research presents "indicators derived from well-established studies in order to reach a set of media literacy competencies that support educational proposals aimed at fostering critical and reflective perceptions of the media" (Spinelli, 2021, p. 135).
New Media Literacy (NML) Theory by Chen et al. (2011)	The theory proposes a framework of New Media Literacy based on four core dimensions, considering both technical and sociocultural characteristics of new media. The components of the NML framework are: • **Functional Consumption:** the ability to access and understand newly created media. • **Functional Prosumer:** the ability to actively participate in media content creation. • **Critical Consumer:** the ability of media users to analyze the social, economic, political, and cultural contexts of media content. • **Critical Prosumer:** the ability to interpret media content contextually while engaging in participatory media practices.
Case Analysis of the Brazilian EducaMídia Media Literacy Program	Selected for its relevance to the Brazilian context and for having a clear and well-defined set of objectives that address the country's specific educational and media literacy needs.

The application of this framework also presents several challenges. One of the main issues lies in the need for constant adaptation in response to the evolving nature of digital networks and platforms, as well as the diversity of individuals' cultural backgrounds. Moreover, the measurement of competencies such as critical evaluation, ethical content production or online engagement depends on contextual interpretations and may vary significantly across regions, age groups, and social segments.

Another limitation concerns the inherent subjectivity present in any assessment tool: The conceptual choices, illustrative examples, and proficiency criteria inevitably reflect the values of those who design the instrument. Therefore, the framework should be understood as a methodological starting point subject to revision and expansion -particularly through validation processes involving experts from different fields and a variety of target audiences.

6 Conclusion

The reference framework developed in this study represents a significant methodological development for the field of media education in Brazil, as it proposes a systematized structure of competencies, dimensions, and material items applicable to the critical assessment of media use and comprehension. Organized into three main dimensions access, evaluation, and responsible creation—The framework has the potential to serve as a foundational tool for the development of a national media literacy indicator. Its application could support educational diagnostics, guide teacher training programs, and serve as a reference for public policies aimed at fostering media literacy competencies as part of digital citizenship, informational inclusion, and educational equity.

Given Brazil's challenging landscape marked by unequal access, cultural diversity, lack of consolidated regulation, and rapid technological change—The framework emerges as a structuring proposal, though it requires empirical validation. The next stage involves conducting studies with experts from various fields (education, communication, consumption), using methods such as the Delphi technique to test and refine the conceptual robustness and practical applicability of the artifact.

Simultaneously, the artifact may serve as a basis for building a reliable and valid national indicator capable of assessing the media literacy level of the population and informing the design of pedagogical interventions, educational campaigns, and more effective regulations. Inspired by established models such as the Brazilian Program for International Student Assessment (PISA), the indicator could be implemented on a large scale - particularly among high school students to generate comparable and context-specific data on media proficiency across different regions of the country. This would enable a more accurate understanding of which competencies are developed, which gaps remain and where training and investment efforts should be concentrated.

In this way, the framework serves not only an evaluative function but also positions itself as a strategic instrument for public policy formulation connecting the measurement of media literacy to improvements in educational quality, the promotion of digital equity, and the defense of democracy.

It is important to acknowledge the limitations and challenges associated with this proposal. Brazil's sociocultural diversity and structural inequalities in access to technology require continuous methodological care to avoid regional or socioeconomic biases. Furthermore, the construction of a national media literacy indicator demands inter-institutional efforts, coordination between academia, government, and civil society and an ongoing process of validation and adaptation. Therefore, this framework does not represent a final outcome, but rather the beginning of a collective journey toward a more robust, accessible and context-sensitive media education for Brazil.

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Pedagogical Methodology and Inclusive Education

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Abstract. Pedagogical methodologies in inclusive education are aimed at guaranteeing the right of all students to learn under equal conditions, recognizing and valuing diversity in the classroom. These methodologies are characterized by their flexibility, personalization, and student-centered approach. Among the most prominent are Universal Design for Learning (UDL), cooperative learning, multilevel teaching and project work, which allow content, processes and assessments to be adapted in different styles, rhythms and learning needs according to the needs of students. Therefore, these strategies promote participation, peer collaboration, and the development of cognitive and socio-emotional competencies. It is said that effective inclusion requires the teacher to act as a mediator, adjusting their practices according to the particularities and needs of the group with continuous training in attention to diversity. In addition, inclusive methodologies integrate technological tools, differentiated assessments and accessible materials to eliminate barriers in the development of learning and thus not only improve the academic performance of students with special educational needs, but also the classroom climate and the learning of the entire school community become different, thus consolidating a fairer education, equitable and quality.

Keywords: Pedagogical methodology · inclusive education · specific educational needs

1 Introduction

Specific Educational Support Needs (SEN) refer to those situations in which a student requires pedagogical or contextual adaptations to ensure their access, participation and progress in the school environment. These needs can originate from a variety of reasons, such as disabling conditions, developmental disorders, or specific difficulties in areas of learning, such as reading comprehension or mathematical reasoning [1]. It should be noted that the NEAE are not homogeneous; On the contrary, they reflect the uniqueness of each student, which requires educational responses adjusted to their individual characteristics.

Adopting a socio-formative approach to address these needs implies going beyond clinical or psycho-pedagogical diagnosis and considering the multiple dimensions que afectan el aprendizaje: El contexto familiar, la historia escolar, los factores culturales y the emotional conditions of the student. This comprehensive vision favors a deeper and

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 314–322, 2025.
https://doi.org/10.1007/978-3-032-09080-5_32

more humanized understanding of the educational process, thus facilitating the planning of interventions that effectively respond to the real needs of each student [2].

Inclusive education has established itself as a fundamental principle in contemporary education systems, aimed at guaranteeing the right of all students to a quality education, regardless of their personal, social or cultural characteristics. This approach recognizes diversity as a value and not as an obstacle and requires a profound transformation of traditional pedagogical practices. Pedagogical methodology, understood as the set of strategies, resources and forms of learning organization, plays an essential role in the effective implementation of inclusion [3].

The use of assistive technologies has established itself as a key resource to eliminate barriers in the educational process of students with disabilities. Fernández-Batanero et al. highlight that these technologies, which include everything from screen reading software to augmentative communication devices, make it possible to personalize learning and facilitate participation in inclusive educational environments [9]. Technological integration not only improves access to information but also enhances cognitive and social skills through interactive tools. The authors emphasize that the success of these technological interventions depends largely on their adequate selection, adaptation and use by teachers, who require specific training in this field. Thus, technology becomes not only a means of support, but also an engine of educational transformation that promotes equity and inclusion in a tangible and sustainable way.

The research question of this study is: What are the most effective pedagogical methodologies to promote inclusive education in diverse school contexts, according to the evidence collected in recent studies?

The objective of the research is to analyze the most relevant inclusive pedagogical methodologies and their effectiveness in diverse school contexts, based on the scientific evidence available in recent studies.

The methodology of the article is a systematic review of academic literature focused on the analysis of inclusive pedagogical methodologies. This type of study aims to synthesize and critically evaluate the existing evidence on a specific topic, in this case, educational inclusion and the associated methodological strategies.

1.1 Diversity

Diversity is understood as the inherent characteristic of each person that distinguishes them and makes them unique within a wide and varied environment. In the educational context, this diversity implies that the system must have adequate resources and make the relevant adjustments to understand and address the specific needs of each student effectively [4].

According to Blanco [4], the concept of "diversity" in the educational field invites us to recognize and value the individual differences of each student, whether in terms of cognitive abilities, learning styles, socioeconomic and cultural contexts, or even emotional and psychological needs. Diversity, therefore, is a fundamental principle that underscores the idea that not all students learn in the same way or have the same needs. This understanding implies that education should not be homogeneous, but flexible and adaptive, allowing everyone to access learning and develop according to their own pace and personal characteristics.

1.2 Special Needs

Disability is understood as the restriction or absence of a specific ability to perform activities in the way that society considers normal, this limitation or lack of capacity can occur due to conditions external to the individual without this implying an annulment of their possibilities [4].

The model proposed by the Ministry of Social Inclusion of Ecuador mentions that disability is currently considered a human rights issue, it always was or at least should have been, but it was not visible and consequently was not strongly considered in the different laws. The term "disability" encompasses anything related to permanent or temporary physical, mental, or sensory impairments that may limit the ability to perform one or more essential activities of daily living. This condition can be caused or aggravated by the economic and/or social environment and makes it difficult for people to face barriers to access that can be social, cultural, material or physical, which for other citizens do not represent a difficulty [4].

The concept of SEN refers to the barriers that certain students face during the educational process, either temporarily or permanently, and that requires the provision of differentiated resources to guarantee an inclusive education. This approach originated from the Warnock Report in 1978 [1]. It is still in force today as a basis for the development of educational policies aimed at equity [1].

In their systematic review, [12] they analyze a total of 62 studies published between 2019 and 2023 in databases such as Scopus and Web of Science, focusing on inclusive education practices at the higher level. The authors show that 78% of the studies reviewed report significant advances in institutional policies for inclusion, while only 42% document a systematic use of accessible technologies within university classrooms. In addition, it is noted that 61% of the research identifies the lack of teacher training as one of the main barriers to the implementation of inclusive strategies. These data reflect a growing concern on the part of the academic community, but also an urgent need to strengthen technological and pedagogical resources aimed at the effective inclusion of students with disabilities in higher education.

1.3 Types of Disabilities

Intellectual disability is characterized by significant limitations in intellectual functioning and adaptive behavior, encompassing the conceptual, social, and practical skills necessary for daily living. These limitations usually manifest themselves before the age of 18 and require specialized support that promotes inclusion and learning. Intellectual disability should not be seen as a static condition, but as a functional state that can be improved with appropriate interventions, focused on the person and their contexts [5]. In the educational field, these people benefit from curricular adaptations, structured teaching and functional skills programs.

Pegalajar et al. argue that artificial intelligence (AI) represents a disruptive tool with high potential to transform inclusive education by enabling unprecedented personalization in teaching and learning processes [13]. AI facilitates the design of adaptive environments capable of responding to the specific needs of students with disabilities, optimizing accessibility and encouraging active participation. However, they warn that

this technological integration does not automatically guarantee inclusion, as it must be accompanied by a pedagogical approach focused on equity and ethics. In this sense, technology, although it is a powerful enabler, does not replace institutional commitment or teacher training in inclusive practices. Therefore, the challenge is not only to incorporate AI into education, but to do so with a critical approach that prioritizes educational justice and respect for diversity.

Curricular flexibility and collaborative work are essential for their real and effective inclusion.

Inclusive education is a pedagogical approach that seeks to guarantee the right to quality education for all students, regardless of their personal, social or cultural conditions. This model rejects exclusion and promotes full participation in the school environment, especially for those who have historically been marginalized, such as people with disabilities, indigenous peoples or those in poverty. According to UNESCO [6], educational inclusion is a fundamental pillar to achieve the Sustainable Development Goals, especially SDG 4, which seeks to ensure equitable and inclusive quality education for all.

In practice, inclusive education involves adapting the curriculum, methodologies and school organization to meet the diversity of students' needs. This requires the design of flexible environments, the use of assistive technologies, and ongoing teacher training. Both Ainscow propose that schools be transformed into communities that celebrate diversity and remove barriers to learning and participation. Inclusion not only benefits students with specific needs but also improves the quality of education for the entire school community.

This study [13] also highlights that, although artificial intelligence offers innovative solutions such as virtual tutors, automated feedback systems or speech and text recognition tools, its effectiveness in inclusive contexts depends on how its use is contextualized. It is not enough to implement advanced technology; It is essential that these tools are designed with principles of universal accessibility and adapted to specific sociocultural and educational environments. Otherwise, the risk is to reproduce new forms of digital exclusion, especially among students with less access to technological resources. For this reason, the authors underline the need for interdisciplinary research that integrates pedagogy, computer science and inclusion as inseparable axes for truly equitable technological development. Thus, AI becomes not only a technical advance, but also an ethical and social challenge for inclusive education in the 21st century.

Inclusive education must be understood not only as a pedagogical strategy or a technical adaptation, but as an ethical and political imperative that reflects the commitment to equity, social justice and respect for human rights.

The present study [14] provides a broad and up-to-date perspective on how Information and Communication Technologies (ICTs), when implemented as learning technologies (LTs), can profoundly transform inclusive and special education. Based on a systematic review of more than a decade of research, the authors argue that ICT not only allows content and methods to different functional needs but also encourage the active participation of students with disabilities in ordinary educational environments. Tools such as interactive platforms, accessible digital resources, and personalized virtual learning environments have proven effective in improving the academic performance and

motivation of these students. However, it is noted that the potential of these technologies is only fully realized when integrated with inclusive pedagogical practices and committed institutional planning. Therefore, technology is not an end, but a means to ensure a truly equitable education.

2 Methodology

This research adopts a qualitative approach of documentary and analytical type, oriented to the critical examination of the academic literature on pedagogical methodologies in the framework of inclusive education. The study is part of a narrative review, whose purpose is to integrate various theoretical and empirical contributions to understand how inclusive strategies have been addressed and applied in different educational contexts.

This study is relevant because it reviews pedagogical methodologies from an inclusive perspective. Educational inclusion cannot be limited to the physical integration of students with specific needs but requires the transformation of teaching practices to ensure meaningful participation and equitable learning for all. In this sense, analyzing and critically reflecting on the pedagogical strategies that have proven to be effective in diverse contexts makes it possible to make good practices visible and identify persistent barriers and opportunities for improvement.

2.1 Selection Criteria

The selection of sources was based on their thematic relevance, topicality and academic rigor. Research published between 2019 and 2023, available in recognized databases such as Scopus, Web of Science and other repositories specialized in education, was considered. The chosen works had to meet the following criteria: (1) be focused on inclusive pedagogical practices in basic or higher education; (2) include methodological approaches such as Universal Design for Learning (UDL), cooperative learning, multilevel teaching, among others; (3) be academic publications with peer review or institutional reports with methodological support; (4) offer evidence on the effects, challenges, or outcomes of implementing inclusive strategies.

No exclusionary criteria related to the methodological approach of the studies (quantitative, qualitative or mixed) were applied, as long as they provided relevant information about the object of study.

2.2 Analysis Procedure

Once the sources were collected, a process of comprehensive reading and thematic analysis was carried out. This stage included the identification of emerging categories such as inclusive methodologies, use of assistive technologies, curricular accessibility, teacher training, and family participation.

The analysis was developed in an inductive and comparative manner, with the aim of establishing relationships between the different approaches and determining common patterns or divergences in the application of the revised methodologies. The information

was organized according to the main axes of the study, which allowed the construction of an interpretative framework coherent with the purposes of the research.

Finally, this methodology made it possible to articulate a critical and updated vision of inclusive pedagogical practices, highlighting both their contributions and the challenges that persist in their effective implementation.

2.3 Limitations

A relevant limitation of this study is that, as it is a narrative review without the application of a formal systematic protocol, such as PRISMA, it cannot guarantee complete completeness in the identification of all the available literature. It should be noted that the selection of sources could have been influenced by access to certain databases and by subjective criteria of relevance. However, efforts were made to maintain academic rigor by including recent, pertinent, and scientifically recognized studies.

3 Analysis and Discussion

The relationship between pedagogical methodology and inclusive education has gained relevance in recent decades, especially in the context of the transformation of education systems towards more equitable models. Methodology, understood as the set of strategies, techniques and approaches used in teaching, plays a central role in ensuring that all students, regardless of their abilities and social or cultural conditions, have real access to learning. In this context, inclusive education requires active, participatory, and flexible methodologies, capable of adapting to classroom diversity and removing barriers to learning and participation [7].

Traditionally, pedagogical methodologies have been based on homogeneous schemes, focused on the teacher as a transmitter of knowledge and on the student as a passive receiver. However, this paradigm is obsolete in the framework of inclusion, where it is recognized that each student learns differently and needs personalized support. As indicated by UNESCO [6], the transition to inclusive education requires the redesign of pedagogical practices, so that the curriculum is flexible enough to respond to individual differences without segregating or stigmatizing.

Pedagogical methodology in the context of inclusive education has evolved significantly in recent years, integrating approaches such as Universal Design for Learning (UDL), collaborative learning, and problem-based learning. These methodologies seek to eliminate physical, sensory, and cognitive barriers, promoting the participation of all students, especially those with disabilities or special educational needs. According to the COCEMFE guide (2021), more than 100,000 people benefit annually from these inclusive practices in Spain, highlighting the positive impact of UDL on educational equity. In addition, the use of adaptive technologies has proven to be key to facilitating access to content and promoting the autonomy of students with functional diversity.

A relevant case study is the one implemented by the National University of Education in Ecuador, where an inclusive educational model was applied in basic education classrooms with students with and without disabilities. The results, published in 2024,

show that the active inclusion of families, continuous teacher training and a flexible curriculum are determining factors for the success of inclusive education

Different authors [16] argue that inclusion should not only focus on physical access to the classroom, but on meaningful participation in school culture and curriculum. This vision is shared by other researchers who highlight the need to transform education systems to respond to diversity from a rights-based and social justice perspective

Among the most prominent inclusive methodologies are cooperative learning, universal design for learning (UDL), multilevel teaching and project work. These strategies allow different learning styles and rhythms to be addressed, encourage collaboration between peers and promote student autonomy. The UDL, for example, states that content should be presented in multiple ways, offer diverse avenues for student expression and participation, and use technological supports when necessary [8]. This methodology is especially effective in addressing heterogeneity in classrooms with and without disabilities.

Likewise, the figure of the teacher is transformed in inclusive education: It goes from being a mere transmitter to becoming a mediator of learning. This implies that they must be trained to diagnose the educational needs of their students, design differentiated strategies and work as a team with other professionals. Initial and continuous teacher training is an indispensable condition for the implementation of effective inclusive methodologies [1]. Without this component, inclusion risks becoming a statement of principles with no real application in the classroom.

In addition, didactic planning must incorporate the principle of curricular accessibility, which means that not only the content, but also the assessments and materials must be adapted to the needs of all students. Even assessments, for example, are considered in written, oral, and visual formats depending on each student and their need and therefore prioritize learning processes over standardized outcomes. Quality inclusive teaching is based on the conviction that all students can learn, and that the pedagogical challenge is to find ways to make this possible [9, 10].

The school context also influences the feasibility of applying inclusive methodologies. Factors such as the teacher-student ratio, institutional support, the existence of accessible teaching resources and school culture are decisive. In many Latin American countries, including Ecuador and Colombia, inclusion policies have advanced at the normative level, but they still face implementation challenges in everyday classroom practice [6]. This shows the need for an articulation between educational policies, teacher training and the development of inclusive school environments.

On the other hand, the inclusive methodology must also consider the socio-emotional dimensions of learning. An inclusive environment not only supports academic learning, but also students' emotional well-being, self-esteem, and sense of belonging. Inclusive pedagogy promotes relationships based on respect, empathy and collaboration, creating learning communities where each student feels valued. Inclusion is not a state that is achieved, but a continuous process that requires ethical vigilance, critical reflection and professional commitment [11].

The inclusion of students with disabilities in the classroom cannot be effectively conceived without the support of assistive technologies that respond to their specific

needs. Fernández-Batanero et al. argue that these tools as readers de display, Augmentative Communication Devices, and Adaptive Mobile Apps Not Only Improve access to information but also promote the autonomy and active participation of students in the learning process [12]. The study demonstrates that technology, when properly integrated into educational contexts, acts as a catalyst to reduce exclusion gaps, if it is accompanied by inclusive teacher training and policies. In this sense, inclusion should not be limited to physical access to the classroom but should guarantee pedagogical and technological conditions that promote the academic success of all students, valuing diversity as an opportunity to enrich the educational process.

4 Conclusions

The implementation of inclusive pedagogical methodologies represents a key element in improving the learning of all students in the classroom, especially those who face barriers to learning and participation. Strategies such as Universal Design for Learning (UDL), cooperative learning and differentiated teaching have proven to be effective in addressing student diversity, by allowing multiple forms of access, expression and motivation [8], UDL favors more equitable learning environments, by removing obstacles from curricular planning, thus promoting a student-friendly education, and not the other way around. In addition, recent research states that students who learn in inclusive contexts with active methodologies not only improve their academic performance, but also their socio-emotional skills and willingness to learn collaboratively [9].

Likewise, it has been shown that an inclusive pedagogy not only benefits students with special educational needs but also raises the quality of teaching for the entire school community. Inclusion, when articulated with effective pedagogical practices, makes it possible to reduce educational gaps and build a school culture based on respect, participation and equity. Slee [11] argues that inclusive methodologies act as levers for educational justice, by transforming classrooms into spaces where diversity is a value and not a limitation. Therefore, the commitment to inclusive education based on flexible, collaborative and student center methodologies is not only an ethical requirement, but also an effective pedagogical strategy to improve the learning of all students, in increasingly diverse contexts.

It can be concluded [15] that the incorporation of technological tools in higher education is essential to promote an inclusive pedagogy that effectively responds to the needs of students with disabilities. Their systematic review shows that technologies, from specialized software to adaptive platforms, not only facilitate access to academic content, but also promote the autonomous development of students. The authors highlight that technology, coherently integrated with inclusive pedagogical strategies, becomes a transformative agent that contributes to breaking down barriers and consolidating more equitable and accessible educational spaces. Therefore, technological inclusion should not be seen as an optional complement, but as an essential component to guarantee real and effective inclusive education at higher levels.

It is recommended to strengthen the initial and continuous training of teachers in inclusive methodologies, with emphasis on the pedagogical use of adaptive technologies and universal design for learning. It is also essential that educational institutions promote

a school culture focused on equity, through policies that guarantee accessible resources, interdisciplinary support and active participation of families.

Future research could focus empirically assessing the impact of specific inclusive methodologies, such as cooperative learning or UDL, on different educational levels and sociocultural contexts. In addition, it is pertinent to explore how the integration of emerging technologies, such as artificial intelligence, can enhance the personalization of learning in inclusive environments, always from an ethical and pedagogical approach.

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Exploration, Learning, and Change: Virtual Ecological Games as Innovative Tools for Environmental Education

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Abstract. This article explores the significance of virtual ecological games in the context of environmental education at the National University of Education (UNAE). The methodology adopts a qualitative approach, incorporating the pedagogical principles of collaborative work with students through a series of activities such as cooperative games, educational escape games, and digital content projects. This approach fosters critical thinking, awareness, environmental education, leadership, technological skills, and the relevance of environmental education in the digital age among UNAE students. The article's findings highlight how virtual ecological games constitute a meaningful educational strategy for students by exploring emerging trends, challenges, and opportunities associated with this innovative form of education.

Keywords: environmental education · virtual ecological games · meaningful learning · digital competence · sustainability

1 Introduction

The rapid changes of the 21st century have immersed us in the digital age, giving rise to an expanding range of technological tools and platforms with enormous pedagogical potential. One such experience is the use of technological innovations in virtual ecological games developed in the Ecuadorian Amazon as part of the Professionalization Program of the National University of Education (UNAE). These games were designed to explore how environmental education can benefit from digitalization and technology, becoming a tool to transmit knowledge, inspire action, and foster a sustainable awareness aligned with the 2030 Sustainable Development Goals (SDGs).

Important to highlight that virtual ecological games provide an interactive environment that allows students to explore and learn about ecological systems and their levels of complexity, thus encouraging a change in attitude towards sustainability in students. However, in the research developed, a gap has been detected in the scientific literature

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 323–333, 2025.
https://doi.org/10.1007/978-3-032-09080-5_33

on the use of emerging technological tools to promote learning and engagement around environmental issues [20].

Virtual ecological games present a practical perspective, using gamification, for environmental education, which lies in developing the capacity to effectively integrate digital tools and platforms into the dynamics of the game [10].

The environments proposed for the design of gamified spaces required teamwork on the part of the teachers who created the space, but also on the part of the participants. This type of environment has an organization and structure that encourages unlearning in order to learn, as indicated by the UNAE pedagogical educational model (2023).

2 Methodology

The methodology used in this research was part of a qualitative approach with a design based on the fusion of two pedagogical methods: collaborative work and design thinking, Design Thinking, [15].

The collaboration paradigm assumed in this study encourages a more significant acquisition of knowledge, in contrast to individual learning, considering it as a consequence of effective interaction between team members [4]. It is important to highlight that this type of learning materializes when a reciprocity is established between a group of individuals capable of discerning and contrasting their respective perspectives, thus detaching a constructive process of knowledge.

Through collaborative work, we seek to enhance student learning through cooperation and group synergy [7]. This teaching strategy was used to promote interaction and exchange of ideas among students, thus enhancing meaningful learning and the joint construction of knowledge.

Learning collaboratively with the help of online tools allows the individual to receive feedback and know their own pace and learning style, which facilitates the application of metacognitive strategies that optimize performance2. In the words of [12]: "It is a process in which each individual learns more than they would learn on their own, as a result of the interaction of the team members."

On the other hand, the design thinking methodology, Design Thinking is part of the innovative teaching methods focused on students [18], its purpose being to promote creative thinking in problem solving, which is why it was incorporated in this study in order to stimulate creative and design thinking, thus achieving the ability to combine three key skills: empathy to understand the context or framework of the problem, creativity in generating ideas and solutions and reasoning to analyze and adjust solutions to a particular context.

On the other hand, design thinking examines various development phases that allow for the exploration of innovative solutions and offer an effective response to student needs. Table 1 outlines these development phases and describes how each contributes to the design thinking process.

The systematic process, as shown in Table 1, is student-centered and seeks to guide the development of virtual ecological games, ensuring that their design can effectively respond to students' needs to promote positive change in their behavior and achieve an understanding of the socialized ecological and environmental issues.

Table 1. Development spaces in the design thinking methodology, Design Thinking

Space	Development
Inspiration	The design process begins by recognizing the problem or opportunity that drives the search for a solution. This is the time to present ideas, observe, explore needs, interact with the community, and experience their reality.
Ideation	After conducting on-site design research, the team adopts a holistic approach to transform their observations and insights *into* solutions and transformative possibilities. This method fosters the creation of diverse alternatives and diverse perspectives on human behavior.
Implementation	In the Execution area, the best ideas that emerge during ideation are translated into concrete and well-thought-out action plans. At the heart of this process is prototyping. Prototyping transforms ideas into real products or services that are tested, iterated, and refined.

Source: [14]

In this educational context, it is important to highlight that virtual ecological games take advantage of the variety and versatility of the different applications offered, as well as the tools and use of 3.0 platforms, as detailed in Table 2. This combination of technological resources, which ranges from interactive interfaces to artificial intelligence systems, demonstrates a firm investment in the principles of 3.0 and 4.0 education, characterized by dynamic, collaborative and student-centered learning.

This premise was corroborated in the virtual meetings held by the teams on the Microsoft Teams platform. Seventy-two students from the province of Morona Santiago and 90 from the province of Francisco de Orellana participated, for a total of 162 students. The aforementioned provinces are part of the Ecuadorian Amazon in the eastern part of the country. The following guidelines were given for the formation of the participating teams.

1. Each parallel had to choose its representatives voluntarily.
2. It was established that all teams will respect gender equality, allowing the team to be made up of 3 women and 3 men.
3. Finally, it was indicated that a leader should be chosen to guide the team and achieve the objectives proposed within the challenges.

Below, we detail the different tools used to develop each of the challenges, along with their description and use in the game, allowing students to strengthen their technological skills.

The aforementioned tools (Table 2) were used in the virtual ecological games to optimize student participation, interaction, engagement, and collaboration. It should be noted that each of the tools used had specific characteristics that facilitated the achievement of the goals established in the game.

It's worth mentioning that each challenge had its own evaluation rubric, a document that was shared with the participating teams so they could develop their solution proposals tailored to the challenge's requirements.

Table 2. 3.0 tools and digital applications for virtual ecological games

Virtual tools	**Description and Use in the Game**
Learning and reinforcing content through gamification	They are used for learning and content reinforcement. They are intended to promote the development of interactive surveys that encourage active student participation, for example, Kahoot.
Interactive assessment	It is an interactive assessment tool with free access that allows teachers to motivate and monitor student progress through tests, assessments and other activities, for example: Socrative
Collaborative work and collective construction tools	They are platforms that encourage students to work and build knowledge collaboratively, for example: Yammer (Virtual Forum-Microsoft)
Instant communication	They are applications that achieve instant communication, facilitating the exchange of content, documents, images, audios and videos, for example: WhatsApp, Signal, Telegram
QR Codes	They are used to solve challenges and problems posed in games, serve as a source of motivation, and provide access to additional resources.
Educational social network	They are educational platforms that provide communication and collaboration between teachers, students and families in a closed and secure environment, for example: Edmodo
Means of disseminating content	They are used to create content, to promote independent learning and raise awareness among students and the educational community, for example: You channel Tubey for
Social networks	They are social tools that are used to promote pedagogical innovation in games and encourage participants to acquire knowledge in an enjoyable way, for example: Tik Tok, Facebook, Instagram
Video editing	Video editing applications that facilitate the creation and design of advertising for games. Participants learn design and editing principles from educational materials, such as Filmora. Go, Camtasia

(*continued*)

Table 2. (*continued*)

Virtual tools	Description and Use in the Game
Interactive learning	They are tools that promote interactive learning and creativity in the development of teaching materials, for example: Genially
Applications for design	Inspire and challenge participants to create infographics, posters, and other materials for the games and challenges, for example: CANVA
Cloud storage	Cloud storage platforms that enhance collaborative work and remote work, for example: Google Drive
Virtual platforms	Platforms that facilitate student meetings to design strategies and tactics to win the game, for example, TEAMS
3D images for challenges	A creative, visual, and engaging tool that motivates participants to recognize specific landscapes and areas.
Robotics	Robot design, analysis, application, and operation station, with a focus on environmental protection.

Source: own elaboration.

3 Results

Through virtual ecological games, an interactive learning environment was fostered that actively engaged students, enabling them to explore, assimilate, and transform their perspectives and behaviors regarding pressing environmental and ecological challenges through the use of digital tools and information technology 3.0.

In other words, virtual ecological games generate an internal vision of Nature and environmental problems, encouraging inquiry and learning. Students learn through action, interaction and exploration, managing to experience the natural world through their senses, intellect and affection, reinforcing the learning of concepts, which contributes to a real awareness of the problems that society currently faces. This does not occur as isolated activities, but as collaborative and dialogical processes that take place in a digital context.

One of the challenges of education is ensuring that students and teachers are trained to work collaboratively and learn to develop these practices in the classroom. We are also experiencing the transition from Web 2.0 to Web 3.0, which represents much more than just an advance in virtual intelligence [17].

It is there where the 3.0 educational model appropriates the technological and participatory approaches introduced in education 2.0, which lead to a transition towards an active and motivating learning paradigm, where students go from being simple receivers of information to active producers of knowledge. This transformation is what causes a significant impact on the teaching-learning process.

The implementation of interactive games and gamification strategies, unprecedented in Ecuador, creates an environment in which participants can explore and learn about environmental issues in an engaging and fun way. This approach promotes inclusion and engagement, factors that have proven essential for optimizing educational quality and promoting change in behaviors and attitudes [21].

4 Discussion

Emerging on the scene of the Education 3.0 era, virtual ecological games are seen as a strong example of the evolution of educational processes. Initially, this project embodied the cardinal principles of Education 3.0, emphasizing active student participation and promoting technology as a strategic tool to enhance learning [2].

However, far from stagnating in the 3.0 era, the project, in line with the constant evolution of the educational field, motivated by technological advances, evolved to incorporate characteristic elements of the Education 4.0 methodology. This is evidenced by the integration of cutting-edge technologies such as artificial intelligence, machine learning and the analysis of large volumes of data [3].

In their current version, eco-games are emerging as an innovative synthesis of 3.0 educational paradigms and evolving in the future towards education 4.0. Through interactivity and gamification, an engaging and playful learning environment is created, where participants explore and learn about environmental issues in an interesting and motivating way [19]. This approach fosters inclusion and active participation, which are crucial elements for optimizing the quality of learning and bringing about significant changes in attitudes and behaviors.

The transition of virtual ecological games from the Education 3.0 methodology to version 4.0 represents a direct application of pedagogical innovation in the digital age, becoming a benchmark model of adaptation and continuous growth from its inception to the present, in the face of the challenges and opportunities arising in the contemporary educational landscape within the framework of emerging technologies.

According to the document of the European Council for Vocational Training in the Information Society, it is essential to develop hybrid capabilities that combine the use of information technologies, hardware and software, with the development of complementary skills, [11].

Soft skills include argumentation, negotiation of meanings, emotional balance, language, and self-learning. Emphasis is also placed on the ability to adapt to changes in attitude, initiative, perseverance, and consistency between thought and action, especially in relation to environmental conservation. This combination of technical and personal skills is essential for fostering the comprehensive development of students and preparing them for the challenges of the 21st century [16].

The importance of ecological games as an educational strategy has been documented in another work developed by the authors, [14], where their effectiveness in raising awareness and enhancing learning from multiple perspectives has been demonstrated, as can be seen in Fig. 1. These findings support the potential of virtual ecological games as an innovative and effective educational tool in teaching environmental issues in the digital age.

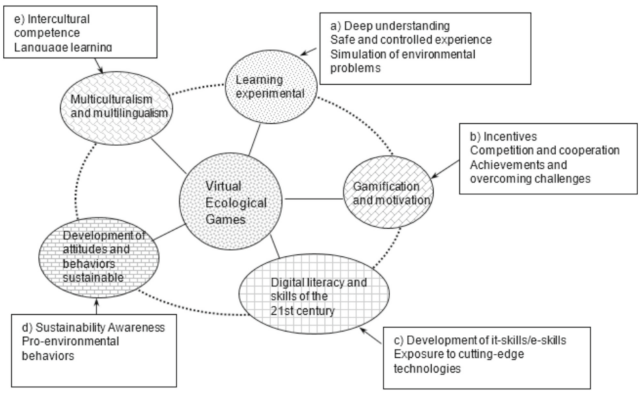

Fig. 1. Educational strategy of virtual ecological games

The pedagogical strategy employed and represented in (Fig. 1) explains the flow of skills that are developed as the game progresses. First, the game's dynamics establish roles for participants that are supported by game theory and gamification, which impacts participant motivation.

One of the didactic aspects evident in games is experiential learning. Virtual ecological games provide a controlled, safe, virtual environment where students, in order to overcome the challenges of the game, experiment, explore, and investigate to discover solutions. This approach stimulates a deeper understanding of ecological and environmental problems by allowing participants to simulate situations and solutions in a virtual environment. Through this active interaction, participants can discern the interconnections and consequences derived from different decisions and actions within an environmental context [6].

The inherent elements of games, such as competition, cooperation, progression and challenges, have the power to inspire and motivate students to engage more deeply in learning about environmental issues [1].

The development of sustainable attitudes and behaviors is also an integral part of this pedagogical approach. Virtual games provide an effective means of raising students' awareness of the importance of sustainability and encouraging them to adopt attitudes that promote a greener future [13].

Multiculturalism and multilingualism constitute a social space in the nations of the Ecuadorian Amazon. Virtual ecological games are a way to facilitate the development of intercultural competence and the learning of other languages, since they have been developed in three languages: Spanish, Shuar and Quechua. This promotes intercultural and multilingual competence in an increasingly globalized world, where intercultural and multilingual competence becomes an increasingly necessary and indispensable social requirement, [8].

The learning space within virtual ecological games fosters meaningful learning about environmental care, consistent with the principles of UNAE. A learning process is generated in which students can link new information with their prior knowledge, fostering a deeper and more lasting understanding of the content. In turn, they offer a safe and

regulated space for experiential learning, facilitating participants' understanding of the interrelationships of ecological and environmental challenges. Through the simulation of problems and solutions in real time, participants can discern the interconnections and effects of various decisions and actions [9].

Hands-on exposure to emerging technologies is another key benefit of these games. Students gain valuable familiarity with advanced Education 3.0 technologies, which are essential for developing advanced digital skills and understanding their applicability in educational contexts.

Table 3 summarizes the highlights of the contribution of ecological games to environmental education.

Table 3. Contributions of virtual ecological games to environmental education

Impact of Virtual Eco-Games	**Description**
Experiential learning	Ecological games allow students to experiment with diverse situations and solutions in a safe and controlled environment. This strategy contributes to a deeper understanding and understanding of ecological and environmental issues.
Gamification and motivation	Gamification introduces an additional motivating factor into learning, encouraging students to learn and explore environmental issues through competition, cooperation, and overcoming challenges.
Digital Literacy and 21st Century Skills	Eco-friendly games promote digital literacy and the development of 21st-century skills, both of which are increasingly essential in our society.
Development of sustainable attitudes and behaviors	Eco-friendly games can help students understand the importance of sustainability and adopt attitudes and behaviors that promote a more sustainable future.

Source: Prepared by the authors.

For [19], ecological or environmental games represent a valid alternative to address the teaching and learning processes, because their work methodology is developed under the guidelines of the ecological paradigm. Likewise, it states that ecological games serve to learn by construction or discovery, in work environments to provide students with a special sensitivity towards the environment and an integrative thinking that allows them to know their reality, conceive the environment in a systematic way, have active participation in decision-making to achieve the solution of problems that affect their lives and social development.

The praxis of ecological games is strengthened by psychological theories of learning and teaching; educational theories; educational approaches from behaviorist, cognitive, critical and humanist currents and are nourished by the UNESCO guidelines proposed by [8].

Gamification emerges as a powerful motivational catalyst, engaging students in environmental education in a playful way. This approach can encourage students to explore environmental issues through competition, cooperation, and challenge-solving, thereby increasing their engagement and active participation [5].

Through the pedagogical strategy of gamification, virtual ecological games offer an attractive and motivating approach to learning. A study carried out by [14] corroborates that gamification can serve as a powerful driver of student participation and commitment, which in turn can foster deeper and more lasting learning, and can become essential educational processes in the generation of sustainable attitudes and behaviors, since they can raise awareness among students about the importance of sustainability and encourage them to adopt attitudes and actions oriented towards a more sustainable future.

5 Conclusions

The results achieved highlight the value of virtual ecological games as effective tools for promoting environmental education and cultivating essential skills and abilities for the 21st century. The implementation of these games in the educational environment reveals an increase in students' digital competencies and the promotion of meaningful learning, enhancing essential skills such as critical thinking, problem-solving, leadership, and creative and design thinking.

The findings emphasize the value of experiential learning that these games provide. Students' ability to explore, experiment, and implement new solutions in a safe and controlled environment allows them to develop a deeper understanding of ecological and environmental concepts and appreciate the interconnections and impacts of different decisions and actions in these contexts.

After the experience, students have replicated the ecological games in their different contexts within the Amazon and incorporated them into their classroom strategies. This has been corroborated by the monitoring carried out with the different groups that have participated in these five editions.

Additionally, this study highlights the value of virtual ecological games in fostering intercultural and multilingual competence. In an increasingly globalized world, these skills are increasingly crucial, and games offer an innovative approach to their development.

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Chile and the Challenge of Sustainable Reporting: Key Advances and New Perspectives

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Abstract. Historically, investors have required financial information as a fundamental basis for decision-making. Asset valuation has been a subject of ongoing debate, intensified by the multinationalization of companies and globalization, which has generated a broad discussion on comparative accounting. This essay reviews how the positioning of international standards issued by the IASB has faced various challenges, from which important lessons have been drawn. Since 2008, Chile has gradually begun to integrate into the harmonizing trend of international accounting. However, the evolution of factors influencing investors' decision-making, along with the growing prominence of other stakeholders, has led to a new set of corporate requirements. This shift has transformed the way companies report, moving towards new metrics, indicators, and types of qualitative information, known as non-financial information. This information is commonly presented in integrated reports. The new scenario in Chile, characterized by regulations that have emerged since 2022, is the focus of this work. The analysis will explore aspects of the Chilean process in both the financial and non-financial spheres, discussing the progress made and the lessons learned on the path toward greater transparency and accountability in corporate reporting.

Keywords: International Accounting · Financial Reporting Standards (IFRS) · Corporate Disclosure · ESG (Environmental, Social, and Governance) Reporting · Harmonization of Accounting Standards

1 Introduction

International financial information has become increasingly relevant in a globalized world, driven by expanding trade, multinational operations, digital businesses, and global banking regulations. However, one of the major challenges of this internationalization is the management of financial information, particularly in accounting, where practices remain diverse in terms of valuation and financial reporting.

In response, comparative accounting has sought to standardize criteria such as recognition, measurement (via IFRS), and presentation through tools like XBRL. While financial reporting has advanced, non-financial disclosures—covering governance, environmental, and social issues—often remain voluntary or minimally regulated, leading to global inconsistencies.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 334–345, 2025.
https://doi.org/10.1007/978-3-032-09080-5_34

Transparency and accountability have gained prominence, with growing societal expectations for organizations to report their impacts and engage stakeholders. As Centeno et al. (2018) note, accountability is built on three pillars: reporting actions, accepting consequences, and fostering stakeholder dialogue.

Corporate disclosure has thus evolved as a strategic tool, responding to varied stakeholder demands beyond regulatory compliance. According to Sader (2019), companies bear the cost of information disclosure, while its benefits extend to shareholders, regulators, and society.

Since the 1990s, international accounting research has addressed systems harmonization, multinational practices, and training. Hopwood (1983) emphasized the need to study accounting within its social context, a view increasingly relevant amid calls for sustainable reporting.

The shift toward ESG reporting has transformed accounting practices, requiring greater use of qualitative and non-financial indicators. This demands changes in regulation, professional standards, and education, to align with integrated reporting models.

John Elkington's "triple bottom line" concept—focusing on social, economic, and environmental dimensions—challenges organizations to redefine success. The future of accounting lies in embedding these principles into practice, ensuring that organizations are not only accountable but also socially and environmentally responsible.

2 Methodology

The methodology for the literature review on the international evolution of financial reporting focuses on analyzing the historical, theoretical, and practical developments that have shaped contemporary accounting standards and practices. The primary objective is to explore both the evolution of international accounting standards and the integration of sustainability reporting within the context of global financial markets.

The review encompasses several key aspects, including:

- Historical Milestones: Analyzing significant events in international accounting.
- Organizational Roles: Examining the impact of entities such as the International Accounting Standards Board (IASB) and the IFRS Foundation on standardization efforts.
- Theoretical Frameworks: Assessing the underlying theories of financial reporting, including stakeholder theory, institutional theory, and agency theory.
- Cultural and Regulatory Influences: Investigating how cultural and regulatory factors affect accounting practices.
- Emerging Trends: Identifying new trends in non-financial reporting, particularly regarding environmental, social, and governance (ESG) criteria.

The review will include a thematic analysis evaluating the historical context of international accounting standards, alongside a discussion of applicable theoretical frameworks and cultural considerations influencing the adoption and interpretation of these standards. The emergence of non-financial reporting standards will be explored, with an emphasis on the role of the ISSB and the integration of ESG criteria in reporting.

This methodology not only ensures rigor in the review but also provides a solid foundation for understanding the evolution and challenges of international accounting and sustainability in the current context.

3 Results

3.1 Learnings from the International Evolution of Financial Reporting

International accounting has evolved alongside globalization, multinational corporations, and the need for harmonized practices. It covers more than just the presentation of financial statements under IASB standards, encompassing topics like accounting systems, audit harmonization, inflation effects, currency fluctuations, transfer pricing, international taxation, and global training for accounting professionals (García Benau et al., 1995, 1996; Prather & Rueschhoff, 1996).

The IASB has led harmonization efforts since 1973 through the issuance of IAS and later IFRS. A key milestone occurred in 2002 when the European Community approved IFRS for publicly traded parent companies starting in 2005, with full convergence by 2007 (Laínez, 2001). While some jurisdictions, like the U.S., continue to use their own standards (US-GAAP), a convergence roadmap was established to allow IFRS-based financial statements in the U.S. without reconciliation (Amat & Perramon, 2004).

Institutional agreements and political tensions have shaped international accounting. The IASB and FASB's collaboration and the SEC's influence after corporate scandals like Enron, leading to the Sarbanes-Oxley Act (SOX), have been pivotal (Fritz & Lämmle, 2003). The IOSCO's endorsement of global accounting standardization in the 1990s helped secure broader acceptance of IFRS (Laínez, 2001).

Cultural differences affect how international standards are interpreted and applied. Radebaugh and Gray (1997) noted contrasts between Anglo-Saxon and Nordic transparency-focused approaches versus Latin American secrecy and conservatism, which may conflict with IFRS principles.

Over time, IFRS has undergone more than 130 changes, including 21 new standards. The rise of sustainability and corporate social responsibility has led to increased focus on ESG disclosures. This shift requires expanded competencies from accounting professionals (Laínez, 2001).

The future of international financial reporting depends on balancing regulatory compliance with transparency and accountability. Continued collaboration among regulators, practitioners, and academia will be vital to maintain relevance in a rapidly changing global environment (Laínez, 2001).

3.2 Theoretical

We are transitioning to new reporting models that respond to evolving informational needs in markets and society. This shift, driven by global standard-setters, reflects user diversity and cultural dispersion, and is theoretically grounded, not random.

Freeman's (1983) stakeholder theory stresses the importance of communicating with all affected groups to build trust. Stakeholders, as Freeman and McVea (2001) define,

are "those who can affect or are affected by the activities of a company," necessitating tailored and timely disclosures—both regulated and voluntary.

Institutional theory deepens this view. Briano (2014) highlights how formal and informal rules guide business behavior. Scott (2008) outlines three institutional pillars—regulatory, normative, and cultural-cognitive—designed to protect stakeholders. Organizations pursue legitimacy through transparency (Zucker, 1977; Restrepo & Rosero, 2002), and institutional theory has become a dominant framework (Gutiérrez & Salas, 2015; Greenwood et al., 2008).

Legitimacy theory explains how firms align with societal expectations to ensure survival. Vargas (2008) notes that, under the neo-institutional model, organizations must adapt to global stakeholder demands using effective disclosure mechanisms.

Signaling theory (Ross, 1979) highlights the strategic role of transparency, where better-informed firms "signal" their quality to the market. Akerlof (1970) warns that information asymmetries can distort markets; full (mandatory and voluntary) disclosure helps mitigate these effects.

Agency theory addresses conflicts arising from information asymmetries in firms with dispersed ownership. Jensen and Meckling (1976) argue that transparency helps align managers with shareholder interests. Leftwich et al. (1981) support this, noting disclosure reduces agency conflicts—especially important in global capital markets, where consistent governance standards are essential (AECA, 2008). Institutional frameworks help internalize externalities from such asymmetries.

3.3 Guiding Ideas

Finally, the guiding ideas of this work, which transitions from the Chilean experience of accounting harmonization to non-financial reporting based on ESG criteria, recognize critical accounting theory as an important current of thought that underpins these new challenges. Archel and Gómez (2014) point out that there is a crisis of measurement stemming from valuation criteria—both conventional (associated with industrial capitalism) and contemporary (linked to financial capitalism)—that are inadequate for capturing the complexities of immaterial production, extending beyond the traditional factory-entity boundaries. Understanding the historical and intrinsic relationships between types of capitalism, corporate governance forms, and accounting models allows us to identify the potentials and limitations of the dominant accounting valuation criteria to date. In this sense, the term "critical accounting" is broad enough to encompass a variety of perspectives on accounting and its functions, but they all share a common thread: questioning the role that accounting plays in reinforcing the privileged position of certain segments of society over others (Gray, 2002).

From this reflection, we can recognize that over time, diverse informational practices have emerged to address the limitations of more traditional accounting information. This is particularly relevant in contexts where the culture of cost-based reporting (historical cost, in Latin terminology) has deeply ingrained itself in many countries, even with the adoption of IFRS standards, moving toward a corporate disclosure style that distinguishes financial disclosures from the other information that companies need to provide.

3.4 Historical Journey and Approaches to Non-Financial Reporting Standards

However, a pivotal historical event marks a significant turning point in this evolutionary process: the Industrial Revolution, which originated in England between the mid-18th century and the early 19th century before spreading across Europe. The Industrial Revolution transformed social, economic, and political aspects, along with the lifestyle of the global population. New production methods emerged, facilitating access to new products at more affordable prices for the general public, thereby improving the quality of life for certain social strata, while unfortunately condemning others to poverty. In this new context, marked differences began to solidify between social groups (the bourgeoisie and the proletariat), defining interaction roles that persist to this day.

As society evolved, the need for transparent and accountable reporting became increasingly evident, especially as businesses grew larger and more complex. The emergence of non-financial reporting standards can be traced back to these historical developments, highlighting the importance of addressing not only financial performance but also social and environmental impacts. Today, the challenge remains to align corporate reporting practices with the diverse expectations of stakeholders, ensuring that companies are held accountable for their broader impact on society and the environment.

3.5 Historical Overview and Approaches to Non-Financial Reporting Standards

Historically, societal development has been closely tied to economic evolution, transitioning from barter systems to modern corporations. A pivotal moment in this process was the Industrial Revolution in England (mid-18th to early 19th century), which transformed social, economic, and political structures. It enabled mass production and improved access to goods, but also deepened inequality between classes such as the bourgeoisie and the proletariat.

The capital generated through industrialization spurred financial market growth and expanded private enterprise. Mechanization in agriculture led to reduced land use, prompting significant rural-to-urban migration. As Íñigo Fernández (2012) notes, "mechanization and concentrated industrial development generated huge waves of migration that depopulated villages and increased urban populations."

While some countries benefited economically, industrial progress often entailed environmental degradation and resource overexploitation. These impacts, now widely questioned, have raised ethical concerns about production's long-term effects on ecosystems and human welfare. This has shifted the notion of success toward incorporating social and environmental dimensions.

In response, society has increasingly demanded corporate accountability for negative externalities, particularly environmental ones. Key initiatives include the International Union for Conservation of Nature's (IUCN) 1980 global conservation strategy and the UN's World Charter for Nature (1982), both advocating for the intrinsic value of all life forms. The influential Brundtland Report (1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

These concerns have elevated the importance of non-financial disclosures in corporate reporting. Scholars such as Gray (1992, 2006) emphasized how these disclosures—once marginal—are now essential. Despite complex regulatory pathways, various frameworks have emerged to align sustainability reporting practices.

A major advancement came with the announcement of the International Sustainability Standards Board (ISSB) at COP26 in Glasgow. The ISSB seeks to unify global ESG (Environmental, Social, and Governance) standards, addressing investor demands for consistent and transparent reporting, and promoting a more responsible and sustainable corporate landscape.

3.6 Arrival of the ISSB and Its Relevance in Sustainability Reporting Standards

In April 2019, Hans Hoogervorst, President of the IASB, highlighted the confusion caused by the overwhelming number of sustainability reporting standards. He used Tesla's inconsistent ESG ratings from different agencies as an example, showing how discrepancies complicate decision-making and emphasizing the need for consolidation (IFRS-F, 2019).

Since then, the IFRS Foundation has made significant progress in addressing the fragmented sustainability landscape. The creation of the International Sustainability Standards Board (ISSB) aims to curb the proliferation of voluntary disclosures, ensuring that investors receive comparable, high-quality information on sustainability risks and opportunities, and improving communication between companies and investors (IFRS-F, 2024).

The ISSB draws on the experience of its predecessor organizations, such as the IASC and IASB, which helped harmonize global financial reporting. Its new standards, IFRS S1 and IFRS S2, set out sustainability reporting and climate-related disclosure requirements, effective from January 1, 2024.

The ISSB has quickly established its influence, especially after its president's involvement in COP26 (2021), where agreements were reached with key organizations, including the CDSB, VRF, and TCFD. It is also collaborating with the GRI, which has been working on non-financial reporting standardization since 1997. Additionally, intergovernmental initiatives, such as the UN's Sustainable Development Goals

(SDGs), and the EU's Corporate Sustainability Reporting Directive (CSRD) further emphasize the importance of sustainability in corporate reporting.

3.7 Position of the Chilean Regulator and Initial Results of Integrated Reporting

Chile has a longstanding tradition of requiring standardized financial reports. Since 1982, companies have been mandated to submit the Uniform Coded Statistical Form (FECU) under circulars from the Superintendence of Securities and Insurance (SVS). Morales (2004) highlights this regulatory evolution:

"Since 1924, there has been a review body, albeit with limited powers. The regulations governing the presentation of financial statements have been established by the traditional circular 239... Although this circular was repealed in 2000, its application was postponed until 2001… being succeeded by circular 1,501, supplemented by circular 1,522 in 2001" (Morales, 2004).

The FECU transitioned from paper to digital formats, first via CDs and later through the Online Information Submission System (SEIL). A major step was aligning with IFRS. Circular 1,879 (2008) established IFRS-based reporting and promoted the use of XBRL, supporting international efforts to improve investor access to digital financial data (IFRS-F, 2017).

Companies must also submit an annual report with financial statements, management discussion, and other key data. Since General Norm 30 (1989), this includes sustainability topics. NCG 461 (2021) replaced NCG 385 (2015), integrating sustainability and governance through an enhanced "comply or explain" model.

Chile stands out in Latin America for its responsiveness to evolving disclosure norms, underlining its dedication to transparency and corporate social responsibility. With NCG 461 applicable from the 2022 accounting close, annual reports have adopted an "integrated" format. While inspired by IIRC standards, the Chilean version blends international indicators with localized elements, forming a unique structure for sustainability-related disclosure (Table 1).

Table 1. Dates and requirements for the validity of the issuance of the new integrated report.

Period 2021	**2022**	**(Voluntary)**
Period 2022	Reported this year, 2023	Publicly Traded Companies with consolidated total assets as of December 31, 2021: 20 million Unidades de Fomento (UF), approximately MMUS$ 795,334,000, based on currency conversion as of August 1, 2024.
Period 2023	Reported 2024	Publicly Traded Companies with consolidated total assets as of December 31, 2022: one million UF, approximately MMUS$ 39,766,000, based on currency conversion as of August 1, 2024.
Period 2024	Reported 2024	Publicly Traded Companies registered with the Commission for the Financial Market (CMF) under NCG 431, Circular 991, or NCG 30; includes issuers such as banks and insurance companies.

One notable characteristic of this new regulation is its emphasis on issues related to corporate governance, which is reflected in the inclusion of a previously issued and still valid standard that has addressed these topics since 2015. These aspects are organized into 26 sustainability factors grouped into five dimensions: business model, leadership and governance, environment, social capital, and human capital.

Regarding strategy, the regulator has taken into account the TCFD (Task Force on Climate-related Financial Disclosures), GRI (Global Reporting Initiative), and VRF (Value Reporting Foundation) standards. Issues related to people, the business model, and supplier management align with the GRI and VRF standards. Meanwhile, the

required indicators in areas such as customers, workers, the environment, fair competition, and some industry-specific metrics follow the North American SASB (Sustainability Accounting Standards Board) standard. This measure primarily impacts large regulated Chilean companies and will be implemented gradually, with a calendar presented in the following table.

One of the first studies examining the process of mandatory sustainable or integrated reporting adoption in Chile was conducted by PwC and ESE (2023). This study was based on the 30 companies that make up the main stock market index in Chile, plus nine additional companies. From the sample, 43.6% reported following the GRI standard as a reference, and 30.8% stated that they comply with this standard. Additionally, 89.7% of the companies, or 35, reported being aligned with SASB, a significant increase from just 14 companies the previous year. The majority of companies use XBRL (eXtensible Business Reporting Language) for reporting, and 68.4% mention TCFD (27 cases compared to only six the previous year), although in a descriptive or qualitative manner. The presentation of carbon footprint measurement is less common. Regarding materiality, 23.7% of companies do not disclose information on this aspect; 26.3% report at level 1 (results/matrix); 7.9% are at level 2 (process/methodology); and 42.1% reach level 3 (considering stakeholders).

4 Discussion

The study highlights a significant gap between financial and non-financial reporting within companies, leading to independent external reviews for non-financial matters, despite global efforts to unify these processes (PwC & ESE, 2023). While regulatory compliance is met, the adoption of the SASB standard demands further discussion. Azúa Álvarez and Jara (2024) stress the importance of accurately defining industries, as this classification affects the relevance of sustainability disclosures. Their research shows that most companies self-classify within a single industry.

The shift towards integrating sustainability into corporate reporting is influenced by regulatory pressures, investor expectations, and a fundamental change in business success criteria. The establishment of the ISSB aims to standardize sustainability reporting, addressing concerns about the proliferation of reporting standards and inconsistencies in evaluating sustainability, especially relevant in Chile, where frameworks are rapidly evolving. The introduction of IFRS S1 and S2 in 2024 will enhance transparency and comparability in ESG information.

Chile's NCG 461 illustrates the shift to integrated reporting, emphasizing corporate governance through 26 sustainability factors. This move aligns with global standards such as GRI, SASB, and TCFD. However, the PwC and ESE study (2023) reveals a persistent disconnect between financial and non-financial reporting, highlighting the need for a cohesive approach to ensure consistency and reliability.

The trend towards self-classification within industries is emerging in Chile, but Azúa Álvarez and Jara (2024) warn that careful handling is required to ensure relevance to stakeholders. Additionally, there is growing demand for audits of ESG reports to assure investors of data accuracy. The upcoming public consultation on ISSA5000 reflects the global push for standardizing and verifying non-financial information.

Education plays a key role in improving non-financial reporting, with a need for training in sustainability competencies for future business leaders. In conclusion, achieving transparency and accountability in corporate reporting requires collaboration among regulators, companies, and professionals, ultimately contributing to a more sustainable future.

4.1 Final Comments

- The concept of accountability has taken center stage. Since the emergence of AA1000, which establishes internationally recognized principles guiding companies to develop a responsible sustainability approach and communicate their accountability (Centeno et al., 2018), entities utilize various types of reports-such as annual reports, sustainability reports, integrated reports, or corporate websites-to disclose their non-financial (ESG) information, employing different frameworks and metrics (Lokuwaduge and De Silva, 2022).
- IOSCO (2019) has recognized the relevance of disclosing information on ESG aspects, noting that these aspects can have material impacts on the performance of securities issuers and on the decisions and outcomes of investors. Given the importance of this organization due to its influence over local regulators worldwide, it is anticipated that alignment with the new ISSB project will lead to mandatory requirements in the short term.
- Accounting and information management professionals can and should take on the commitments associated with sustainability information management. The financial-accounting methodology is proven, with systems and processes that function effectively in the accumulation, verifiability, and reliability-even externally-which should extend to non-financial (ESG) information that is increasingly demanded and reported.
- The path toward sustainable reporting is already established, while the path to ensuring the reliability of this newly reported (and forthcoming) non-financial information is still under discussion. The Big Four firms and auditing standard setters are moving quickly. The IAASB of IFAC has already released a draft of ISSA5000 (August 2023) for public consultation, which was open until December 1, 2023, so updates on this matter are expected soon.

- If, twenty years ago in Europe, García Benau and Zorio (2001) stated, "we should already begin to design the incorporation of the study of IASC standards, perhaps simultaneously with the study of the accounting model in courses that specifically address accounting standardization," we should now consider whether the study and teaching of ISSB standards should prompt educational institutions and the accounting profession-especially those focused on reporting, primarily from a financial perspective-to broaden their scope to include non-financial information.

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Proposal for a Fitness Program for Police Officers

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Abstract. The National Police require adequate physical fitness to perform their functions effectively. However, studies show that many agents do not have it. This research designed a fitness plan to improve performance, prevent injury and promote health. A mixed approach was applied: qualitative (documentary review and interviews) and quantitative (surveys). Only 36% of agents are in good physical condition, more than 60% exercise less than three times a week, 51% have difficulties with their tasks and 33% have not received advice. There is also evidence of needs such as time optimization, adequate spaces and greater institutional support. Results reflect sedentary lifestyle, overweight and low participation in programs. In response to this, a structured plan with technical, pedagogical and technological components was proposed as a key strategy for strengthening the health and performance of police personnel.

Keywords: Safety · fitness · physical · difficulties · sedentary lifestyle

1 Introduction

The National Police is a civilian institution that is professional, specialized, armed, and technical that provides security within the national territory [1]. Its competencies include crime prevention, custody of offenders, control of illicit traffic of narcotic substances, chemicals, addressing other criminal behaviors such as illicit enrichment and safeguarding individuals from crime, while ensuring adherence to the law [2].

The Organic Code of Entities and Public Security of the State (COESCOP), establishes that this institution is structured through subsystems linked to prevention, investigation, and anti-crime intelligence, which are part of the National Public System [3]. The police structure requires officers to maintain high physical strength and dexterity. Consequently, it is essential to establish physical, mental and professional development programs, supported by administrative, educational and technological estrategies. The regulation guarantees that the institution provides resources and outlines responsibilities for the physical training of its personnel [4].

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 346–358, 2025.
https://doi.org/10.1007/978-3-032-09080-5_35

From an administrative perspective, the development of physical conditioning and training programs enhance the management of human management. These improvement initiatives aim to optimize police performance through continuous training in security, conflict prevention and conflict resolution. Additionally, to incorporate physical conditioning to ensure endurance and agility, strengthening the overall health of personnel and improving the quality of service in the "Eloy Alfaro" Police District.

The Physical training regimen encompasses flexibility, speed, strength and endurance, along with healthy habits, injury prevention and stress management [5]. These elements improve the integral development of staff and their ability to make decisions in critical situations.

An evaluation of 110 police officers from the Metropolitan District of Quito revealed that, more than 75% were overweight, elevated body fat and cardio metabolic risk, according to bioimpedance, IMC and abdominal circumference. Only 25 of them had results within normal limits [6]. The lack of physical activity presents a national challenge that adversely impacts the well-being, strength and endurance of police officers. Although sports injuries are common, it has been shown that training with appropriate strategies can reduce them and improve performance.

Nationally, various activities have been implemented with the main purpose to eradicate sedentism, such as the practice of active breaks among workers, though they are not properly conducted in certain institutions [7]. Within the police institution, many existing programs lack continuity or local adaptation. There is no comprehensive plan in the district that integrates physical activity and operational training with a preventive approach. Subsequently, this absence limits the necessary physical development, affects operational efficacy in operations and contributes to increased fatigue and stress, as a result, reducing the responsiveness of officers [8].

An adequate program can optimize police training, improving health, wellness and performance. Therefore, it is considered to design a specific proposal for the district.

From this need, the research question arises: What are the physical requirements of police officers in operational activities according to existing or available evidence, and how do these influence their functional and work performance? Consequently, this article focused on a documentary review that allowed identifying deficiencies and risks faced by police personnel. It also designed a program incorporating strategies, which allow these public servants to maintain integral well-being. This study aims to be a useful input for national organizations and state officials responsible for police training, which will foster a more profound understanding of the problem, and will also clearly highlight the need to promote more designs and implementations of physical conditioning programs, in each police district nationwide.

2 Theoretical Foundation

Physical exercise is defined as any voluntary movement aimed at expending energy. Its incorporation into daily habits improves integral health, increasing capacities such as endurance and muscle strengthening [9]. Adopting healthy practices reduces sedentary lifestyle, improves diet and promotes general well-being.

2.1 Types of Physical Exercise

Physical activity is key to fundamental well-being, preventing disease and improving mental and physical health. It is necessary in sectors such as the police, where it optimizes work performance. Aerobic and anaerobic exercises strengthen resistance and strength [10].

2.2 Benefits of Physical Activity

Regular exercise contributes to preserve optimal health, reducing disease and fostering a better quality of life. Besides, the benefits are psychological, physiological and social [11]. At a physiological level, it reduces the risk of cardiovascular disease, regulate blood pressure, it decreases the incidence of colorectal cancer and prevents Diabetes Mellitus II, usually related with overweight. It also strengthens bones & muscles and improves stamina.

2.3 Causes of Physical Inactivity

Sedentary lifestyle is a major cause of physical inactivity. According to the WHO, a person is considered sedentary if he or she does not perform at least 30 min of activity per day [12].

Factors such as urban expansion, reduction of recreational spaces and increased use of electronic means and motorized transport, have collectively reduced opportunities for daily movement, negatively impacting public health worldwide [13].

2.4 Consequences of Physical Inactivity

This inactivity leads to issues such as overweight and obesity. These conditions emerge when energy consumed through food exceeds the energy expended [14].

Daily activities such as walking or doing household chores generate energy expenditure, but are often not enough to balance caloric intake, which can lead to body fat storage. This increases the risk of chronic comorbidities such as diabetes, hypertension, metabolic syndrome and cancer [15].

2.5 "Eloy Alfaro" Police Institution

The "Eloy Alfaro" Police district is an entity located in the south of Quito, representing one of the city's eight administrations (MINISTRY OF GOVERNMENT, 2021). This institution is responsible for safeguarding civil order through the application of prevention and control policies as a response to criminal incidents. For this reason, they must maintain continuous integral training, encompassing theoretical and practical knowledge focused on their competencies.

As part of the National Police, its mission follows its principles: maintaining security within the city and public order, while also safeguarding the free exercise of rights and national security. Besides, its vision is to be a reliable and technical institution that applies and integrates transparency and guarantees national security by 2025 [4]. This entity's staff consists of highly qualified individuals, holding third and fourth level of high education degrees in areas related to public security, law, administration, psychology, pedagogy, health, among others [16]. The Police Institution, in each of its establishments, has spaces and infrastructure that allow them to train new personnel, conduct simulations of real cases, utilize training platforms, and provide recreational areas for citizens [16].

2.6 Exercises Required on Police Personnel

Due to their duties, police personnel must maintain a satisfactory overall physical condition, achieved through various exercises. These include:

Stretching, executed in a slow and controlled manner, preparing the joints and muscles for physical activity. Coordination, which improves displacement, defined as the ability of the brain to synchronize muscle movements at the body level [16].

Strength, categorized into static, dynamic, explosive and resistance, and its selection depends on the specific demands of the activity or sport [17]. Speed, defined as the ability to perform motor actions in the shortest possible time, it is enhanced by constant practice [17].

2.7 Importance of Physical Exercise in Police Work

Physical exercise is fundamental for police officers, as it improves their physical and mental health by increasing endurance, strength and the ability to cope with stressful situations. International programs, such as those implemented in the United States have demonstrated the benefits of maintaining adequate physical conditions, which also helps prevent injuries and improve overall work performance. Furthermore, regular physical activity helps agents stay alert and respond efficiently during operations [18].

2.8 Legal Regulations

The regulations on Physical Education, Sports, and Recreation for police officers in Ecuador establish:

Art 15: All units within the police sector must conduct physical training at least twice a week, with each training session lasting 60 min. These sessions will be established by the official operations personnel of each unit, and attendance is strictly mandatory [19]. Art 16: Annual physical training and its evaluation is mandatory for all members of the institution, and it will be completed in the institutional uniform [19]. Art 17: Physical training in police facilities must be determined by proper planning and execution. This will be reflected in an excellent physical evaluation result [19].

2.9 Previous Studies

Velastegui (2023), aimed to apply a detailed analysis of relevant aspects in his research work, maintaining continuous police learning from a quality education perspective. Methodologically, a documentary approach was employed, analyzing various accessible and verifiable public sources. The study highlighted the importance of implementing plans and programs focused on continuous police education, which must consider knowledge, skills, and abilities that should be applied theoretically and practically [20].

Pineda (2023) sought to identify improvements observed in police officers after the application of a physical conditioning program within the Metropolitan District of Quito. A quasi-experimental research approach was used, identifying a target population of 68 active-duty officers, who were randomly selected. 59 of them were men and 9 were women. In the data collection processes, several speed tests and a work stress test were applied, adapting questionnaires for psychosomatic issues, which allowed for the identification of substantial results in the enhancement of physical condition and stress management. It was determined that applying physical conditioning plans allows the improvement of several physical activities such as endurance, speed, and strength, along with a reduction in BMI and stress levels [21].

Duchitanga and Sichi (2020), in their study, aimed to identify and apply a physical conditioning program that allowed for optimizing and improving the performance of various police professionals. A sample of 20 individuals was identified and selected through random sampling. Here, it was determined that each participant maintained adequate physical and psychological development after the training. Additionally, an increase in motivation for the research was identified, along with their awareness of the requirement for permanent physical exercise among police personnel [22].

Figueroa (2020) sought to enhance the physical condition of active police officers through intensive short-term preparation, applying an entertainment method. Methodologically, it maintained a qualitative, explanatory scope approach, which used a quasi-experimental design with initial and subsequent tests with a specific control group, involving 10 students from the Professional Technical program of the Simón Bolívar Police School in Tuluá Valle. Nevertheless, the control group maintained a habitual exercise program in the three weekly sessions. An advance was identified in some exercise indicators, such as performance, aerobic, and anaerobic endurance. Afterward, endurance tests were analyzed in the lower and upper limbs with good progress, and unipodal squats with wall support and push-ups were applied [22].

3 Methodological Process

3.1 Study Design and Type

A mixed-methods approach was applied, applying validated questionnaires to analyze patterns among police officers. Data was collected on age, position, and experiences with physical training. Interviews with specialists and field observations helped identify areas for enhancement and develop strategies. The explanatory research enabled understanding causes and effects, providing a key analysis for the progress of this research. This integral approach allowed for a deep understanding of the context and needs of police officers

3.2 Population and Sample

1.The population consisted of 554 police officers holding various positions within the Eloy Alfaro Police District. The sample included 228 survey respondents and 4 interviewees. This study included active police personnel who voluntarily agreed to participate and were the most available for program implementation.

3.3 Technique and Instruments

A perception survey was administered to police officers based on the design of this program, by using a previously developed questionnaire. Informed consent was obtained before its application. This technique helped gain an initial diagnosis within the studied context, as well as demonstrating the level of importance and impact of physical exercise on the performance of police officers. Moreover, interviews were conducted with technical specialists in human talent, psychology, physical rehabilitation, and nutrition. All Information was gathered using a guide of questions about techniques and recommendations according to their area of expertise, which also encompassed the importance of creating constant comprehensive training and physical conditioning programs.

3.4 Limitations

Due to operational workload, infrastructure limitations, and inadequate personnel and resource allocation, the execution and implementation of the program could not be carried out. In fact, it was only designed. However, relevant useful information was gathered during the diagnostic phase, establishing a solid foundation that will serve as a pillar or basis for new research.

4 Results

Based on the frequency of physical exercise (Chart 1), 60% of participants report exercising less than three times a week, 32% exercise three to five times a week, and only 8% exercise daily.

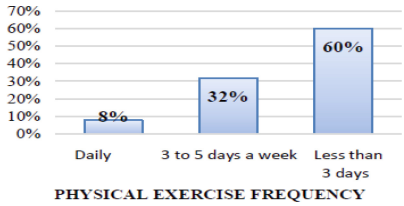


Chart 1. Physical Exercise Frequency

Regarding the self-perceived physical condition of police officers (Chart 2), the majority describe their condition as fair, 36% consider it good, and 13% consider it poor.

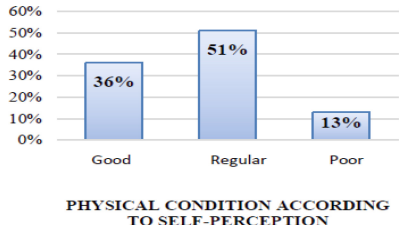


Chart 2. Physical Condition according to self-perception

With respect to the difficulty in carrying out daily work activities, 49% report no significant difficulty, 40% report a moderate difficulty, and 11% indicate a high level of difficulty (Chart 3).

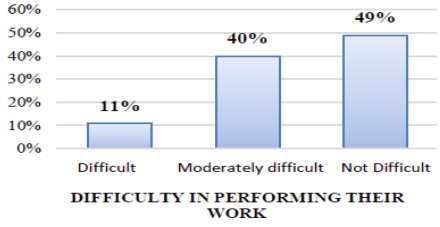


Chart 3. Difficulty in performing their work

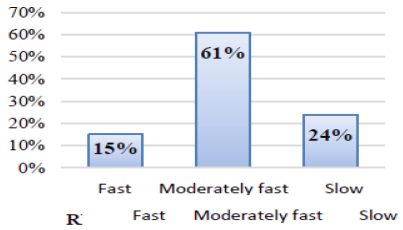


Chart 4. Recovery after Intense Physical Activity

Considering their recovery after intense physical exercise, 61% of respondents stated they experience a moderately fast recovery, 24% report a slow recovery, and 15% report a fast recovery (Chart 4).

Note. The data obtained was from the Survey. Source: Own elaboration (2025) (Chart 6).

Finally, regarding training on physical exercise provided by the institution, 54% report receiving it once a year, 33% say they have not received any, and 13% indicate it is provided on a regular basis (Chart 5).

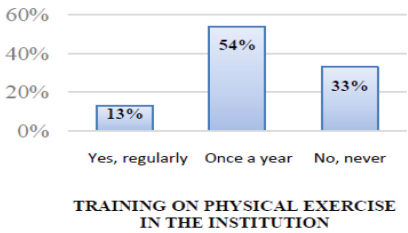


Chart 5. Training oh Phisical excercise in the Institution

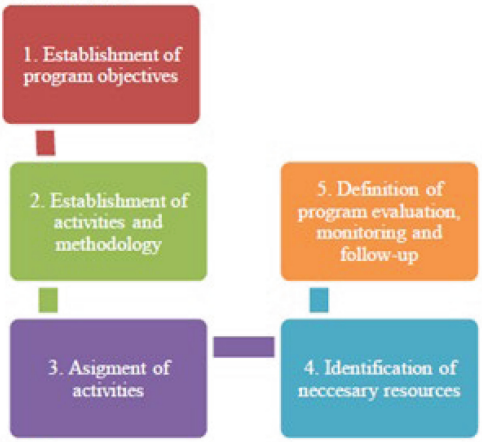
Relevant Results from Interviews and Surveys

SECTIONS	INTERVIEW	POSITION
Interviewee 1	Does the program improve police well-being and, with professional support, promote effective prevention and health strategies?	Psychologist
Interviewee 2	Physical conditioning is vital for police work. It is recommended to plan during hours with low criminal activity to overcome limitations.	Head of Human Resources
Interviewee 3	An individual approach and physiotherapy are vital to prevent injuries and ensure correct exercises.	Licensed Physical Therapist
Interviewee 4	Diet and body indicators are key for health and maintaining healthy habits.	Licensed Nutritionist

5 Note. Classification criteria (percentage of 100)

Chart 6. Relevant Results from Interviews and Surveys

Police Physical Conditioning Program



Note. Own elaboration (2025).

Chart 7. Police Physical conditioning Program

Relevant Results from Interviews and Surveys

Activities	Objectives	Activities - Responsible for Implementation	Methodology – Implementation Time	Evaluation – Monitoring	Resources
Internal Coordination	Identify optimal schedules for physical exercise.	Personnel management; Delegation of functions	**Responsible:** Human Resources **Methodology:** Systems Theory. This proposes organizational balance with its environment. **Time:** 3 months	Survey to measure the level of satisfaction with internal communication (Application of KPIs)	List of police members, List of assignments and schedules
Physical Exercise Planning	Determine exercise series according to police personnel needs. Plan strength, endurance, coordination, and flexibility exercises. Use daily exercise control applications.	**Responsible:** Physical Trainer	**Methodology:** Waterfall Methodology. It has a linear characteristic, dividing the project into well-defined phases. **Time:** 4 months	Direct instruction	Exercise plan, Training applications, Training equipment

Chart 8. Relevant Results from Interviews and Surveys

Reduction of Anxiety, Depression, and Stress Disorders	Apply anxiety, stress, and depression management techniques.	Personal psychological follow-up; Application of anti-stress, antidepressant, and anxiolytic techniques	**Responsible:** Psychologist	**Method:** Cognitive Behavioral Therapy. Allows identification of behavior patterns, improving skills and conflict resolution. **Time:** 3 months	ILO-WHO Work Stress Scale
Injury Reduction	Advise on injury management.	Personnel training	**Responsible:** Physical Rehabilitator	**Method:** Direct Instruction. Provides clear indications on a specific skill or concept. **Time:** 2 months	Feedback (Will allow personnel to know which activities are performed correctly and which are performed incorrectly.)
Nutritional Assessment	Anthropometrically evaluate personnel. Determine nutritional needs in exercise.	Measurement of fat percentage, muscle mass, and water. Food assessment. Diet preparation.	**Responsible:** Nutritionist	**Method:** Bioimpedance. **Method:** Dietary calculation of requirements per person. **Time:** 6 months	Bioimpedance, Dietary anamnesis

Chart 8. (*continued*)

5 Discussion

The data reflected a high percentage of the surveyed population not meeting the minimum physical activity recommendations according to WHO guidelines. This can be described by the fact that police officers maintain heavy workloads, with irregular shifts and personal responsibilities, which indirectly delays the practice of physical exercise, reducing the time that would be used for it [16].

This situation highlights the need to promote healthier habits within the evaluated group. Moderate activity lasting at least 30 min, five days a week, or high-intensity physical activity with a frequency of 3 days a week for at least 20 min is advised [23]. Therefore, it is highlighted that sedentary lifestyles lead to chronic non-communicable diseases such as Diabetes, Hypertension, Cardiovascular, and metabolic diseases [24]. More active lifestyles improve work performance and staff mood [16].

More than half of the respondents consider their physical activity to be regular, followed by those who rate it as good, and a smaller proportion have poor physical condition. Because of their work, police officers must maintain adequate physical condition.

A study in the city of Latacunga revealed that, although the average rating of officers was acceptable in the Cooper test, many did not meet the necessary individual requirements, which affected their performance in police duties [25].

It is important to apply different types of exercise. Cardiovascular exercise will lead to greater weight loss, improving heart health and boosting overall body performance [25]. Muscular strength allows for body toning and increased strength, which are fundamentals in sports performance [26]. Flexibility and agility exercises will improve coordination within training and enhance human mobility.

A study showed that participants who maintained vigorous and moderate intensities tended to remain more positive, allowing them to maintain greater work dynamism, with a better mood, quality of life, and health [26]. The use of nutrition in training is also considered to complete dietary requirements, avoiding excesses in diet and the use of unnecessary or inappropriate supplements according to requirements. Adequate nutrition will allow for muscle mass recovery and prevention of fatigue [26].

The majority of police officers have received advice within the institution, although a minority has not, and a small group receives it regularly. This variability suggests that programs and plans are not consistently applied at all levels and services, which could limit the overall efficiency of training initiatives.

These results specify the importance of motivating all personnel to engage in physical testing programs and maintain continuous training. This will allow police officers to maintain a greater potential for daily required skills and abilities, and subsequently provide a quicker response to adverse situations that may arise in real life.

Consequently, the use of a physical conditioning program (Chart 7), supported by technical and empirical viability, it has been deemed necessary and relevant, as it will be described below (Chart 8).

6 Conclusions

Police personnel exhibit alarming rates of physical inactivity, which affects their health, well-being, and operational performance. There is a gap between institutional regulations and the current implementation of physical training. The diagnostic results approximately justify the implementation of a physical conditioning program adapted to the needs of police personnel. This program should adopt an interdisciplinary approach, integrating assessment, planning, execution, and monitoring. Ultimately, this initiative aims to enhance officers' overall well-being, mitigate occupational hazards, and boost the institution's operational effectiveness.

The proposed program, with an interdisciplinary, flexible, technological, and sustainable approach, which responds to the identified needs. Several topics were considered in the program's design, encompassing nutritional management, performance improvement, physical recovery, and stress management. Personnel with knowledge in these areas have been assigned responsibilities and functions accordingly. Thus, its institutionalization as part of the National Police's permanent training plan is recommended. To conclude, it is recommended to replicate this model in other countries, adapting it to their particular contexts and conducting prior diagnostics.

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Collaborative Work Mediated by ICT To Strengthen Reading Comprehension in Language and Literature

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Abstract. This study addresses the challenge of improving reading comprehension in secondary students within rural educational contexts, where traditional methods often fail to foster interpretation and critical thinking. It evaluates the impact of ICT-mediated collaborative strategies on reading performance in Language and Literature. A quasi-experimental design was applied in an Ecuadorian public school, involving 180 students divided into experimental and control groups. The experimental group engaged in eight weeks of interactive activities using digital tools such as Genially, Padlet, and Storyjumper. Results showed a significant improvement in the experimental group's performance (from 6.4 to 8.1 average), along with increased motivation and classroom engagement. These findings confirm the effectiveness of integrating collaborative digital strategies to enhance reading comprehension. The originality of this study lies in its contextualized application of ICT tools at the secondary level, offering scalable pedagogical insights for broader educational innovation.

Keywords: Reading Comprehension · Collaborative Work · ICT-Mediated Instruction · Quasi-Experimental Design · Secondary Education

1 Introduction

Reading comprehension is an essential competency in the area of Language and Literature, as it enables students to decode, interpret, reflect, and construct meaning from diverse types of texts [1]. In today's educational landscape—marked by heterogeneity and digital advancement—it is necessary to rethink traditional methodologies in favor of more active, collaborative, and contextualized learning strategies.

Research has demonstrated that collaborative work fosters cognitive, social, and communicative development by promoting idea exchange, meaning negotiation, and collective problem-solving [2–4]. In Language and Literature, these dynamics enhance critical text analysis, argumentation, creative expression, and deeper engagement with

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 359–368, 2025.
https://doi.org/10.1007/978-3-032-09080-5_36

literary and linguistic content, especially when supported by digital tools that stimulate student motivation and participation.

The integration of collaborative learning with digital technologies has been shown to significantly improve both reading comprehension and student motivation [5], Tools such as Nearpod, Genially, and Blooket facilitate progress in reading skills, while ICT-enriched active methodologies promote interaction, meaningful learning, and sustained engagement with reading and writing tasks [6].

Despite these advances, key research gaps persist. Few studies examine the use of digital technologies to enhance reading comprehension in rural or mixed contexts, or how these tools differentially affect the various sublevels within Language and Literature. Furthermore, teacher training in digital competencies and the design of content-specific collaborative strategies remain limited.

This study analyzes the effectiveness of collaborative teaching strategies mediated by digital technologies in improving reading comprehension among eighth, ninth, and tenth-grade students in Higher Basic Education, specifically within the Eugenio Espejo Educational Unit. It employs a quantitative, quasi-experimental design to assess the pedagogical impact of the intervention under authentic classroom conditions.

This research addresses these gaps by implementing and evaluating a structured ICT-based collaborative intervention specifically designed for rural secondary students, targeting all three levels of reading comprehension (literal, inferential, and critical). It further explores teacher perceptions, providing insight into practical implementation and professional development needs.

2 Background

2.1 Nature of Reading Comprehension

Reading comprehension is a complex cognitive process that allows students to construct meaning from a written text, integrating prior information, linguistic knowledge and inferential skills [7]. According to [8], comprehending a text involves identifying explicit ideas, inferring implicit meanings, relating information, and critically reflecting on the content. In the area of Language and Literature, this competence is directly related to the interpretation of narrative, expository, poetic, and argumentative texts, which demands advanced skills such as intertextuality, stylistic analysis, and discursive production. As noted by [1] a deep understanding strengthens academic performance, critical thinking, and expressive ability.

Several studies reveal that students in higher basic education face multiple challenges [7, 9, 10] when dealing with texts, among them: poor concentration, limited vocabulary, weak connection to literary contexts, and difficulties in making inferences or synthesizing information. These comprehension issues are especially evident in students from socio-educationally disadvantaged environments and are further aggravated when teaching practices rely on mechanical activities such as underlining or rote memorization [8, 10].

2.2 Fundamentals of Collaborative Learning

Collaborative learning emphasizes peer interaction to achieve shared goals, fostering social skills, empathy, and collective responsibility key elements in the educational

process [2]. In Language and Literature, this approach enables students to interpret texts from diverse viewpoints, engage in dialogic analysis, and co-construct written discourse through sustained cooperation.

Research highlights its effectiveness in enhancing reading comprehension, textual analysis, and argumentative skills. Group discussion facilitates deeper understanding by confronting ideas, validating interpretations, and reshaping collective meaning [11], Activities such as co-authoring stories, analyzing poems collaboratively, or debating literary themes exemplify how this strategy enriches comprehension while also promoting critical thinking and creativity.

2.3 Ict Tools and Their Impact on Learning

Information and Communication Technologies (ICT) have reshaped educational practices, offering dynamic tools to teach reading and writing more interactively. Platforms such as Genially, Padlet, Canva, Edpuzzle, and Storyjumper support the creation of engaging resources that enhance literary and linguistic work. Their integration fosters active learning, creativity, and student autonomy, especially when aligned with collaborative methodologies [12].

In Language and Literature, ICT tools not only improve textual production and critical analysis but also enable multimodal interpretations through visual and auditory inputs [13]. I Furthermore, they support classroom diversity by adapting to various learning styles and academic levels, fostering inclusion and equitable participation.

3 Methodology

3.1 Research Approach

This research is framed within the quantitative approach, since it seeks to objectively measure, compare and analyze the effect of an educational intervention on reading comprehension in the area of Language and Literature. Through the collection of numerical data and their statistical analysis, the aim is to establish causal relationships between the strategies applied and the academic results obtained by the students.

3.2 Methodological Design

The study employed a quasi-experimental design with intact groups (experimental and control) to evaluate the impact of ICT-mediated collaborative strategies on reading comprehension. Participants were assigned based on the natural class structure, respecting institutional organization. Pretest and posttest measures were applied to both groups to assess learning gains. Data were collected during the 2024–2025 academic year, specifically between October and December 2024.

3.3 Scope of the Study

The scope of the research is explanatory and descriptive. It is explanatory because it seeks to determine if there is a significant relationship between the application of collaborative strategies with ICT and the improvement in reading comprehension; and it is descriptive because it characterizes the initial and final reading behavior of the students, as well as their performance in relation to the processes of textual analysis, interpretation and production.

3.4 Population and Sample

The study involved 270 students from eighth, ninth, and tenth grades at the Eugenio Espejo Educational Unit. An intentional sample of 180 students was selected and evenly distributed into two groups: 90 in the experimental group and 90 in the control group. Participants ranged in age from 12 to 15, with a balanced gender distribution (51% female, 49% male), and most came from low- to middle-income households in rural Ambato. None had prior systematic exposure to digital tools in Language and Literature classes. These conditions ensured comparability and contextual relevance of the findings.

3.5 Data Collection Techniques and Instruments

To assess reading comprehension, a standardized test aligned with the national curriculum was applied, covering literal, inferential, and critical levels. The instrument's reliability was confirmed via Cronbach's Alpha ($\alpha = 0.72$). It was administered as both pretest and posttest. Additionally, a semi-structured interview with the experimental group's teacher was conducted to explore perceived benefits, challenges, and implementation experiences. The interview guide is provided in Appendix A, and selected excerpts are integrated in the discussion to support qualitative interpretation.

3.6 Intervention Procedure

Over eight weeks, the experimental group followed a didactic sequence based on collaborative strategies using digital tools such as Genially (timelines), Padlet (opinion walls), Storyjumper (co-authored stories), Edpuzzle (video analysis), and Canva (infographics). Sessions promoted active participation, group dialogue, peer evaluation, and collaborative text production. Meanwhile, the control group continued with traditional instruction focused on guided reading, comprehension questions, and individual written tasks without ICT integration.

3.7 Data Analysis

Pretest and posttest results were processed using SPSS (v.26). Student's t-tests for related and independent samples were applied to assess intra- and intergroup differences, with a significance level of 0.05. Interview data were examined through thematic coding to identify key perceptions regarding the implementation of ICT-mediated collaborative strategies.

4 Results

To evaluate the impact of ICT-mediated collaborative strategies on reading comprehension, a standardized pretest and posttest were applied to 90 students in both experimental and control groups. Table 1 summarizes academic improvement ranges. Most students in the experimental group improved between 1 and 2 points (n = 81), while 8 improved by more than 2 points. In contrast, 82 students in the control group improved by less than 1 point. These results reveal a markedly greater effect of the intervention in the experimental group.

Table 1. Distribution of students according to range of improvement

No.	Range of improvement	Experimental group	Control group
1	Between 1 and 2 points	81	7
2	No improvement	0	1
3	Less than 1 point	1	82
4	More than 2 points	8	0
	Total students	90	90

Note: Classification according to individual increase between pretest and posttest in reading comprehension

4.1 Comparative Performance

The experimental group's average score rose from 6.42 to 8.10, while the control group improved from 5.83 to 6.38 (Table 2). Students using ICT tools outperformed those under traditional instruction by 1.13 points on average, indicating a strong pedagogical gain.

Table 2. Mean scores by group

Group	Pretest (Mean)	Postest (Mean)	Improvement
Experimental (n = 90)	6,42	8,10	+1,68
Control (n = 90)	5,83	6,38	+0,55

4.2 Effect Size

The effect size (Cohen's d = 1.25) indicates a large impact of the intervention on reading comprehension outcomes in the experimental group.

4.3 Qualitative Improvement

Experimental group students improved in identifying main ideas, making inferences, participating in discussions, and producing more coherent and lexically rich texts. These gains validate the hypothesis that ICT-supported collaboration enhances both comprehension and communication skills in Language and Literature.

4.4 Instrument Reliability

The test showed acceptable internal consistency (Cronbach's alpha = 0.600) for classroom research.

4.5 Test Score Ranges

Table 3 displays score ranges. The experimental group moved from 5.20–7.90 to 7.40–9.60, confirming substantial improvement.

Table 3. Experimental group score ranges

Range/student	Range/grades Pretest n = 90	Range/ grades Postest n = 90
Student 1–90	5,20 – 7,90	7,40 – 9,60

Note: Averages **a) Pretest:** 6,42; b) **Postest:** 8,10

4.6 Normality Validation

Kolmogorov-Smirnov and Shapiro-Wilk tests confirmed normal data distribution in both groups ($p > 0.05$), justifying use of parametric tests. (Table 4)

Table 4. Normality tests - experimental group

Test	Statistic Pretest	Sig. Pretest	Statistic Postest	Sig. Postest
Kolmogorov-Smirnov	0,0498	0,9706	0,0711	0,7258
Shapiro-Wilk	0,9894	0,6864	0,9772	0,1153

Note: Significance values indicate normal distribution for both sets of data ($p > 0.05$).

4.7 Control Group Results

In the control group, which did not receive technological intervention, a less pronounced improvement in scores was observed. Table 5 presents the scores obtained by the 90 students before and after the intervention.

Table 5. Pretest and posttest scores of the control group

Range/student	Range/grades Pretest n = 90	Range/ grades Postest n = 90
Student 1–90	4.2–6.9	5.2–7.4

Note: Averages **a) Pretest:** 5,83; b) **Postest:** 6,39

4.8 Normality Test

In order to validate the application of parametric tests, a normality test was performed on the pretest and posttest results in both groups. The results obtained using the Kolmogorov-Smirnov and Shapiro-Wilk tests indicate that the data present a normal distribution ($p > 0.05$), allowing the use of inferential statistical test in Table 6, 7.

Table 6. Normality tests - Experimental group

Test	Statistic	gl	Sig.
Pretest Experimental	0,9894	90	0,6864
Postest Experimental	0,9772	90	0,1153

Table 7. Normality tests - Control group

Test	Statistic	gl	Sig.
Pretest Control	0,9778	90	0,1258
Postest Control	0,9809	90	0,2100

In both groups and evaluation times, the significance values are greater than 0.05, which indicates that the data are normally distributed and allow the application of parametric tests such as Student's t-test.

4.9 Hypothesis Testing

Student's t-tests showed statistically significant differences ($p = 0.000$) in favor of the experimental group (Table 8).

Table 8. T-test summary

Comparison	t	gl	Sig. (bilateral)	Mean difference	95% Confidence Interval (Lower - Upper)
Postest Exp vs. Control	36,771	31	0,000	7,875	7,44 – 8,31

The intervention significantly enhanced reading comprehension, confirming the study hypothesis.

5 Discussions

The results of this study confirm that the implementation of collaborative strategies mediated by digital technologies has a significant impact on the development of reading comprehension in eighth, ninth and tenth grade students. The increase in the average of the experimental group (from 6.42 to 8.10), compared to that of the control group (from 5.83 to 6.38), shows that active methodologies supported by ICT enhance learning beyond what traditional strategies allow. This improvement is in line with [5], who argue that platforms such as Genially, Padlet or Storyjumper not only increase academic performance, but also raise motivation and encourage active participation. These tools facilitate interactive and multimodal reading, catering to the diversity of learning styles present in the classroom and promoting a richer and more accessible reading experience.

The findings of this research also reinforce the principles of meaningful learning, in that they demonstrate that students achieve a deeper understanding when they relate new knowledge to their previous knowledge and construct it collaboratively. In this line, [10, 14], point out that meaningful learning is consolidated through processes of social interaction and critical analysis, characteristics present in this intervention. The collaborative text production activities, the creation of digital stories and the shared reflection on literary readings promoted not only the appropriation of the content, but also the development of metacognitive, argumentative and creative skills, which are difficult to achieve with methodologies focused solely on teaching exposition.

Collaborative work, an essential component of this methodological proposal, not only improved academic performance, but also strengthened key dimensions of socioemotional development, such as empathy, argumentation and shared decision-making. This perspective is supported by [15–17], who emphasize that collaborative learning enhances both cognitive and affective development by fostering the joint construction of meanings. In this study, students in the experimental group evidenced greater confidence when expressing themselves, in addition to a noticeable improvement in the coherence and lexical richness of their written productions. Added to this is the transformative value of digital technologies, used with a clear pedagogical purpose, which allow generating more inclusive, creative and participatory learning environments [18–20]**.**The selected platforms not only facilitated access to content, but also promoted self-regulation of learning, teamwork and effective integration of diversity in the classroom.

6 Conclusions

The implementation of collaborative teaching strategies mediated by digital technologies significantly improves reading comprehension in the area of Language and Literature in students of Higher Basic Education. The comparison of results between the experimental group and the control group shows a statistically significant difference in favor of the former, which shows that collaborative learning, supported by tools such as Genially, Padlet and Storyjumper, not only increases academic performance, but also enhances skills such as critical interpretation, argumentation and creative textual production.

Collaborative work, when integrated with digital technologies from an active pedagogical perspective, is configured as an inclusive, motivating and effective didactic strategy. This combination favors equitable participation, critical thinking and the shared construction of knowledge, essential aspects in the integral formation of the student. However, its success depends to a large extent on teacher preparation in the pedagogical use of ICT and rigorous methodological planning that guarantees coherence between objectives, activities and evaluation.

Acknowledgments. A thank you to Centro de Investigación en Ciencias Humanas y de la Educación-Ciche, Universidad Tecnológica Indoamérica for its support in the development of this research under the project IIDI-001–23

Conflicts of Interest The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Funding. This research received no external funding. The APC was funded by Universidad Tecnológica Indoamérica under the project IIDI-001–23.

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Bridging Academia and Society: A Digital Platform for Stakeholder Engagement at the Polytechnic Institute of Viseu

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Abstract. The project consists of creating an online platform dedicated to the interaction of stakeholders at the Polytechnic Institute of Viseu (IPV). This platform will allow stakeholders to search for courses, register, create profiles, and participate in activities, courses, training, and other initiatives offered by IPV. The platform will serve as a central tool to promote participation, inclusion, and dialogue between IPV and its stakeholders, aiming to improve the quality of educational services and strengthen communication with the academic community and society at large.

The project will be developed by a multidisciplinary technical team composed of professors and students from IPV with expertise in software development, interface design, project management, and communication. The team will work together to conduct a detailed survey of stakeholder's needs and expectations, defining the necessary functionalities and features for the platform. The project approach will be based on a combination of requirements analysis, user-centered design, and implementation of technological solutions. Interactive prototypes and implementation plans will be developed, including user interface design and development, system integration, and the creation of a secure and intuitive environment for users and stakeholders.

The implementation of such platforms has already proven effective in other educational institutions, enabling co-creation of solutions, increased transparency, and improvement in the quality of services offered. Therefore, it is essential for IPV to keep up with these trends and adopt modern stakeholder engagement strategies aligned with best practices.

Keywords: Stakeholder Engagement · Digital Platform · Higher Education · User-Centered Design · Community Interaction · Educational Innovation

1 Introduction

The aim of this project is to overcome the lack of interaction between stakeholders and the Polytechnic Institute of Viseu (IPV). It will allow stakeholders to search for courses, register, create profiles and take part in activities, courses, training and other initiatives offered by the IPV, its organic units (schools) and community interface unit (ADIV).

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 369–378, 2025.
https://doi.org/10.1007/978-3-032-09080-5_37

Through this project, stakeholders will have the opportunity to become actively involved in decisions, collaborate with the IPV, exchange ideas and contribute to strengthening the academic community. The proposed solution will be a central tool for promoting participation, inclusion and dialog between the IPV and its Stakeholders, with the aim of improving the quality of educational services and strengthening ties with the academic community and society in general.

The Polytechnic Institute of Viseu (IPV) is a higher education institution located in the city of Viseu, as well as an organic unit in Lamego, with a track record of academic excellence and commitment to educational quality. IPV constantly seeks to innovate and promote the involvement of its stakeholders in its activities.

In this project, the institution has a multidisciplinary technical team made up of teachers and students with expertise in the areas of software development, interface design, project management and communication, who will work together to develop and implement the platform.

2 Conception

The project employed a qualitative methodology to explore the needs, expectations, and experiences of stakeholders regarding the platform. Meetings with involved faculty members provided valuable insights for identifying requirements. Additionally, a review of existing platforms linked to IPV—such as the ESTGL, ESTGV, ESSV, ESAV, ESEV, and ADIV websites—enabled the identification of good practices that informed the platform's design.

A key preliminary task was to assess the project's objectives and requirements to determine the functionalities and resources necessary for development.

The team adopted Agile Methodology, a widely accepted approach in software development for its emphasis on flexibility, collaboration, and continuous value delivery [6, 12]. Originating from dissatisfaction with rigid traditional methods, Agile prioritizes:

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
- Customer collaboration over contract negotiation;
- Responding to change over following a fixed plan.

These values, as outlined in the Agile Manifesto [6], are supported by twelve principles promoting frequent software delivery, customer engagement, and responsiveness to change.

The adoption of Agile was appropriate due to the dynamic nature of stakeholder participation and the iterative design of the platform. Existing literature and case studies confirm the effectiveness of digital platforms in promoting engagement and transparency in higher education contexts [5, 25]. Thus, IPV's alignment with these trends ensures the project's relevance and sustainability.

General objective:

- To develop and implement a stakeholder participation platform that encourages inclusive and active involvement from the academic community and other stakeholders.

Specific objectives:

- Identify stakeholder needs and expectations;
- Define platform functionalities based on best practices;
- Design an intuitive user interface;
- Ensure secure integration with IPV's existing systems;
- Promote platform adoption and continuous stakeholder engagement;
- Enhance transparency and the quality of educational services.

Key technical aspects considered included technology selection, system architecture, integration, scalability, performance, security, and user interface design. The choice of technology and architectural model ensured alignment with project goals and software engineering best practices [21].

Security protocols such as data encryption and adherence to established standards were implemented to protect user information. Scalability strategies, including horizontal scaling and load distribution, were employed to support high user volume and responsiveness.

A user-centered design ensured an intuitive interface for all stakeholders. This comprehensive and technically grounded approach enabled the achievement of the project's objectives, culminating in the creation of the Stakeholder Interface platform.

3 Implementation and Results

To understand and model the interactions between users and the system, a use case diagram was developed. This diagram provides a visual overview of the system's main usage scenarios, identifying actors (users, external systems, devices) and their respective interactions with the platform's functionalities. Represented by ellipses, use cases illustrate how users engage with the system, forming the basis for defining functional requirements. Use case diagrams facilitate communication by offering a common language among stakeholders, enhancing comprehension of system functionality and project expectations [21].

Figure 1 presents the use case diagram developed to model user interactions with the system, identifying the platform's main usage scenarios. In parallel, a class diagram was created to describe the system's static structure. This object-oriented model outlines classes, attributes, methods, and the relationships between entities such as association, inheritance, and dependency. Class diagrams promote shared understanding of software architecture by visually representing the system's core components [21].

Figure 2 shows the system's static structure through a class diagram, highlighting the main entities and their relationships.

The system comprises several interconnected classes:

- Entity: represents institutions or departments with fields such as name, address, and contact information.
- Activity: a superclass for platform offerings, includes name, description, cost, and contact details.
- Service: a specialized form of Activity with additional properties.

Fig. 1. Use case diagram

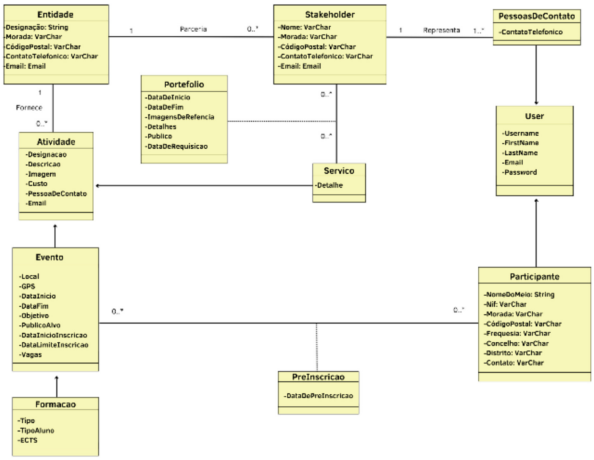

Fig. 2. Class diagram

- Event: a type of Activity, associated with specific locations, dates, and audiences, linked many-to-many with the Participant class.
- Stakeholder: individuals or organizations linked to Entities, storing contact details and forming one-to-many relationships.
- Contact Person: supports communication, linked to Stakeholders in flexible relationships.
- User: a base class for Stakeholders and Contact Persons, encompassing login credentials.
- Participant: users involved in events, with detailed personal and geographic data.

Additional association classes include:

- Pre-registration: links participants to events, recording registration data;
- Portfolio: connects stakeholders to services, marked as public or private.

This class structure aligns with the platform's goals—mapping user roles, defining interactions, and supporting the development of a coherent and intuitive interface.

In evaluating the technological foundation for the project, two mainstream frameworks were compared: Laravel and Django. A framework provides standardized tools, libraries, and conventions that accelerate development while maintaining consistency and scalability [13]. These include libraries, APIs, modules, and testing utilities that allow developers to focus on business logic rather than low-level coding. The team's analysis informed the final decision, which is detailed in the subsequent section.

Additionally, version control was established via GitHub [16], allowing collaborative development, branch management, and code reviews. The team configured a shared repository and adopted best practices for maintaining source code integrity.

To ensure a consistent development environment, virtual environments were created, isolating dependencies and enabling the installation of specific library versions. This setup was supported by Python's Virtualenv and dependency tracking via requirements.txt files. Such practices minimize conflicts and maintain software stability across deployments. These implementation choices—rooted in established software engineering principles—ensured the robustness and scalability of the Stakeholder Interface platform, supporting user needs and institutional requirements.

3.1 Laravel

Laravel is an open-source web framework developed in PHP that adheres to the Model-View-Controller (MVC) design pattern [13]. It is recognized for its elegant and expressive syntax, prioritizing readability and developer productivity.

Laravel simplifies common development tasks such as authentication, database migrations, and task scheduling through integrated tools, making it accessible even for developers with limited experience. Its extensive documentation and ecosystem of third-party packages contribute to its usability. Nevertheless, for applications requiring high concurrency, additional configurations may be necessary to ensure scalability and optimal performance [24]. Figure 3 illustrates an example of information entry in a version of the platform developed using the Laravel framework.

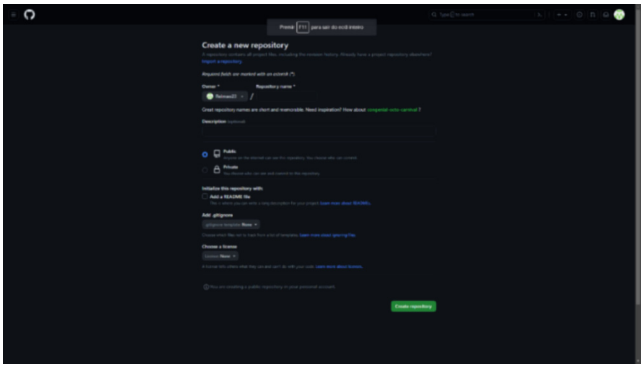

Fig. 3. Filling in information on the platform developed with Laravel

3.2 Django

Django is a high-level web framework written in Python, following the MVC architecture and grounded in the DRY (Don't Repeat Yourself) principle [13, 14]. This design philosophy emphasizes reusable code and modular structure, thereby enhancing maintainability. Django incorporates a rich set of built-in features, including an administrative interface, form handling, user authentication, and protections against security threats such as SQL injection, Cross-Site Request Forgery (CSRF), and Cross-Site Scripting (XSS) [15, 19, 22].

Figure 4 displays the login interface developed with the Django framework, emphasizing its simplicity and user-friendly navigation.

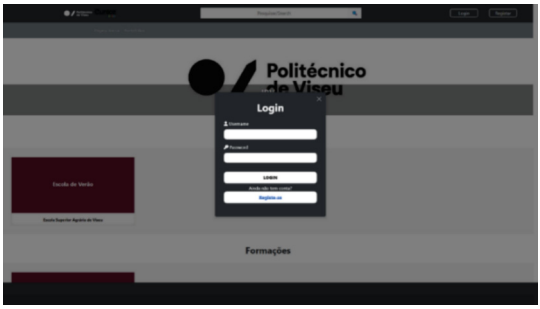

Fig. 4. Login form interface implemented using Django

The aim of this navigability diagram is to provide users with a fluid and intuitive experience when pre-registering for activities or requesting services on the Stakeholder Interface platform. The navigability diagram begins with the platform's home page, where users have several options available to them. They can choose to log in if they already have a registered account, or register if they are new users. In addition, there is the option of registering either by pre-registering for activities or by requesting services.

Figure 5 presents the registration form used in the platform, one of the main steps in the user sign-up process. Also available are the options to view the portfolio and request

partnerships, where users can obtain information and details about the various activities or services. After carrying out the initial steps, users have the possibility to access the profile page, where they can manage their personal information and adjust preferences, the platform offers the partnership request feature, allowing users to request partnerships with entities.

Fig. 5. Registration form

Python, Django's underlying language, is lauded for its clean syntax and readability, which aids rapid development and reduces the learning curve [13]. Although Django offers substantial functionality out of the box, it may pose challenges to developers unfamiliar with Python or the framework's architectural conventions. Considering the specific requirements of this project—namely, security, scalability, and development efficiency—Django was chosen as the preferred solution, reinforced by the team's prior experience with Python and its ecosystem [24]. Version control was managed via GitHub, a collaborative platform that allows for distributed versioning, branch management, and peer code review [16]. Visual Studio Code (VS Code) was employed as the Integrated Development Environment (IDE), supporting advanced code navigation, syntax highlighting, and integration with Git. To maintain consistency across development environments, virtual environments were established using

Virtualenv, with dependencies managed through pip and requirements.txt files. Additional environment-specific configurations, including API keys and file paths, were defined to ensure secure and reliable deployment.

Figure 6 shows the navigability diagram describing the user interaction flow within the platform, from login to main functionalities.

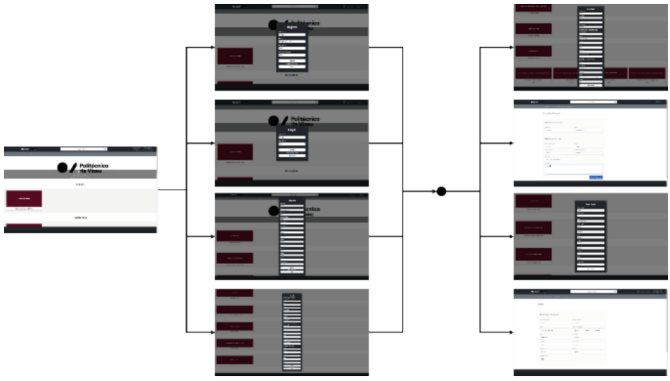

Fig. 6. Navigability Diagram illustrating user interaction flow within the platform.

Fig. 7. Carousel of involved entities

This development approach promotes an efficient, collaborative workflow and supports the construction of a secure and user-friendly platform interface, aligning with the best practices in modern software engineering [21].

4 Conclusion

Throughout the development of this project, particular emphasis was placed on the clarity and accessibility of information presented on the platform. The interface was designed with a logical and coherent layout, organizing content into distinct sections to facilitate intuitive navigation.

Attention was given to accessibility standards, including appropriate visual contrast and readable font sizes, to ensure usability across diverse user profiles and devices [18]. Functional clarity was also a design priority. Descriptions of platform features were written in accessible, non-technical language to accommodate a broad audience. One highlighted feature is the carousel component, which dynamically rotates through entities and updates the displayed activities and services accordingly, ensuring relevance and clarity.

Figure 7 depicts the dynamic carousel that highlights involved entities and automatically updates the available services and activities.

One of the main challenges during development was capturing comprehensive and representative feedback from all stakeholders. Despite thorough data collection efforts,

some perspectives may have been missed. However, iterative adjustments and feedback from the academic staff involved helped address these gaps. A well-executed requirements analysis, combined with user-centered design, led to the development of an intuitive interface and an engaging user experience [18].

Two key areas identified for future enhancement include the implementation of automated confirmation emails upon user registration and integration with existing internal systems at IPV. These improvements will further streamline user interactions and data management.

The project adhered to best practices in stakeholder participation and digital service design, employing prototyping and iterative design techniques to support usability. All specific objectives were met: identifying stakeholder needs, defining functionalities, creating a secure and user-friendly interface, and encouraging adoption across the academic community.

The resulting platform has become a foundational tool for stakeholder engagement at IPV. It fosters participation, strengthens institutional communication, and supports transparency and co-creation. Key functionalities such as service searches, course registration, and access to activities enhance stakeholder involvement.

Beyond operational benefits, the platform elevates IPV's institutional image by showcasing innovation and responsiveness to community needs. It facilitates partnerships and collaborative opportunities, promoting a culture of shared development and academic integration [25].

Looking ahead, continuous improvement based on user feedback is essential. Evaluations and satisfaction surveys can identify enhancement opportunities, guiding the introduction of new features and interface refinements. Additionally, expanding the platform to other educational institutions or allied organizations could broaden its impact and promote knowledge exchange.

To measure long-term effectiveness, future studies should assess the platform's role in enhancing stakeholder engagement and service quality. These findings will inform adjustments, ensuring the platform evolves to meet emerging needs and supports institutional goals sustainably.

Acknowledgements. This work is funded by National Funds through the FCT—Foundation for Science and Technology, I.P., within the scope of the project Ref. UIDB/05583/2020. Furthermore, we would like to thank the Research Centre in Digital Services (CISeD) and the Instituto Politécnico de Viseu for their support.

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The Impact of Using Digital Marketing Tools for the Strategic Visibility of the Organization: A Study in Social Institutions in the Municipality of Vagos

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Abstract. Digital marketing has become a widely adopted strategy for companies seeking to promote their activities and enhance visibility. This study investigates the impact of digital marketing on third sector social organizations, focusing on how these entities perceive and implement digital strategies. The research involved interviews with organizations based in the municipality of Vagos, aiming to identify the digital tools employed and the extent of their strategic planning in this area. Findings indicate that most social organizations in Vagos lack structured digital marketing strategies. However, there is a strong recognition of the growing importance of digital tools for organizational development and competitiveness. Notably, organizations that have integrated such tools tend to exhibit greater structural consistency and financial sustainability.

Keywords: Third Sector · Digital Marketing · Social Organizations · Strategies · Vagos

1 Introduction

The use of digital tools in our daily lives is increasingly common, and, in fact, the third sector and social organizations are no exception. This is due to their frequent use by individuals, professionals, and companies alike.

Given the still limited training of administrative staff in Portugal's third sector and the corresponding strategic concerns, this article aims to bring these two areas together to understand the perspectives on and the importance of digital marketing within the social sector. Furthermore, the objectives include examining the viewpoints of a group of

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 379–389, 2025.
https://doi.org/10.1007/978-3-032-09080-5_38

social organizations in the municipality of Vagos regarding digital marketing strategies, to understand the contribution of digital tools to these organizations and, if digital tools are not implemented, to identify the reasons behind this choice.

The study seeks to investigate how social organizations value digital marketing strategies, which tools they use, and which they consider most beneficial for promoting their organization. In other words, it aims to identify which organizations do not use digital marketing strategies, the reasons and barriers they face, how this affects their organizational strategy, and which means they use to communicate their services to the community.

Regarding the structure of this article, it is organised as follows: a literature review, which addresses the most relevant theoretical concepts underpinning the research; the methodology section, which presents the research methods, population, data collection techniques, and data analysis techniques; followed by the analysis and discussion of results, based on interviews, digital tools, and the financial statements and balance sheets of the organizations under study. Finally, the conclusion will assess whether the objectives have been achieved.

2 Theoretical Framework

2.1 Third Sector

The Social Economy is based on a set of institutional-type economic activities guided by various principles aimed at offering services that promote the well-being and quality of life of individuals, especially the most disadvantaged. These guiding principles are founded on social and territorial cohesion, sustainability, social justice, and equity [1].

According to the Framework Law of the Social Economy in Portugal, it is defined as a set of socio-economic activities carried out by various entities such as cooperatives, associations, charitable institutions, foundations, private social solidarity institutions, among others [2]. These non-profit entities form part of the third sector, which, in partnership with other sectors, aims to mobilise society by implementing social initiatives that address community issues [3].

When relating the third sector to marketing, it is important to note that marketing strategies help social organizations build a stronger image and reputation in the community, promote their services, and consequently attract clients. Moreover, marketing is essential for organizations to fulfil their missions and objectives, thereby increasing the impact of their activities and services on society [4].

2.2 Digital Marketing

The internet and digital media have transformed the reality of marketing. In recent years, technological advances have led to changes in the market and consumer behaviour, encouraging the emergence of digital marketing [5].

According to [5], digital marketing encompasses a set of tools and strategies that address market needs and generate benefits for both organizations and clients.

Digital marketing is defined as a technique that combines technologies to support and facilitate market activities. Its application generally enhances the profitability of

acquiring goods and services through continuous client engagement. In this way, digital technology and strategic planning have gained recognition, enabling organizations to better understand their clients' preferences and needs, with a view to increasing customer satisfaction [6].

Due to the growth of the internet and the substantial increase in users, companies have felt the need to develop new ways of standing out in a highly competitive market [7].

With digital marketing, communication can occur at any time and in real time, and it is globally accessible. Consumers can easily obtain and compare information about products and services. For some companies, digitalisation has become a priority, as it is increasingly important to differentiate themselves in the market [8].

As a result, many companies turn to social media to increase visibility, gain returns, improve their reputation, and enhance customer satisfaction. This is because, by receiving consumer feedback, organizations can improve the quality of their services or products and thus increase their competitiveness [9].

3 Methodology

Regarding the methodology of this research, it falls within a qualitative perspective, as it is based on knowledge construction through interviews conducted with the eleven social organizations in the municipality of Vagos.

After collecting qualitative data through interviews with various social entities in Vagos, the research is based on a comparative study between those that use digital marketing strategies and those that do not. The comparative method thus allows for the identification of similarities and the explanation of differences, enabling the deduction and interpretation of the phenomena observed.

In terms of the study population, the research focuses on the municipality of Vagos and includes presidents, technical directors, or other professionals responsible for the visibility and strategic direction of the 11 social institutions located in the area. During initial contact with these organizations, it became clear that not all were available to participate in the study. As a result, only 8 out of the 11 organizations agreed to take part.

For this study, the most appropriate technique is the interview, to understand the perspective of the presidents, technical directors, or other qualified professionals in this area regarding digital marketing, and to determine whether the organization uses digital tools to promote its services. A semi-structured interview was chosen, as it allows for mutual interaction between the two parties.

The interview objectives were to:

- Understand the professionals' perspectives on digital tools;
- Identify whether any digital marketing strategy exists within the organization and, if so, which one(s);
- Understand the advantages of using digital tools;
- Explore the viewpoints of directors from organizations that do not have a digital marketing strategy in place.

As data collection was conducted through interviews, the most appropriate data analysis technique is content analysis, supported using NVivo *software.*

4 Results and Discussion

The results obtained will be described and treated anonymously, ensuring the confidentiality of the responses provided. In other words, the names of the institutions will not be mentioned and will instead be designated by letters.

The interviews conducted were divided into four sections: one concerning the characterisation of the interviewee, another regarding the characterisation of the organization, a third focused on knowledge related to digital marketing, and finally, the last section included two different interview guides—one for organizations with a digital marketing strategy and another for those without any such strategy.

The sample results revealed that approximately 88% of the respondents were female, and 12% were male. The interviewees are aged between 36 and 65, with an average age of approximately 50 years. The majority (87.5%) hold a university degree, 50% of which are in Social Work, with the remaining in Psychology, Electrotechnics and Industrial Management Engineering, and Business Organization and Management. Only one interviewee has completed secondary education, with a focus on technological administration. Regarding roles, 50% are technical directors, while the others hold positions in quality assessment, communication and image; treasury and service management; presidency and service management; and administrative support, each representing 12.5%. Length of service within the organizations ranges from 13 to 30 years, with an average of 21 years. These data reflect a group with extensive experience and predominantly higher education, occupying roles of responsibility.

Regarding the characterisation of the organization, the aim was to gather information related to the years of operation, the social services each provides to the community, questions about staff members, users/clients, and the geographical areas covered by the organization.

As shown in Fig. 1, the oldest institution is "Organization B", with 63 years of existence, while the most recent are "Organization A" and "Organization C", both with 26 years.

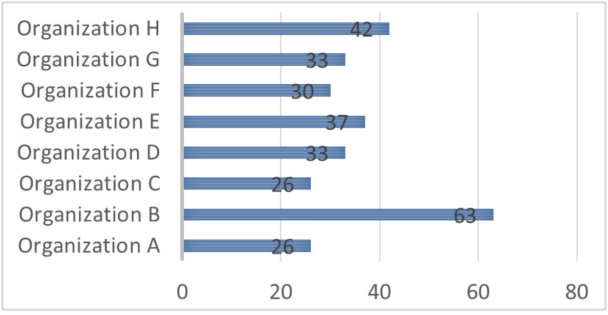

Fig. 1. Years of organization's existence.

Among these social responses, the organizations that stand out more from the others, thus having a greater variety, are "Organization B" and "Organization F."

"Organization B" stands out for having a larger number of responses related to community intervention projects, while "Organization F" is the only one in the municipality offering services in disability. The other organizations in the study all offer social responses in the form of daycare and home support services. Most also have Leisure Activities Centres and Family Support and Animation Activities, and some also offer Day Centres and Kindergartens.

In the municipality of Vagos, social organizations are distinguished by being small and medium-sized. The small-sized organizations are "Organization A," "Organization C," "Organization D," and "Organization G." The medium-sized ones are "Organization B," "Organization E," "Organization F," and "Organization H." In terms of the number of employees, "Organization B" and "Organization F" have the largest number, with 139 and 87 employees, respectively. It is observed that the size of the organization also depends on the number of social services they provide to the community. Organizations with more social responses are those that require more staff.

In relation to the employees, females are the majority. The male gender represents a minority, with some social organizations not having any male employees at all. Concerning the academic qualifications of the staff, 'Organization A' responded that the average was 9th grade. 'Organization B' states that out of 139 staff members, 10 have a 4th-grade education, 12 have a 6th-grade education, 42 have a 9th-grade education, 21 have a 12th-grade education, and 54 staff members have a higher education level. In 'Organization C' and 'Organization E,' the staff have academic qualifications ranging from 4th grade to a bachelor's degree. In 'Organization D,' out of 13 staff members, 10 have a 9th-grade education, 1 has a 12th-grade education, and 2 have a bachelor's degree. 'Organization F' includes schooling from the 1st cycle to a master's degree. 'Organization G' ranges from 4th grade to a master's degree. And finally, 'Organization H,' out of 60 staff members, 16 have a 9th-grade education, 35 have a 12th-grade education, and 9 have a bachelor's degree.

Regarding the users/clients, it is observed that 'Organization B' has the most clients (21%), followed by 'Organization F' with 274 clients (17%), 'Organization H' with 242 clients (15%), and 'Organization G' with 230 users (14%). The social institution with the fewest clients/users is 'Organization D' with only 56 (4%). We also find that when analysing the number of users, the number of staff members, and the social services provided, the largest organizations in the municipality of Vagos are 'Organization B' and 'Organization F.'

The type of users served by the institutions varies between children, young people, the elderly, and people with disabilities. Regarding 'Organization A,' out of 93 users, 60 are elderly and 33 are children. In 'Organization B,' out of 341 users, 87 are elderly, 234 are children, and 20 are young people. 'Organization C' only mentions that they have 180 users, including children and the elderly. 'Organization D' states that out of 56 users, 15 are elderly and 41 are children. Concerning 'Organization E,' out of 183 users, 100 are elderly and 83 are children. In 'Organization F' out of 274 users, 55 are elderly, 76 are people with disabilities, 133 are children, 7 are young people, and 3 are

adults. 'Organization G' and 'Organization H' report that they have 230 and 242 users, respectively, which include children and the elderly.

Regarding the geographical areas covered by the social organizations, it is possible to verify that 'Organization E' and 'Organization F' encompass all geographical areas. 'Organization B' covers both rural and urban areas. It is emphasized that the rural area is predominant, being present in all social organizations and exclusively in 'Organization A,' 'Organization C,' 'Organization D,' 'Organization G,' and 'Organization H'.

In the third part of the interview, the topic of Digital Marketing applied to each interviewee's knowledge was addressed, and furthermore, it was determined whether or not digital marketing strategies exist within each social organization.

Considering the answers to the interview questions, only one organization ("Organization C") does not know what digital marketing is; all the others know what it is, and some even mention what they understand it to be. This is the case with "Organization B":

> *Therefore, for me, the notion I have of digital marketing is essentially the way in which the institution has to promote itself through the media, there it is, social networks, pamphlets, our vans that have logos with slogans, therefore, the news that we put out, whether for newspapers, radio, and television. So, it's the dissemination of our services and our activities that we do on a daily basis (Quality, Communication and Image Advisor, interview, May 26, 2022).*

"Organization E" mentions it as being a: "Form of communication through the internet, to publicize services and increase the network of relationships" (Technical Director, interview, June 14, 2022).

And "Organization F" states that "Digital marketing is the process of attracting customers and identifying, anticipating and satisfying their needs and desires, through the internet and devices with a digital base, such as computers, smartphones or tablets" (President of the Board, interview, June 3, 2022).

Regarding the question about each interviewee's view on new technologies/digital tools/digital marketing, the opinions are like each other.

Most of the organizations state that digital tools promote the dissemination of their services and mention the speed and usefulness that they present. It is also mentioned that they are important for attracting clients, expanding knowledge, revitalizing the social services they offer, contributing to a higher quality of work developed, and for being tools that enable clearer and more efficient communication. Only one organization ("Organization C") has no knowledge in this area.

In relation to the question about the digital marketing tools they know, the most common answers were, without a doubt, social networks (Facebook, Instagram, Twitter and WhatsApp) and websites, but some also mentioned advertisements in Apps.

Concerning the importance that the use of digital tools has for the strategic visibility of the organization, the answers were all very similar, given that everyone addressed the issue of it being very and increasingly important to use this type of tool, since it promotes the organization and publicizes the services they provide. In other words, the use of these tools' fits into the organization's strategy, to publicize the work and daily activities they develop.

The last question of the third part of the interview serves to understand which social organizations have a defined strategy in digital marketing. Out of the 8 institutions interviewed, only 2 mentions having a developed digital marketing strategy. These are "Organization E" and "Organization F."

Of the Social Organizations interviewed, only two state that they have a defined digital marketing strategy. Both the strategy of "Organization E" and the strategy of "Organization F" involve using social networks and the website to publicize their services and the activities they develop. It is observed which digital tools they use to promote their visibility. Everyone answered Facebook and the Website, and "Organization E" mentioned the use of WhatsApp.

When these strategies were implemented, the impact was positive, considering the response from "Organization E," and allowed greater community involvement in the organization's activities, as "Organization F" reports. Regarding the difficulties they experienced, "Organization E" says that there were none, and "Organization F" states that the biggest difficulty was sensitizing employees to the importance of the strategies they intended to implement. Despite this, both organizations mention that there are no disadvantages, only advantages. "Organization E" reports advantages in terms of increased communication and networking and also advantages in terms of the organization's visibility to the outside world. And "Organization F" states that the advantages they feel are in terms of publicizing the services available to help solve problems in the surrounding community and their activities.

Regarding the question about the Covid-19 pandemic, "Organization E" states that it changed digital marketing strategies, but they had a good adaptation. This change is due to the social distancing that existed and the adaptation and existence of new techniques such as videoconferences and online training. "Organization F," on the other hand, says that the pandemic did not change the strategy. This leads to the conclusion that they already had digital strategies implemented before the pandemic.

As for the factors that differentiate and distinguish these two organizations from the others, they are: regarding "Organization E," the equivalence with other organizations in the municipality, and in "Organization F," the wide range of services provided, the specialized technicians, and the pleasant outdoor spaces.

Checking now the social organizations in the municipality of Vagos that do not have a digital marketing strategy, out of the 8 interviewed, 6 do not have any strategy outlined in this area. It was found that there are no digital marketing strategies for various reasons, such as lack of specialized support, lack of knowledge, and because it is not a priority, with the focus being on other issues. However, the majority state that they would like the organization to have digital marketing as a way to publicize and promote the institution's work, and others state that they do not have much knowledge and would have to analyze the advantages and disadvantages.

Regarding the advantages that it could bring to the organization, the professionals say that it would help with visibility and dissemination, so that the community knows what is done within the organization, and it is also important due to the fact that having a structured and detailed plan helps in following the outlined objectives. Regarding the question about how the non-use of digital tools influences the organization's strategy, the answers are divided between not having formed opinions and stating that not using

digital tools greatly influences and hinders dissemination, because people do not know about them.

Concerning the question about the means they use to publicize their services to the community, the answers were mainly Facebook, the website, and word of mouth. In other words, despite being organizations without a defined digital marketing strategy, there is an awareness that it is important to have something at the digital level that promotes them, and in this case, the option that best helps them is Facebook, since it is a free and easily accessible and manageable social network.

Finally, the last question refers to what distinguishes each organization from the others. The answers were divided:

- "Organization A" replied that what differentiates it is the use of two online platforms: "MySenior" and "Educabiz." These are platforms, one at the level of the elderly and the other at the level of children, respectively, that allow for the computerization and access to daily records of the activities of users and children, thus helping professionals, family members of the elderly, and guardians of the children.
- "Organization B" responds that it focuses on differentiating social services, thus having projects that other institutions do not have. "Organization C" talks about the service provided and its human resources, as do "Organization G" and "Organization H," which also mention as a differentiator, the quality of their services and the professionalism and dedication of the employees. "Organization D" says that the factors that differentiate it is the fact that they have a traditional and family-oriented service. In other words, everyone knows each other, the environment where it is located is small, and the service provided is very homely. This justifies the fact that it is the smallest organization, as we saw earlier.

Through the answers obtained from the interviews, we verified that, although most organizations do not have a defined digital marketing strategy, both these and those that have strategies use certain digital tools. The most talked about were Facebook and the Website. Thus, we will try to understand the return that institutions can obtain with their use and the impact it will have on the organization.

- "Organization A" refers to the use of Facebook and the Website. Analysing their Facebook page, it appears somewhat outdated in terms of publications. It is an institution that does not frequently use it, and when it does, it is to share notices, information, and some activities carried out with children and the elderly. Their Facebook page provides the location, telephone number, email, and the link to their website. Regarding the number of likes, "Organization A" has 782 likes (Organization A, 2022). Concerning their website, the institution presents a simple page, with only 4 tabs, one about the social center, including information about the history, social bodies, mission, vision and values, management reports, activity plan, and code of conduct. Another tab about the social services they offer to the community. A tab called news, where they publish some information. Finally, a tab with the organization's contacts. This institution's website possibly does not have much reach, since when searching in the search engine, it does not appear prominently.
- "Organization B" uses tools such as Facebook, Instagram, and the Website. This institution's Facebook has a total of 4275 likes (Organization B, 2022a). They have a fairly

updated page, always with references to activities carried out with users and children, publication of events and news. It also includes information about the organization, as well as its email and website. The Instagram page has 648 followers (Organization B, 2022b), with the content being the same as that of Facebook. The website is quite intuitive and easy to use, standing out when searching in the search engine. The website has 7 tabs, including the homepage, where all the synthesized information is understood. One about the institution, including aspects of history, organization chart, provider's message, mission, vision and values, quality policy, and official documents. Another tab about the areas of intervention, mentioning all the social services they offer. Another regarding culture. Another with the digital newspaper. Another with partnerships, and finally one with the organization's contacts.

- "Organization C" uses Facebook and the website, even though the latter was not mentioned during the interview. As for Facebook, this institution reaches approximately 1200 likes (Organization C, 2022). They only provide the location and use this platform to share activities carried out within the institution. This organization's website is divided into 6 tabs. The first is about the organization, subdivided into topics such as history, mission, vision and values, organization chart, social bodies, types of services, educational project, and accounts. Followed by 4 tabs that refer to the existing social services. And the last one presents the contacts. This website, despite appearing prominently in the search engine, we observe that it has a simple and unappealing page. We also observe that it is out of date, since it does not present more financial reports after the year 2019 and the regulations of the social services are from 2017/2018.
- "Organization D," they are only present on Facebook, which they created recently. They only have 538 likes (Organization D, 2022). On this social network, they present information about the location, telephone number, and email of the organization, using it to share the daily activities carried out with the children.
- "Organization E," their main digital means are Facebook and the website. Facebook has approximately 1300 likes (Organization E, 2022). This page mentions information about the location, telephone number, email, and the link to the website. They also make publications of the activities that take place throughout the day in the institution. The website is divided into 4 tabs. The first is about the history and financial reports. The second concerns the services that the organization offers. The third is about the activities carried out, and finally, the last tab refers to the contacts. It appears first when searched in the search engine and presents a simple page.
- "Organization F" mentions Facebook and the website as the main digital tools used to publicize their services. Facebook has 1962 likes (Organization F, 2022), including information such as the location, telephone contact, email, and the website. They are used to promote the activities carried out within the institution. As for the website, it includes 4 divisions, one about the institution, another about the official documents, another concerns the services they provide, and the last one refers to the organization's contacts, being appealing and when searched in the search engine, it stands out first.
- "Organization G" only refers to word of mouth as the main means of dissemination, however, they use Facebook and the Website as complements. This organization's Facebook has 801 likes (Organization G, 2022), informing the community with the

location, telephone number, and email. This institution shares the moments and activities carried out with children and the elderly. Regarding the website, it contains a simple page and does not appear prominently when searched. It is divided into 4 tabs, the first being the homepage, the second the history of the social organization, the third refers to the documents, and the last one is about the contacts.

- "Organization H," they state that the means used for their dissemination is only Facebook. This institution's Facebook page has approximately 1200 likes (Organization H, 2022) and is only used for the dissemination of certain activities carried out in the organization.

5 Conclusions

Regarding the objectives, we find that digital marketing tools in social organizations are important, insofar as they allow for greater dissemination of activities and services, making their purpose known to clients and the community in general. In addition to dissemination, they also manage to maintain and create new partnerships, receive feedback, and communicate more easily and quickly with stakeholders.

It was found that not all social organizations in the municipality of Vagos value digital marketing. However, there is the future possibility of creating digital strategies, in addition to there being awareness and interest on the part of some organizations regarding this topic. Even without having defined strategies, they all use social networks to promote their organization.

The limitations of this study are mainly because there is little literature with regard to the association of digital marketing with the Third Sector. The reduced number of organizations reflects the need for more and better organizations in the social field. Notwithstanding the reduced number of organizations, this study is crucial for the development of both organizations and the region. Another limitation is the lack of information and documentation that these organizations have, which makes it difficult to obtain data.

As future research, it is suggested to develop comparative studies between regions, between segments of social organizations, and national-level studies, to understand the evolution and knowledge of new strategies and tools, replicating this study with third-sector organizations with different sizes and markets, as well as with new variables.

In conclusion, with this article we were able to perceive how organizations view digital in their daily lives and the impact it has. Including, we verified that there is still a long way to go, regarding the development of this theme in the Third Sector.

Acknowledgments. This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Refª UIDB/05507/2020. Furthermore, we would like to thank the Centre for Studies in Education and Innovation (CI&DEI) and the Polytechnic of Viseu for their support.

This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Ref. UIDB/05583/2020. Furthermore, we would like to thank the Research Centre in Digital Services (CISeD) and the Instituto Politécnico de Viseu for their support.

This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Ref. UIDB/05583/2020. Furthermore, we would like to thank the Research Centre CERNAS and the Instituto Politécnico de Viseu for their support.

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Internship as a Strategy for Approaching the Job Market and Industry: The Case of the Fishing Traditions in São Vicente (Cape Verde)

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Abstract. This paper explores the critical role of internships and international student mobility in higher education, emphasizing their significance in preparing students for the evolving job market. As higher education institutions (HEIs) face increasing pressure to align academic training with industry demands, the integration of practical experiences through internships emerges as a vital strategy. These experiences not only enhance students' technical and behavioral skills but also foster personal and professional development, thereby improving the overall quality of education. Furthermore, international student mobility is highlighted as a transformative opportunity that equips students with intercultural competencies and enhances their employability. By facilitating a continuous dialogue between HEIs and the job market, this paper advocates for a proactive approach in shaping educational curricula that respond to market needs. The findings underscore the necessity for HEIs to adapt and innovate in their educational practices, ensuring that graduates are well-prepared to navigate the complexities of the modern workforce. This study contributes to the ongoing discourse on digital transformation in education, illustrating how strategic partnerships and experiential learning can drive institutional success and student outcomes.

Keywords: Digital Transformation · Higher Education · Internship

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 390–398, 2025.
https://doi.org/10.1007/978-3-032-09080-5_39

1 Introduction

The text presented provides an in-depth exploration of the role of internships and international student mobility in higher education, particularly in the context of preparing students for the job market and fostering their professional development. The introduction highlights the importance of the curricular internship as an educational practice that allows students to apply theoretical knowledge to real-world work situations, thereby developing essential professional competencies and facilitating their integration into the job market.

The text delves into the complex relationship between higher education institutions (HEIs) and the job market/industry, acknowledging the need for continuous dialogue and collaboration to ensure that academic training aligns with the evolving demands of the labor market. The authors emphasize the importance of HEIs not only responding to market demands but also proactively shaping them, through initiatives such as supervised internships and the integration of theory and practice.

The paper further explores the various benefits of the curricular internship, including the development of technical and behavioral skills, the integration of theory and practice, the enhancement of employability, and the contribution to personal and professional growth. Additionally, the text highlights the positive impact of internships on the quality of higher education, as they allow for the continuous improvement of academic curricula and the establishment of partnerships between educational institutions and the industry.

The discussion then shifts to the topic of international student mobility, which has become an increasingly common practice in higher education. The text outlines the numerous advantages of international mobility, such as the development of intercultural competencies, the improvement of academic performance, the increase in employment opportunities, and the enhancement of specific professional competencies. The authors also acknowledge the positive impact of international mobility on the quality of higher education, as it enables students to evaluate the relevance and applicability of academic content in a global context.

The core of the paper is the presentation of a case study focused on an internship experience abroad, specifically at the National Institute of Statistics of Cabo Verde. This internship project aimed to document and preserve the informational and cultural heritage of the fishing communities in São Vicente, a region known for its rich maritime culture. The text details the various tasks undertaken during the internship, including information gathering, qualitative data collection, and data analysis, which led to the preparation of a final report with recommendations for the preservation and promotion of the fishing communities' heritage.

The internship experience is described as a transformative journey that allowed the student to apply theoretical knowledge in a real-world context and reinforced the importance of cultural heritage preservation and the role of information professionals in facilitating this process.

2 The Relationship Between Higher Education Institutions and the Job Market/Industry

The relationship between higher education institutions and the job market has become a central theme in academic discussions, especially in a context of rapid changes like the current one. We are facing a complex scenario, where higher education institutions (HEIs) are challenged to adapt to market demands, while preserving their educational and social function.

Peciar (2009) discusses how the acceleration of the industrial process and the demands of neoliberalism have led HEIs to focus on technological improvement that meets market demands. This change, although necessary, raises questions about academic autonomy and the true purpose of science, which, according to the author, should go beyond meeting immediate economic interests. The author argues that HEIs should prepare a new profile of worker, capable of adapting to the flexibility of the new production pattern, which reinforces the need for an educational model that proactively responds to market requirements.

In turn, Lima, Alves, and Alves (2012) emphasize that professional training should not only respond to market demands, but also create them. They propose a reevaluation of the guidelines for higher education in Brazil, suggesting that practice should be closely linked to theory, as exemplified by supervised internships. The authors defend the importance of aligning pedagogical projects with the business reality, promoting a synergy that favors the training of professionals better prepared for the job market.

Hoff, Pereira, and Paula (2016) expand this discussion by highlighting the role of public HEIs in regional development. The authors state that these institutions should not be seen only as sources of knowledge, but also as agents of innovation that interact with the community and the market. This perspective is fundamental for the construction of a higher education that acts in an interdisciplinary way, contributing to the economic, social, and cultural development of the region where it is inserted and that creates and develops networks in other regions of the country and the world.

Rosa, Nitibailoff, and Macedo (2019), on the other hand, address the interaction between companies and universities as a strategy to improve the quality of academic training. They emphasize the importance of the proximity of academics to the business environment, highlighting that this interaction not only facilitates the understanding of market dynamics, but also allows universities to contribute with diagnoses and proposals for improvements for companies. The creation of partnerships based on reciprocity is seen as a promising path to strengthen the ties between academia and the job market.

These contributions reveal the need for continuous dialogue between higher education institutions and the market, where both parties benefit and develop mutually, reflecting on the importance of training professionals who are not only qualified, but also critical and innovative.

Indeed, higher education institutions are increasingly challenged to balance academic integrity with the evolving demands of the job market. As detailed in the NMC Horizon Report (Johnson et al., 2016), there is a growing need for institutions to strategically integrate digital tools and emerging technologies into learning processes.

This integration not only enhances technical proficiency but also prepares students for the multifaceted nature of contemporary workplaces. By adopting supervised internships

and real-world projects, HEIs create environments where theoretical learning meets practical application. This proactive approach addresses market needs and cultivates future-ready graduates, ensuring that educational experiences are both dynamic and relevant, while still preserving the social and intellectual missions of academic institutions.

3 Internship as an Empowering Strategy for Integration into the Job Market

The curricular internship in higher education is an educational practice that aims to provide students with the opportunity to apply the theoretical knowledge acquired in the classroom to real work situations. This experience is fundamental for the development of professional competencies and for integration into the job market. Recent studies have shown that the curricular internship has a significant positive impact on the professional performance of graduates, contributing to the formation of more prepared and competitive professionals.

3.1 Development of Professional Competencies

The curricular internship allows students to develop technical and behavioral skills essential for professional practice. According to Souza et al. (2024), internships provide a practical learning environment where students can improve specific skills in their area of study, such as problem-solving, decision-making, and effective communication. In addition, internships help develop transversal competencies, such as teamwork, leadership, and adaptability, which are highly valued in the job market (Souza et al., 2024).

3.2 Integration of Theory and Practice

The integration of theory and practice is one of the main benefits of the curricular internship. According to Teixeira (2022), internships allow students to apply the theoretical knowledge acquired during the course in practical situations, which facilitates the understanding and retention of the content. This integration is fundamental for the training of professionals capable of acting in a critical and reflective way, adapting to the demands of the job market (Teixeira, 2022).

3.3 Integration into the Job Market

Curricular internships play a crucial role in the integration of students into the job market. Studies show that the internship experience significantly increases the employability of graduates. Macedo de Souza et al. (2024) highlight that students who complete internships are more likely to find a job in their field of study, as they already have practical experience and are familiar with the dynamics of the work environment. In addition, internships allow students to build professional networks, which can facilitate their integration into the job market (Macedo de Souza et al., 2024).

3.4 Personal and Professional Development

The curricular internship also contributes to the personal development of students. The internship experience allows students to face real challenges, which promotes personal growth and self-confidence. According to Teixeira (2022), internships help students develop a better understanding of their own skills and limitations, which is essential for continuous professional development. In addition, the internship experience can help students better define their professional goals and interests, contributing to a more satisfying and successful career (Teixeira, 2022).

3.5 Contribution to the Quality of Higher Education

Curricular internships also have a positive impact on the quality of higher education. The practical experience provided by internships allows students to evaluate the relevance and applicability of the theoretical content taught in educational institutions. This can lead to continuous improvement of academic curricula, making them more aligned with the needs of the job market. In addition, internships allow educational institutions to establish partnerships with companies and organizations, which can result in mutual benefits, such as the updating of curricular content and the offer of internship opportunities for students (Souza et al., 2024).

Internships have emerged as powerful conduits for student empowerment and professional integration. According to insights from Selwyn (2016), curricular internships enrich the learning experience by blending theory with hands-on practice, ultimately boosting both technical and behavioral skills required in today's digital workforce. The strategic use of digital platforms in managing and coordinating internship opportunities enhances learning outcomes and fosters closer ties between education and industry.

These platforms facilitate effective communication and collaboration, allowing students to access cutting-edge resources and industry insights regardless of geographic boundaries. Such efforts not only support the seamless integration of academic knowledge with professional expertise but also encourage continual dialogue between industry and academia.

4 International Student Mobility

International student mobility has become an increasingly common practice in higher education, providing students with the opportunity to study in different countries and cultures. This experience can have a significant impact on the professional development of students, preparing them to face the challenges of the globalized job market. Recent studies have shown that international mobility offers several benefits that contribute to the improvement of professional skills and successful integration into the job market.

4.1 Development of Intercultural Competencies

International mobility allows students to develop intercultural competencies essential for the global job market. According to Hanley et al. (2025), the experience of studying in a

foreign country helps students understand and appreciate different cultures, promoting empathy and adaptability. These competencies are highly valued by employers who seek professionals capable of working in multicultural environments and establishing effective international relationships (Hanley et al., 2025).

4.2 Improvement of Academic Performance

Studies indicate that international mobility can improve the academic performance of students. Granja and Visentin (2023) found that students who participate in international mobility programs tend to obtain better grades and develop a greater understanding of academic content. This occurs because the experience of studying abroad challenges students to adapt to new educational systems and develop more effective study skills (Granja & Visentin, 2023).

4.3 Increase in Employment Opportunities

The experience of international mobility can significantly increase the employment opportunities of students. Gutema et al. (2024) highlight that employers value international experience as an indicator of skills such as independence, initiative, and problem-solving ability. In addition, students who study abroad have the opportunity to build international professional networks, which can facilitate their integration into the global job market (Gutema et al., 2024).

4.4 Development of Professional Competencies

International mobility also contributes to the development of specific professional competencies. Hanley et al. (2025) state that international mobility programs allow students to acquire knowledge and skills that are directly applicable to their future careers. For example, students may learn new work techniques and methodologies, as well as develop communication and negotiation skills in an international context (Hanley et al., 2025).

4.5 Impact on the Quality of Higher Education

International mobility has a positive impact on the quality of higher education. According to Granja and Visentin (2023), the experience of studying abroad allows students to evaluate the relevance and applicability of the academic content taught in their home institutions. This can lead to continuous improvement of academic curricula, making them more aligned with the needs of the global job market (Granja & Visentin, 2023).

International student mobility plays a pivotal role in equipping graduates with a global perspective, essential in an increasingly digitalized economy. Both the NMC Horizon Report and the discussions by Selwyn highlight that exposure to diverse cultural and professional environments via mobility programs significantly broadens students' outlook. Digital transformation in global education has made international collaboration more accessible, enabling institutions to host virtual internships and cross-border

projects that enrich educational trajectories. These experiences foster adaptability, cultural competency, and innovative problem-solving capabilities, contributing to the development of future leaders. Through the integration of digital tools supporting international engagement, HEIs can build resilient, globally connected learning communities that drive continuous innovation in teaching, research, and professional practice.

5 Internship Experience Abroad

During the internship at the National Institute of Statistics of Cabo Verde, student had a unique opportunity to engage in a project that focused on documenting and preserving the informational and cultural heritage of the fishing communities in São Vicente.

This region, known for its rich maritime culture, faces numerous challenges that threaten its traditional practices and livelihoods. The fishing communities here are not only vital for the local economy but also play a crucial role in maintaining the cultural identity of the island.

The project aimed to gather comprehensive data on the fishing sector, which is essential for understanding the socio-economic dynamics of these communities. To achieve this, the student undertook several key tasks such as:

- information gathering, which involved collecting and analyzing statistical reports from the National Institute of Statistics of Cabo Verde (INE-CV) and biodiversity reports from the Institute of the Sea (IMar). These documents provided valuable insights into the current state of the fishing industry, including trends in fish catches, the economic impact of fishing on local communities, and the environmental challenges faced by the sector.
- qualitative data collection. Student conducted semi-structured interviews with representatives from IMar and a Spanish NGO involved in sustainable development projects in the fishing communities of São Vicente. These interviews were instrumental in capturing the qualitative aspects of the fishing industry, such as the experiences and perspectives of local fishermen, the challenges they face, and their aspirations for the future. Engaging with stakeholders allowed me to understand the complexities of the fishing sector and the importance of collaboration among various entities to address the issues at hand.

The data analysis phase was particularly enlightening. The collected data was analyzed to identify patterns and trends that emphasized the challenges faced by the fishing communities in São Vicente. One significant finding was the decline in fish catches over the years, which has been attributed to overfishing, climate change, and inadequate infrastructure. Many fishermen expressed concerns about the lack of safety equipment and the need for generational renewal in the fishing profession, as younger individuals are often reluctant to pursue careers in this field due to the associated risks and economic instability.

Even with a high degree of traditionalism, according to Branco (2018), these communities are increasingly joining cooperatives, unions, and/or associations that advocate for some of their interests, leading them to participate in decisive processes regarding fishery management, thereby enhancing the value of cooperative management and participation in small-scale fishing. In other words, a symbiotic relationship was found;

that is, the communities possess traditional ecological knowledge stemming from local observations and experiences.

For Sousa et al. (2022), this knowledge can be passed down from generation to generation as a means of adapting to changes in the marine ecosystem and, at the same time, shared with associations or institutions to identify and monitor species in reduced numbers. That is why this is a fundamental partnership for the sustainability of fisheries, allowing for the adoption of more conscious and sustainable practices. Thus, associations benefit from the practical and detailed knowledge of fishermen, while fishing communities gain a voice and influence in the management of ocean resources, promoting a more balanced and sustainable fishing industry. Sustainable cultural tourism is relevant in the current context, and the European Commission (2021) assumes that sustainable local tourism places cultural heritage and local communities at the center of decision-making processes, ensuring good practices of conservation and sustainability, not only economic but also cultural, associated with an authentic interpretation that supports the local economy.

The culmination of the internship was the preparation of a final report that synthesized the findings from the research. This report included a review of the relevant literature on cultural heritage management and the role of information professionals in such projects. Recommendations were provided for the preservation and promotion of the informational and cultural heritage of the fishing communities in São Vicente. These recommendations emphasized the need for sustainable fishing practices, improved infrastructure, and enhanced training programs for young fishermen to ensure the continuity of traditional practices.

Throughout this internship, a range of skills were developed that are invaluable for the student professional growth. Abilities in qualitative data collection and analysis were honed, which are essential for conducting thorough research. The experience also enhanced stakeholder engagement and collaboration skills, and improved students ability to navigate the complexities of working with various organizations and individuals. Additionally, improvements in report writing and presentation skills were obtained, which are crucial for effectively communicating research findings to diverse audiences.

The overall impact of this internship was profound. It not only increased the awareness of the challenges faced by the fishing communities in São Vicente but also highlighted the importance of preserving their informational and cultural heritage. The project underscored the need for stronger collaboration between institutions, such as IMar and NGOs, to ensure the long-term sustainability of the fishing industry and the well-being of local communities.

The internship also enabled a deeper understanding of the intersection between cultural heritage and sustainable development, and promoted a profound committed to advocating for the preservation of these vital communities in the future.

6 Conclusion

The conclusions of the paper emphasize the crucial role of the curricular internship in higher education, as it prepares students for the job market, provides them with practical experiences, develops essential competencies, and increases their confidence and employability.

From a critical perspective, the paper presents a well-structured and comprehensive analysis of the topic, drawing on a solid theoretical foundation and empirical evidence. The authors effectively integrate the discussion of internships and international student mobility, demonstrating their interconnectedness and the synergistic benefits they offer for student development and the quality of higher education.

The case study presented provides a valuable and contextualized example of the practical application of the concepts discussed, offering insights into the challenges and opportunities faced by fishing communities in Cabo Verde and the role of information professionals in preserving their cultural heritage. The detailed description of the internship tasks and the resulting recommendations further strengthen the paper's contribution to the field.

The authors also highlight the potential for future work to maintain internship experiences, with a focus on mobility contexts, therefore, future work relates to the maintenance of internship experiences, with the intention that some occur in a mobility context.

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Analysis of the Impact of VR and AR Technologies in Italian Cultural Contexts

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Abstract. This study investigates the impact of Virtual Reality (VR) and Augmented Reality (AR) technologies on visitor engagement at Italian cultural heritage sites. The research aims to understand the potential of immersive technologies to enhance cultural appreciation and identify factors affecting their adoption. An online survey distributed through social media and at selected cultural sites collected responses from 190 participants. The findings reveal mixed levels of interest in VR/AR, with many respondents expressing curiosity but limited familiarity. Key barriers to adoption include cost and low awareness, though users report high satisfaction, particularly regarding information clarity and cultural enrichment. The study suggests enhancing VR/AR offerings, implementing flexible pricing strategies, and launching targeted educational initiatives to boost familiarity. Future research should explore the long-term impact of VR/AR on visitor behavior and its influence on heritage preservation policies.

Keywords: augmented reality · cultural heritage · Tourism 4.0 · virtual reality · virtual Tourism

1 Introduction and Literature Note

The integration of Augmented Reality (AR) and Virtual Reality (VR) technologies has become a transformative force in cultural heritage, reshaping how visitors interact with historical and artistic narratives (Bekele & Champion, 2019). By enhancing physical environments with digital overlays (AR) or immersing users in entirely virtual spaces (VR), these technologies create new opportunities for engagement, learning, and preservation. Particularly in the context of cultural tourism, AR and VR enable visitors to experience destinations in unprecedented ways, making intangible aspects of heritage accessible while preserving fragile sites. In recent years, AR and VR have demonstrated

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 399–410, 2025.
https://doi.org/10.1007/978-3-032-09080-5_40

their potential across various applications, including museums, archaeological parks and city tours. They enrich storytelling, make content more accessible to diverse audiences, and address challenges such as limited access to artifacts or the fragility of certain locations. For instance, interactive digital reconstructions allow visitors to envision historical contexts, while VR tours open remote or restricted areas to global audiences (De Paolis et al. 2023; Younes et al., 2017; Tscheu & Buhalis, 2016; Tom Dieck & Jung, 2016). Yet, the adoption of these technologies in cultural heritage is not without challenges. High development costs, the need for technical expertise, and the integration of technology into traditional heritage management systems remain significant barriers (Tsai et al., 2017; Tom Dieck & Jung, 2015).

Home to an unparalleled wealth of cultural and historical assets, Italy presents both opportunities and challenges for AR and VR adoption (Carrozzino & Bergamasco 2010). Italian cultural institutions have begun to explore these technologies, but the implementation remains inconsistent. Museums, galleries, and archaeological sites across the country are increasingly integrating immersive experiences to attract and engage audiences. Projects such as the Hidden Florence app and the Smart City Living Lab in Syracuse showcase the potential of AR to provide innovative visitor experiences while addressing broader issues like overtourism and heritage conservation. However, these initiatives also underscore the need for sustainable funding and long-term planning, as seen in the deactivation of AR totems in Syracuse due to financial constraints (Graziano & Privitera, 2020).

Academic literature highlights key areas where AR and VR can contribute to cultural heritage. Di Pietro et al. (2018) distinguish between two primary approaches: online initiatives that enhance digital interactions and on-site applications that augment the physical visitor experience. Both approaches require careful consideration of audience needs and the unique characteristics of heritage sites. In the Italian context, Miccio (2007) stresses the importance of aligning cultural and economic goals through digital innovation, coining the term "massification of elitism" to describe the democratization of high culture via technology. While these frameworks emphasize the potential of AR and VR, they also reveal gaps in Italy's readiness to fully embrace digital transformation. Many cultural sites still lack basic digital tools, highlighting the need for greater investment and strategic planning. Examples from Italian heritage sites illustrate both the promise and complexity of integrating AR and VR. In Pisa, the TowerAR app allows visitors to explore the Piazza dei Miracoli through 3D reconstructions spanning different historical periods, receiving high marks for usability and enjoyment (Duguleana et al., 2016). Similarly, the Capitoline Museums in Rome employ VR to recreate ancient cityscapes, offering visitors an immersive perspective on the evolution of Rome. These cases demonstrate how AR and VR can bridge the gap between past and present, engaging audiences with dynamic interpretations of history and culture.

Despite these successes, challenges persist. Many initiatives face technical, financial, and logistical hurdles, such as maintaining digital installations or ensuring accessibility for diverse audiences. Projects like Hidden Florence (Nevola & Rosenthal, 2016) and its successor, Hidden Cities, illustrate the potential for AR to extend beyond physical boundaries, reaching global audiences through remote, app-based experiences. However,

as Nevola et al. (2022) point out, the adoption of AR technologies has been gradual and requires sustained commitment from stakeholders.

This paper seeks to contribute to the growing body of research on AR and VR in cultural heritage, with a specific focus on the Italian context. We aim to examine how these technologies are being adopted across Italy's rich landscape of museums and cultural sites, exploring their potential and the barriers they face. To do so, we conducted a comprehensive analysis of Italian cultural institutions and a survey to gauge public perceptions and experiences with AR and VR.

The paper is structured as follows: in Section 2, we explore the integration of immersive technologies into Italian cultural heritage; Section 3 describes the methodology applied in the survey, and the main findings are discussed in Section 4. Finally, we conclude with reflections and future perspectives in the last section.

2 Overview of Immersive Technologies in Italian Museums and Cultural Heritage

This section provides an overview of the main museums and cultural heritage sites in Italy, exploring their types, geographical distribution, and the growing adoption of immersive technologies. We conducted this overview by analyzing the official websites of Italian museums and cultural heritage sites and by directly contacting Regional Directorates and individual museums, particularly those with autonomous governance. This preliminary research, conducted from October 7 to November 7, 2024, laid the foundation for designing the survey and contextualizing its findings. With its wealth of cultural assets, Italy is home to a diverse range of museum institutions and sites dedicated to preserving historical, artistic, and cultural heritage. As such, this section not only analyzes the main types of museums and cultural sites but also highlights the increasing integration of advanced technologies such as Virtual Reality (VR) and Augmented Reality (AR), which are reshaping the museum experience.

Italy boasts one of the richest collections of cultural and artistic heritage in the world, with a significant portion housed in various institutions and places of interest. Many of these works are located outdoors, in archaeological parks and public spaces in historic cities, including squares, fountains, and city walls. Others are housed inside churches, museums, castles, libraries, and other historical sites. The works are found in both public institutions, managed by the Italian Ministry of Culture (MIC), and private spaces, including foundations and private collections. Italian museums are distinguished by their focus and cultural offerings, which can be categorized as follows:

- National Archaeological Museums (MAN): Dedicated to the conservation and enhancement of archaeological finds, often organized by historical periods or geographical regions.
- Art Museums: Housing works of artistic value, from paintings and sculptures to photography and graphics, including civic galleries and private collections open to the public.
- Science and Technology Museums: Focusing on scientific discoveries, innovations, and technological advancements throughout history.

- Civic Museums: Often dedicated to the history and cultural evolution of a specific city or region, with an emphasis on local art, culture, and traditions.
- Castles and Fortresses: Originally built for military purposes, these sites now hold historical, artistic, and cultural value. Many castles house collections of medieval art, armor, weapons, and artifacts from their past.
- Archaeological Parks: Dedicated to the conservation of archaeological remains of ancient civilizations, such as temples, theaters, and sacred areas. These parks are often located near archaeological museums, where artifacts uncovered during excavations are displayed.

The following overview sets the stage for investigating the role of immersive technologies in enhancing the visitor experience in these diverse institutions (Table 1).

Table 1. Italian museums and cultural sites using immersive technologies by type and location

Museum/Heritage Site	Museum Type	Location (Region/Area)	VR/AR	Mode of Use
MAN "La Civitella"	Archaeological Museum	Abruzzo—Chieti	AR	Immersive experiences with AR
Castel del Monte	Castle	Apulia—Andria	AR	Immersive experiences with AR
Castello Normanno-Svevo	Castle	Apulia—Bari	AR	Interactive visits with AR app
MAN "Dinu Adamesteanu"	Archaeological Museum	Apulia—Taranto	AR	Mobile app with AR to explore artifacts
Parco delle Chiese Rupestri di Matera	Archaeological Park	Basilicata—Matera	VR, AR	Virtual and interactive tour with AR/VR
MAN Policoro	Archaeological Museum	Basilicata—Policoro	VR	Virtual tours and 3D visualization
MAN di Reggio Calabria	Archaeological Museum	Calabria—Reggio Calabria	AR	Immersive experiences with AR
Parco Archeologico di Scolacium	Archaeological Park	Calabria—Borgia	AR	3D visualization and AR interaction

(*continued*)

Table 1. (*continued*)

Museum/Heritage Site	Museum Type	Location (Region/Area)	VR/AR	Mode of Use
MAN—Napoli	Archaeological Museum	Campania—Naples	AR, VR	Virtual tours and interactive experiences
Scavi di Pompei	Archaeological Site	Campania—Pompei	VR	Virtual reconstruction of excavations
Cappella Sistina	Sacred Site	Vatican City	VR	Virtual tour of the Sistine Chapel
Colosseo	Archaeological Park	Lazio—Rome	VR, AR	AR/VR virtual tour
Mercati di Traiano	Archaeological Museum	Lazio—Rome	AR	Interactive AR tour
Musei Capitolini	Art/Archaeological Museum	Lazio—Rome	AR, VR	Virtual tour and interactive details
Necropoli etrusche	Archaeological Park	Lazio—Tarquinia	VR	3D reconstruction with VR
Villae (Villa Adriana, Villa d'Este)	Archaeological Park	Lazio—Tivoli	AR	AR visualization of ancient remains
Via Appia Antica	Archaeological Park	Lazio—Rome	AR, VR	Interactive AR/VR app for the ancient site
Museo della Scienza e della Tecnologia "Leonardo da Vinci"	Science and Technology Museum	Lombardy—Milan	VR, AR	Interactive exhibits with AR/VR
Museo Vincenzo Bellini	Civic Museum	Sicily—Catania	AR	Immersive experiences with AR
Antiquarium Turritano	Archaeological Museum	Sardinia—Porto Torres	VR, AR	Immersive experiences with VR and AR
Museo multimedievale Narni	Historical Museum	Umbria—Narni	VR	Virtual medieval tour

(*continued*)

Table 1. (*continued*)

Museum/Heritage Site	Museum Type	Location (Region/Area)	VR/AR	Mode of Use
Beata Lucia Foundation	Sacred Site	Umbria—Narni	AR	Immersive experiences with AR and app
Narni Sotterranea	Archaeological Museum	Umbria—Narni	AR	Storytelling with AR
MUSE Museo delle Scienze di Trento	Science and Technology Museum	Trentino-Alto Adige—Trento	VR, AR	Interactive exhibits with AR/VR
Museo delle Palafitte di Fiavé	Archaeological Museum	Trentino-Alto Adige—Fiavé	VR, AR	AR visualization and virtual tours
MAN Adria	Archaeological Museum	Veneto—Adria	AR	AR visualization of blown glass
M9 Novecento	Thematic Museum	Veneto—Mestre	AR, VR	Virtual tours with AR/VR
MAN di Aquileia	Archaeological Museum	Friuli Venezia Giulia—Aquileia	AR	AR app to explore gemstones
Museo Egizio	Art Museum	Piedmont—Turin	VR, AR	Immersive exhibits with VR and AR
Galata Museo del Mare	Thematic Museum	Liguria—Genoa	VR	Virtual experience of maritime history
Forte di Bard	Art Museum	Aosta Valley—Bard	VR	Virtual reconstruction of mountain landscapes

3 Methodology

An online survey was conducted to explore the awareness and usage of VR and AR in Italian museums and cultural heritage sites. The survey was distributed through an anonymous questionnaire available in Italian and English, distributed via QR codes and links accessible from social media posts and stories on platforms like Facebook

and Instagram, and shared in Facebook groups dedicated to cultural heritage. This rapid method allows for the collection of preliminary data on the knowledge and use of immersive technologies applied to Italian museum and archaeological contexts. Through social media platforms, researchers are able to reach a large and geographically dispersed population, which was a real advantage for the current research, as both cultural sites as well as their visitors are spread across regions.

Additionally, we would like to thank the Italian museums and cultural sites that, after being contacted via official emails and phone calls, agreed to distribute the survey on-site using the poster and QR code: Castello di Rivoli Museo d'Arte Contemporanea (Rivoli, Turin), MUSAL Museo Albino Luciani (Canale d'Agordo, Belluno), Galleria Internazionale d'Arte Moderna Ca′ Pesaro (Venice) and Museo della Guerra Bianca Adamellina (Spiazzo Rendena, Trento).

3.1 Questionnaire Structure

Data collection was conducted through an online survey consisting of closed-ended questions with two or more response options. After the first question determining the participant's preferred language (Italian or English), the questionnaire was organized into two main sections:

1. Socio-Demographic Information: This section collects data on the participant's gender, age group, education level and nationality.
2. Experience and Opinions on Immersive Technologies: Participants are asked if they have experience with VR or AR at cultural heritage sites. If they answer yes, follow-up questions inquire about the mode of use (from home, at the museum, or both) and their satisfaction with the experience. If they answer no, the questionnaire explores whether the participant would be interested in using immersive technologies, for what purposes (e.g., 3D reconstructions, multimedia insights into artworks, etc.), with the option to choose more than one response. Finally, participants are asked how much they would be willing to pay for an immersive experience.

The questionnaire was created using Microsoft Forms. Participation was anonymous, and the data were used exclusively for research purposes, allowing minors to participate as it is not possible to trace the participant's identity. Between November 14 and December 28, 2024, 190 people responded to the questionnaire. The sample size and the sample-to-item ratio adhere to academic guidelines, thus ensuring the statistical validity of the research results. Considering the latest available Italian National Institute of Statistics (ISTAT) data regarding the number of visitors in Italian cultural sites, the formula for calculating sample sizes for finite populations was used:

$$n = \frac{N\, Z^2 p(1-p)}{e^2\, (N-1) + Z^2\, p(1-p)}$$

where:

- (n) is the sample size,
- (N) is the population size (57 million),

- (Z) is the Z-score corresponding to the desired confidence level (1.96 for 95% confidence),
- (p) is the estimated proportion of the population (commonly 0.5 if unknown),
- (e) is the acceptable margin of error (0.05 for 5%).

Using this formula, the ideal sample size would be approximately $n \approx 384$.

However, the 190 responses collected are considered sufficient based on established guidelines and the simplicity of the research model. This approach avoids the assumption that the data follow a normal distribution without performing a statistical test.

Considering the sample-to-item ratio, we align with Suhr (2006), who suggests that the ratio between the number of respondents and the number of items should be at least 5:1. Here, the 50 respondents who used VR/AR answered 11 items, giving a ratio of approximately 4.5:1, which is close to the suggested threshold. The 140 respondents who did not use VR/AR answered 5 items, with a ratio of 28:1, well above the minimum threshold.

4 Results and Discussion

The survey results provide a nuanced perspective on the current state of AR and VR technologies in Italian cultural heritage contexts, offering insights into visitor demographics, interests and experiences. The survey revealed a balanced gender distribution, with a slight majority of respondents identifying as female (55%). This finding resonates with prior studies that show women often exhibit higher engagement levels in cultural heritage settings (Housen, 1987). Regarding age, the largest group of respondents fell within the 55–64 age range, consistent with research suggesting middle-aged visitors are more likely to frequent museums and cultural sites than younger audiences (Del Chiappa et al., 2013). However, younger visitors are increasingly drawn to immersive technologies, highlighting a potential avenue for future engagement. Education levels among respondents predominantly reflected more than a high school background, with 100 participants (52.6%) citing a bachelor degree or higher as their highest level of education. This demographic mirrors broader trends, where educational attainment influences attitudes toward technology adoption in cultural contexts. Geographically, the vast majority of respondents (183 out of 190) resided in Italy, aligning with the local focus of the survey and underscoring the national scope of VR/AR technology adoption in cultural heritage. A significant finding was the limited familiarity with AR/VR technologies among respondents. Nearly 41% of participants indicated they were unfamiliar with these tools, a trend corroborated by other studies where lack of awareness remains a primary barrier to widespread adoption (Bekele & Champion, 2019). Moreover, 140 out of 190 respondents reported never having used AR/VR during visits to cultural heritage sites. This low adoption rate reflects broader patterns observed globally, where immersive technologies in heritage contexts are still in their nascent stages (Younes et al., 2017; Del Chiappa et al., 2013) (Fig. 1).

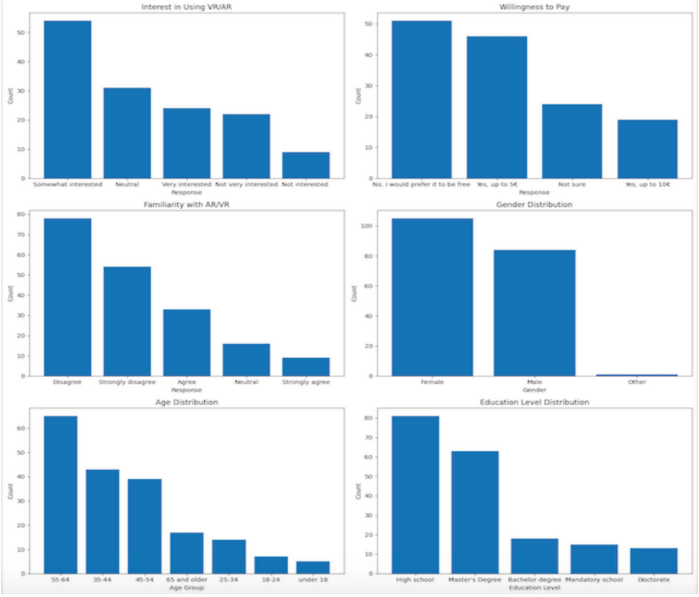

Fig. 1. Survey Results: Demographics and AR/VR Engagement. This figure shows six histograms, summarizing demographic data (gender, age, education) and engagement with AR/VR technologies (interest, familiarity, and willingness to pay).

Despite this, interest in AR/VR remains promising. Among those who had not yet used these technologies (140 out of 190), 54 respondents (38.6%) expressed moderate interest in exploring VR/AR experiences during future visits. This indicates a latent demand that could be nurtured through targeted awareness campaigns and accessible demonstrations. Respondents highlighted key features they valued in VR/AR experiences. Many appreciated 3D historical reconstructions (15 respondents, 10.7%) and the ability to gain a deeper understanding of historical or artistic contexts (27 respondents, 19.3%). These preferences are consistent with findings from other studies, where the educational and experiential benefits of immersive technologies were prioritized by cultural visitors (Pratisto, Thompson, & Potdar, 2022). Cost emerged as a notable barrier to adoption. While 51 respondents (36.4%) preferred VR/AR experiences to be free, 40 (28.6%) were willing to pay up to €5, and 20 (14.3%) indicated a willingness to pay up to €10. This reflects broader concerns about price sensitivity in the adoption of immersive technologies (Creed et al., 2024). Offering tiered pricing models or free trials could alleviate these concerns and encourage broader participation. For those who had used VR/AR, the survey found high levels of satisfaction, particularly regarding the clarity of information provided (70%) and cultural enrichment (48%). These findings align with research demonstrating the educational potential of VR/AR in enhancing museum experiences. Respondents also reported positive emotions and a heightened sense of connection during immersive experiences, with many expressing enthusiasm for future applications and recommending the use of these technologies to others. This emotional engagement underscores the potential of VR/AR to deepen visitor connections with

cultural heritage. The findings point to a mixed interest in VR/AR technologies among respondents. While there is clear enthusiasm among certain groups, a significant portion of participants (56 respondents, 40.0%) remains neutral or uninterested. This highlights the need for targeted efforts to increase awareness and showcase the value of these technologies, a challenge echoed in other studies where long-term engagement with immersive tools has proven difficult. Additionally, the preference for free experiences underscores the importance of addressing cost-related barriers. Financial accessibility is a critical factor in encouraging the widespread use of VR/AR in cultural heritage settings. Educational initiatives and hands-on demonstrations could also play a pivotal role in bridging the familiarity gap, especially among those currently unfamiliar with these tools. The demographic composition of the respondents suggests that the survey largely reflects the Italian population's attitudes toward VR/AR in cultural heritage. However, the findings also point to opportunities for further research, particularly in exploring global trends and best practices in regions with higher levels of VR/AR adoption in museums.

5 Conclusion and Future Perspectives

The findings from this survey provide valuable insights into the adoption and interest in VR/AR technologies in Italian cultural heritage contexts. While there is clear enthusiasm for these immersive tools, barriers to widespread adoption remain, including limited familiarity with the technology and concerns about cost. Despite these challenges, VR/AR has significant potential to enhance the visitor experience at cultural heritage sites. To increase adoption, it is recommended that cultural institutions enhance their VR/AR offerings by focusing on accessibility and interactivity. Given the varying willingness to pay for these experiences, flexible pricing strategies, such as tiered pricing or free trials, could help address cost concerns and attract a broader audience. Targeted awareness campaigns and educational initiatives are also needed to increase familiarity with VR/AR, particularly among middle-aged visitors, the largest demographic group. The online survey provides an initial assessment of visitors' general opinions on Italy's cultural tourism offerings, without focusing on specific heritage sites. To address this gap, tailored questionnaires for each museum are being developed, and soon more detailed, site-specific results will be available. These future analyses will offer deeper insights into the distinct experiences and perceptions at individual heritage locations. Looking ahead, further research is needed to examine the long-term impact of immersive technologies on visitor behavior and their potential influence on policies and preservation strategies for cultural heritage sites.

Acknowledgements. This work is financed by national funds through FCT—Foundation for Science and Technology, IP, within the scope of the reference Project CiTUR 2025–2029. https://doi.org/10.54499/UIDB/04470/2020.

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Zombie Companies in the Furniture Sector in Portugal - Application of Altman's Z-score

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Abstract. Edward Altman says in his study that *zombie* companies are an unintended consequence of the credit market. In this sense, the study and work focused on the treatment of data from the financial statements, elements necessary for the calculation of the *Z-score and Z'-score*. The timeline for analysis in the detection of this type of companies defined by the author is three years, so in this study the presence of *zombie companies* between 2019 and 2021 in the previously furniture sector in Portugal is analysed.

In this sector, in the years under review, there was no exceeding of 25% of all companies in the sector, considered as *zombie* (reference value considering the survival rate of companies provided by Pordata), reinforcing the safeguard of the assumption of continuity in auditing.

The data of this study were worked with a view to performing a Multiple Linear Regression, from which it is concluded that there are statistically significant variables with the ability to explain one model built for *Z-score* and the other for Z″-*score*. Regarding the complete model (for the three years of study) EBIT/ASSET is always accepted, this ratio represents the ability of a company to generate gains based on its equity.

Keywords: Altman · Audit · Zombie companies · Credit Risk · *Z-score*

1 Definition and Identification of *Zombie Companies*

Edward I. Altman et al. (2022), report that these "*walking dead*" companies, under normal circumstances, would become insolvent and cease operations instead, with government support, continue to operate.

Characteristically, these companies have low operational efficiency, consume funds and social resources unproductively, benefit from better policies and access to financial markets through tax benefits. Although they should be eliminated by the market, they are still in operation due to the support of external resources, financial support from the government and banks (Jiang et al. 2017; Shen and Chen, 2017; Dai et al. 2019; Han et al. 2020).

The classification of a company as a *zombie company* depends on whether the following conditions are met over two years, according to the authors, Shen and Chen (2017):

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 411–421, 2025.
https://doi.org/10.1007/978-3-032-09080-5_41

(i) if the ratio of earnings before finance charges and taxes (EBIT) to interest incurred is less than one;
(ii) if the ratio of the market value of the assets to their replacement value (Tobin ratio) is lower than the industry average.

On the other hand, the Organization for Economic Cooperation and Development (OECD) indicates that between 2 and 10% of companies can be classified as *zombie*, if the following conditions are combined:

(i) the operating result is lower than interest expense for at least three consecutive years.
(ii) have been in business for more than 10 years (McGowan et al., 2017).

The authors mentioned above concluded that the number of *zombie* companies outside metropolitan areas increases, pointing to the pressure of these companies to ensure not only the reliability and viability of these areas, but also their sustainability over time.

1.1 Causes of The Formation of Zombie Companies

There are several people responsible for the formation of *zombie companies*, however, several studies point out that the main ones are the government, banks and the companies themselves (Chang et al., 2020).

Katsomitros (2020) classifies the emergence of more *zombie* companies as a process of "*zombification"*. While companies such as *Toys R Us* and *Sears* struggle to maintain their position in the market by adapting to demand, other companies that in 2017 should become insolvent remain active due to the combination of favorable conditions obtained (for example the use of low-interest credit or extended capital grace periods). The aforementioned author also indicates, as a source of "*zombification"* digitization and the growing use of technology, he gives as an example Amazon *that* ends up benefiting from this digitalization, leading to the unsustainability, without government and banking support, of the so-called street commerce.

Jensen (1986) indicates that under unfavourable conditions of the macro and microeconomic context, the government tends to respond to this phenomenon by injecting capital into sectors with difficulties, so that the level of employment is maintained, avoiding changes in social stability. As a result of this policy, companies in difficulty continue to operate and at the same time any financial discipline that would be necessary for their recovery is reduced.

Edward I. Altman et al. (2022) reinforce that small businesses are more likely to receive government subsidies than large companies.

The authors Dias et al. (2014) studied the relationship between factors of production and the labor force. The deficient links between these points lead to the destruction of the creative process, with a reduction in the entry of new companies in the sector and fewer exits, which results from a higher permanence rate, often with government support and credit concession, which prevents the growth of healthy companies through the retention of human capital and financial resources.

Storz et al. (2017) establish a link in their study between banks with economic weaknesses and *zombie* companies. The same causal link is pointed out by Andrews and Petroulakis (2017).

Edward I. Altman et al. (2021) state that easy credit granted by banking institutions and government support are the basic conditions to foster the emergence of this type of companyies This fact, according to the authors, distorts the allocation of credit and impedes the real growth of the economy. They point out as an example the government policies associated with the COVID-19 pandemic situation.

1.2 Consequences of Zombie Companies

The study carried out by the authors Caballero et al. (2008), point out that the industrial productivity of *zombie* companies is reduced, inevitably reducing the gross domestic product (GDP) and the constitution of a factor of macroeconomic stagnation.

Assuming the existence of zombie companies as a fact, Edward I. Altman et al. (2021) indicates that their presence will be an unintended consequence of the development of financial credit markets, especially those with high interest rates. Also, the same authors in 2022, establish metrics (multiple linear regression) between the allocation of resources to support *zombie companies* and the fight against unemployment, seeking to prove the relationship between these two points.

2 The *Z-score* as a Predictor of Zombie Companies

The *Z-score* developed by Altman was a kind of promoter for *credit scoring* activity, currently adopted by banking institutions and researchers, as well as adopted on a large scale as a *rating methodology*.

Over the years, the *Z-score* model has been updated. The first model (1968), a simple model, is based on the linear multivariate discriminating function and aimed to predict that a company will become insolvent up to five years before the occurrence of this fact.

$$Z = 1.2\,T1 + 1.4\,T2 + 3.3\,T3 + 0.6\,T4 + 0.999\,T5$$

T1 = Working capital /Total assets. It measures net assets in relation to the size of the balance sheet.

T2 = Retained earnings/Total assets. It measures the company's ability to generate profit.

T3 = EBIT/Total Assets. Measures operational efficiency without regard to taxes and leverage.

T4 = Market capitalization/Total liabilities. It adds the market reaction as a possible leading indicator.

T5 = Sales/Total assets. Ability to generate operational activity with the assets held.

At an initial stage, this model was applied to a sample of sixty-six companies and twenty-two variables were used. The companies studied were divided into two groups: the first group included potentially insolvent companies, according to the *National Bankruptcy Act.*[1] The second group included companies defined as solvent. Regarding the twenty-two variables initially applied, Altman concluded that the most statistically

[1] "**Nelson Act**", 1 July 1898, ch. 541, 30 Statutes al large. 544.

relevant for the calculation of the *Z-score* indicator are the five variables of the previously mentioned model (Kruchynenko, 2012).

In 1977, Altam, Haldeman and Narayanan tested the model they called *Zeta*, which was composed of the following variables:

- Earnings Before Tax/Total Assets;
- Income Before Tax/Property, Plant and Equipment;
- Earnings Before Taxes/Financial Charges Borne and Paid;
- Retained Earnings/Total Assets;
- Working Capital/Total Assets;
- Equity/ (Equity + Non-Current Liabilities)

From the application of the model, the authors concluded that the improvements compared to the original model were not relevant, since the statistical tests used were very similar.Even so, in 2000, Altman compares the models developed in 1968 and 1977. In this work I concluded that the first model developed is kept up to date.

Eight years later, Altman and Sabato (2008) applied the *Z-score* model, using the *logit*[2] technique, with panel data from two thousand companies in the United States in America, with sales of less than sixty-five million dollars in the period between 1964 and 2002. This model revealed a predictive capacity of almost 30% higher than the generic model.

The latest model was developed in 2022 and is addressed at two levels, using a default leverage ratio and the *Z-score* itself to study and evaluate companies.

In this sense, the application of the model begins by calculating the financial expense coverage ratio (i.e., the ratio between EBITDA and interest incurred).

$$\text{EBITDA} = \text{Operating income} \times (1 - \text{Q}) + \text{Depreciation} + \text{Amortization}$$

$$\text{EBITDA} - \text{Earnings Before Interest Taxes Depreciation and Amortization}$$

$$\text{T} - \text{Tax Rate}$$

When the cash flow is lower than the financial charges, i.e. the ratio is less than one, there is a situation of insolvency with a manifest inability of the company to meet its charges.

However, this ratio alone may not be decisive in the classification of companies as *zombie*, since a low value ratio can be associated with exogenous factors such as changes in the prices of raw materials or adverse economic conditions that inevitably increase the financial burden to which companies are exposed.

On a second level, the calculation of the *Z-score*, a model developed by Altman (1968), and a modified version, the *Z'-score* model, developed for international companies and private equity companies (Edward I. Altman et al., 2021). Both Z-score models analyze the accounting situation, namely in terms of profit and liquidity.

[2] *Logit* - is a statistical technique that aims to produce, from a set of observations, a model that allows the prediction of values taken by a categorical variable, often binary, from a series of continuous and/or binary explanatory variables.

After applying the models, a company is classified as a *zombie* if the ratio between EBITDA and the average finance charges incurred over the last three years is less than one and the *Z-score* or *Z"-score* models are below zero (Edward I. Altman et al. 2022).

The author also compares the results of the *Z-score* and *Z"-score,* not finding relevant differences between the two models.

The relevance of this latest study by Altman lies in the fact that it finds a visible increase in the indicator of *zombie* companies in the United States of America, from 6% in 1990 to 10% in 2020. The author also concluded that the probability of being in the presence of a *zombie* company is greater in small companies compared to larger ones.

3 Research Problem

With this work, it is intended to investigate the phenomenon of *zombie companies*, using the application of the *Z-score*, as well as the main factors and explanatory variables.

In this sense, we will resort to Altman's original theory, and the subsequent changes made over time.

The sector that will be used is the sector with CAE 31 Manufacture of furniture and mattresses, a sector that, as already mentioned in the introduction, has been assuming a growing weight in the Portuguese economy.

Altman's Z *was selected as an* instrument that allows answering the research question formulated here and explained earlier in the introduction.

It should be noted that continuity is a factor of "trust" between economic agents and is the basis of the structural sustainability of a sector.

The relationship between companies and investors thus becomes increasingly important, investors have what companies need most for their growth: capital. The company holds what investors are looking for most: "a vehicle that offers potential and return" (Zucker, 1986). This relationship presupposes a continuous timeline or, at least, guaranteed in the medium/long term, thus safeguarding the assumption of continuity.

3.1 Research Objectives and Hypothesis

The research objectives (already mentioned in the introduction) were defined as:

1. How to spot a *zombie company*.
2. Assess the positives and negatives of a *zombie company*.
3. Apply the *Z-score model*, as a predictor and indicator of a zombie company.

These objectives are divided into the following secondary objectives:

1. Define the concept of insolvent company.
2. Present the existing measurement models/instruments to detect a *zombie company*.

Based on the above, we defined the following research hypotheses for empirical study:

H1: In the Furniture and mattress manufacturing sector in Portugal, in the years 2019, 2020 and 2021 there are no companies classified as *zombie.*

H2: Altman's conclusions that point to non-significant differences between *Z-score and* Z''*-score are confirmed.*

H3: It is possible to create a Multiple Linear Regression with explanatory capacity of *Zscore and Z″-score.*

H4: It is confirmed that the financing expenses for the collected sample have an impact on the determination and classification of a company as a *zombie.*

H5: In view of the results obtained in the number of *zombie* companies in the Furniture and mattress manufacturing sector in Portugal, if it amounts to a maximum of 25% (reference value taking into account the survival rate of the companies provided by Pordata), the assumption of continuity is assured.

3.2 Study Sample

For the selection, obtaining and construction of a sample conditioned to a sector and valid about statistically significant results, complying with the objectives of the study and regression analysis. The empirical study is limited to a time frame of three years (2019–2021).

As a first step and using the Sabi database, it was to extract the accounting information of companies in the furniture and mattress manufacturing sector in Portugal, generating a sample consisting of 2216 companies, which is the basis of this research.

3.3 Study Variables

The variables considered for the study aim to explain and determine the value of the *Zscore and Z'-score.* The Table 1 below presents the variables studied in the following steps.

Table 1. Variables of empirical study

Variables explained	Explanatory variables
Z-score	EBIT/ASSETS
Z″-score	EBITDA
	WORKING CAPITAL
	TOTAL LIABILITIES
	RESULTS CARRIED OVER
	TOTAL ASSETS
	MARKET VALUE
	SALES/ASSETS
	EBITDA /FINANCE CHARGES (AVERAGE LAST 3 YEARS)

3.3.1 Research Methodologies Used

Regarding the quantitative methodology, according to the authors Pardal and Lopes (2011), it is characterized by the application of quantification both in the modalities of data collection and in the treatment of these through statistical techniques, from the simplest to the most complex.

The quantitative methodology for the analysis of the data of all the information collected and worked will be used as the research methodology of this work.

3.3.2 Techniques Used for Data Analysis

The first approach to processed and processed data is related to the underlying descriptive statistics.

The Table 2 summarizes the descriptive statistics for the data analysed.

Table 2. Descriptive statistics of the *Z-score and Z″-score series*

	Z´-SCORE_19	Z´-SCORE_20	Z´-SCORE_21	Z´´-SCORE_19	Z´´-SCORE_20	Z´´-SCORE_21
Average	-8.677088	-4328.748	-55.81655	-23.42471	-35.79091	-153.8139
Median	1.425405	1.305776	1.320484	5.451815	5.483240	5.525068
Máximum	387.1752	64.23105	105.3206	1853.695	1854.354	1854.201
Minimum	-8671.516	-9562937.	-69625.96	-31882.32	-31180.23	-172395.4
Standard deviation	220.9028	203145.1	1574.326	750.6717	899.4300	4087.201
Skewness	-33.26485	-47.04240	-40.26677	-36.78693	-28.81556	-36.59687
Kurtosis	1202.447	2213.992	1738.453	1497.580	898.8051	1468.904
Jarque-Bera	1.33E+08	4.52E+08	2.79E+08	2.07E+08	74401111	1.99E+08
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	2216	2216	2216	2216	2216	2216

The *Skewness* (which is a measure that deals with the asymmetry of the causes of the distribution), does not present values of 0 or close to 0, which indicates that we are not facing a normal distribution.

Regarding *Kurtosis*, as it generally presents disparate values of 3, it is concluded that the series does not follow a normal distribution, which confirms the conclusion drawn previously regarding *Skewness.* The visualization of the different graphs allows us to easily verify that we are not facing a normal distribution, centred around its average, but totally skewed to its right.

Since the value defined by the JB statistic in the different years is very far from 0, these values are indicators that the series do not follow a normal distribution.

3.4 Correlation Matrix

In this sense, three correlation matrices were created, one for each year under study 2019, 2020 and 2021.

In 2019, it is verified that this problem exists in the *Z-score and Z″-score* indicators, but since they will not be worked together, it is understood that there are no multi-collinearity problems. In 2020, this situation does not exist and, finally, in 2021 there is

a situation like 2019 and, given the justification mentioned above, there are no problems with regression.

It would therefore conclude that, in relation to these three years under analysis in relation to the variables in question, there are no problems of multicollinearity and, in this sense, the exclusion of any pair of variables is not justified.

3.4.1 Multiple Linear Regression

R^2 shows how well the data is compatible with and fits the regression model (the quality of the fit). R^2 can assume any value between 0 and 1 (Marôco, 2021), although the statistical measure provides some *useful insights* into the regression model, the user should not rely only on the measure in the evaluation of a statistical model, and there is therefore a need to resort to complementary quality adjustment measures that will be addressed in this work later. For the year 2019, the regression for *Z-score* shows an R^2 of 0.59, and for *Z″-score* of 0.48. For the year 2020, the regression for *Z-score* shows an R^2 of 0.0004, and for *Z″-score* of 0.72 and finally, for non-2021, the regression for *Zscore* shows an R^2 of 0.13, and for *Z″-score* of 0.18.

It is concluded from the results obtained that the series in 2019 adjusts to the regression in a relevant way, although this fact is no longer the same in the following two years, in 2020 the *Z-score indicator* presents disappointing values. It is believed that this fact may be related to the measures imposed by the pandemic situation in force at the time.

According to the author Field (2009), the *Durbin Watson* (*DW)* test is a measure of autocorrelation (also called serial correlation) in the residuals of regression analysis.

In view of the values found for each year under study, we conclude that there is no evidence of autocorrelation since the values are in the range of 1.757 and 2.243 in the *DW table*. According to Singh (2020), in the case where there is no evidence of self-correlation, it is concluded that the evolution of the series is independent between them.

3.5 Determination and Analysis of the Companies

At this point, the number of companies potentially considered as *zombies* for the furniture and mattress manufacturing sector in Portugal will be analyzed, determined for the three years of this study, by *Z-score, Z″-score* and both together.

In this sense, this study is divided into three approaches: in a first approach, the existence of companies considered potentially zombie is determined through the results of the ratio mentioned above and the *Z-score*; in a second approach in the analysis of the results of the ratio and the *Z″-score*, in a third and last approach the results of the ratio and the *Zscore* and the *Z″-score are* compared.

The following Table 3. reflect the results for 2021.

Table 3. Determination of companies in 2021.

YEAR 2021	Number of companies
Sample	2216
Z-score	146
Z″-score	22
Z and *Z″-score*	375
Total *zombie (%)*	24,50%

Source: Prepared by the authors.

In the last year of analysis, 2021, *146 companies were determined* by Z-score and *22 companies potentially considered zombie* by *Z'-score*. It is also detected that the number of companies considered as potentially *zombie* determined by the two indicators together is 375 companies, corresponding to approximately 69.06% of the total forecasts (ratio between *Z and Z″-score* and the sum of *Z-score, Z″-score*, *Z and Z″-score)*. In this year, as in the previous two, Altman's conclusions are corroborated, in the absence of significant differences between these two indicators, since the value determined by the cumulative verification between the EBITDA ratio/average financial charges (last 3 years) less than 1 and the Z *and Z″-score* indicators less than zero is greater than the detection isolated only by the EBITDA/AVERAGE FINANCIAL CHARGES (last 3 years) less than 1 and the *Z-score ratio* less than zero or EBITDA/AVERAGE FINANCIAL CHARGES (last 3 years) less than one and the Z″*-score* indicator less than zero.

This year about 24.50% of companies are considered as potentially *zombie* in relation to the total sample size (ratio between the total sum of companies considered potentially *zombie* and the total number of the sample size).

In view of the values of companies considered as potentially *zombie* between the years 2019 and 2021, there is a growth in the number of these types of companies (growth of 4.45 pp compared to 2019), one of the reasons that can be pointed out is the harmful influence of the COVID-19 pandemic.

With the pandemic situation, the partial and total closure of several activities compromised profitability and led to significant losses. Weakened companies remained in the market at the expense of government support that helped their "artificial" sustainability.

4 Conclusion

Using a sample of 2,216 Portuguese companies in the Furniture and Mattress Manufacturing sector, for the time period between 2019 and 2021 (time phased defined and admitted by the methodology of the authors Edward I. Altman et al. (2021), as necessary for the analysis of the detection of companies considered as potentially *zombie*), it was intended to estimate the dimension of this phenomenon at a national level, in this sector, to understand the impact on the prevalence of this type of companies in the global activity of other companies in the same sector, during the aforementioned period, as well as the impact and role of the auditor in the detection and prevention of the genesis of *zombie companies*.

In terms of validation, in view of the study and work hypotheses, and based on what has been explained throughout this dissertation, the following conclusions can be drawn:

H1: Not validated: the study proved that there are companies potentially considered zombie in the years mentioned.

H2: Validated: the study proved that there are no significant differences between these two indicators, since most detections are common in the indicators.

H3: Validated: it was possible to create a multiple linear regression with partial acceptance of the independent variables except for the *Z-score* in 2020.

H4: Validated: it was corroborated by the study that the *Z-score and Z″-score* indicator have to be combined with the EBITDA/average financial charges ratio (last 3 years), from this combination it results that financing expenses are critical in the analysis and determination of *zombie companies.*

H5: Validated: the number of *zombie* companies detected in this study always represents a value below 25% of the sample (see tables in Chap. III), which indicates that the assumption of continuity of the sector is assured.

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Digital Education in Private Higher Education Institutions in Portugal: Contributions from the Institutional Perspective

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Abstract. Across Europe, and particularly in Portugal, higher education institutions (HEIs) have increasingly turned to digital and hybrid modalities to address the demands of a diversified student body and an evolving professional landscape. While existing studies have largely focused on public HEIs, limited attention has been devoted to the private sector. This study aims to map the current state of digital education in Portuguese private HEIs, within the framework of relevant national and European policy instruments. Drawing on data collected from an online survey sent to institutional leaders of private HEIs, the research explores institutional positioning on digital transformation, adopted pedagogical methodologies, strategies for teacher professional development, student support mechanisms, and deployed technologies. Emphasis is placed on institutional leadership, pedagogical innovation, internationalization strategies, and the expansion of educational offerings to new audiences. The findings, based on a sample comprising a total of 38 private HEIs in Portugal, offer a critical and contemporary analysis of the digital education landscape in Portuguese private higher education, providing insights to inform the development of sustainable, inclusive, and high-quality educational policies and practices.

Keywords: Digital Education · Higher Education Institutions · Pedagogical Innovation

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 422–432, 2025.
https://doi.org/10.1007/978-3-032-09080-5_42

1 Introduction

The social and technological transformations that have marked the last few decades, intensified by the pandemic experience and the advance of generative artificial intelligence, have contributed to a profound reconfiguration of teaching and learning models [1–5]. In this context, digital education (DE) has emerged as a structuring axis of contemporary academic training, showing itself not only as an emergency response, but as a consolidated and strategic way to expand access, flexibility, and diversity of training experiences [4, 6, 7]. Constant technological advances have provided new forms of educational interaction, requiring HEIs to constantly reflect on pedagogy and organization [6, 8], as well as a continuous effort to experiment and innovate, viewing teaching as a design science [9]. According to Gaebel and Zhang, the strong emphasis on digitalization within HEIs is to be expected, given its longstanding integration into all areas of institutional mission, structure, and governance. Although many institutions had developed substantial digital capacity prior to the Covid-19 pandemic, these resources and practices had yet become fully embedded across the system [1]. This reality has led to a growing commitment on the part of European HEIs to digital and hybrid modalities [10], to adapt to the demands of an increasingly diverse public and a rapidly changing professional market [2]. In Portugal, the need to understand the degree of maturity of HEIs, their emerging pedagogical models and the way they organize their human and technological resources is particularly important, not only to assess the quality of the training on offer, but also to support strategic decision-making processes. Studies in the Portuguese context provide evidence about the state of art of DE in public higher education [11]. In this study, blended learning is emphasized as the most viable and appreciated option, especially by institutional leaders, as it allows online and face-to-face experiences to be integrated [11].

The Digital Education Action Plan (2021–2027) from the European Commission [12] has had a significant and strategic influence on HEIs across Europe, including those in Portugal. Effective digital integration requires not only technological adoption but also organizational reconfiguration, including the creation of virtual environments that support innovation in pedagogy. This shift requires systemic institutional efforts to align policies, infrastructure, and practices with a vision of education that prioritizes collaboration, flexibility, and learner engagement [13]. Recent shifts in educational paradigms, particularly within Portuguese HEIs, reflect an urgent need to adopt digitally enriched pedagogical practices [14, 15]. However, merely introducing digital technologies is insufficient. Without pedagogical training, educators risk reproducing conventional practices in virtual settings. For digital transformation to be meaningful, teachers must be equipped to use digital tools critically and creatively, designing and facilitating learning experiences that empower students and foster active knowledge construction [6]. This requires continuous professional development tailored to the demands of online teaching, particularly in areas such as digital resource creation, assessment, and student engagement [16, 17]. Strengthening teachers' digital competence has therefore become a central goal in institutional strategies for sustainable and inclusive DE.

This study aims to map the current scenario of Portuguese private HEIs investing in DE, considering the political and regulatory framework that guides their actions (Decree-Law no. 133/2019, of 3 September). The aim is to characterize the institutions involved,

understand their position in relation to the digitalization of teaching, identify the pedagogical methodologies adopted, as well as teacher training strategies, student support mechanisms and the technologies used. Data was collected from institutional leaders to understand the main challenges faced, with a particular focus on issues of institutional leadership, pedagogical innovation, internationalization opportunities and the expansion of the training offer to new audiences. Therefore, this research aims to contribute to a critical and up-to-date reading of the DE landscape in Portuguese private higher education, providing elements that can support the design of more effective policies and practices that are sustainable and aligned with the principles of quality, inclusion, and educational innovation [6, 18].

2 Methods

This is a quantitative, cross-sectional, and descriptive study. It relies on a non-random, convenience sample consisting of the 38 private HEIs that are members of Portuguese Association of Private Higher Education (www.apesp.pt). This association's primary objective is to represent non-state higher education and to conduct studies and collaborations aimed at fosterage the improvement and development of the higher education system in Portugal. The present study is part of one of this association missions and aims to explore the use of digital tools in order to promote strategies for enhancing and increasing the use of technologies applied to the field of DE.

2.1 Data Collection Instrument

A questionnaire was created for data collection – Reflection on Digital Education in Private Higher Education – consisting of 8 questions to characterize the higher education institution, along with 29 additional questions related to digital education, grouped into three dimensions: *i)* Institutional Dimension – explored indicators related to strategic objectives, leadership, and other institutional resources supporting digital education (20 questions); *ii)* Faculty Dimension – explored indicators related to faculty training and development, their engagement, and experience in digital education (5 questions); *iii)* Student Dimension – explored indicators related to support, usability, monitoring, and student satisfaction with digital education (4 questions). The questionnaire was converted into a Google Forms format to facilitate its dissemination among the HEIs. This paper focuses on the presentation and discussion of results specifically within the institutional level, particularly regarding the facilitating factors, inhibiting factors, and pedagogical model elements identified by the leadership of the HEIs.

2.2 Procedures

The institutions were contacted via email, and a link to access the online questionnaire was provided. Before proceeding with its completion, the HEIs were informed that the data collection would be confidential and that the overall results would be anonymized, in accordance with the General Data Protection Regulation in force in Portugal. The data were collected between July 2024 and April 2025, and then processed using IBM SPSS Statistics, version 30.0.

3 Results and Discussion

The results are presented in three levels of analysis. In the first phase, a demographic characterization of the sample is presented, as well as a detailed overview of how DE is integrated within private HEIs under study. Next, the reliability analysis of the scale measuring DE indicators at the institutional level and of its three subscales, namely, Facilitating Factors, Inhibiting Factors and Elements of the Pedagogical Model for DE, are exhibited. Finally, univariate descriptive statistics measures are presented for the 23 items that constitute the scale considered.

In this sense, as mentioned before, the sample comprised a total of 38 private HEIs in Portugal and Table 1 presents a demographic characterization of the sample categorized by subsystem, student population, and geographical location. In terms of institutional subsystem, 22 (57.9%) institutions were polytechnics and 16 (42.1%) were universities. This distribution indicates a slightly higher representation of polytechnic institutions in the sample. Regarding institutional size, the average number of students enrolled during the 2023/2024 academic year was 1479.61 (SD = 2171.45), with student populations ranging from a minimum of 153 to a maximum of 12000. The high standard deviation indicates substantial variability in institution size, reflecting the inclusion of both small regional institutions and larger universities. Geographically, the sample was predominantly concentrated in the Lisbon Metropolitan Area (n = 18; 47.4%) and the North region (n = 16; 42.1%). Fewer institutions were located in the Center (n = 3; 7.9%) and Madeira (n = 1; 2.6%). This regional distribution aligns with national patterns of private HEIs concentration but suggests underrepresentation from less densely populated regions. The sample reflects diversity in institutional type and size, with a notable concentration in Portugal's main urban and coastal regions.

Table 2 provides a detailed overview of how DE is integrated within private HEIs under study, focusing on strategic planning, infrastructure, course offerings, and institutional support mechanisms. Regarding strategic planning, 68.4% of institutions (n = 26) reported having strategic objectives that explicitly include DE, while an additional 31.6% (n = 12) indicated that such objectives are still under construction. This suggests that nearly all institutions acknowledge the relevance of DE, with varying degrees of formalization in their strategic documents. In terms of technological investment for DE, a substantial majority of institutions (89.5%, n = 34) reported having invested in technologies to support DE, indicating a widespread institutional commitment to digital infrastructure. Similarly, 71.1% (n = 27) confirmed the adoption of an institutional Learning Management System (LMS), reflecting a foundational step in DE implementation.

The integration of DE into formal degree programs remains limited. Only 2.6% of institutions (n = 1) reported offering DE in bachelor's degrees, and the same proportion was observed at the doctoral level. A slightly higher proportion (15.8%, n = 6) offered DE at the master's level. The most significant engagement with DE was observed in non-degree offerings, such as postgraduate courses, advanced training, and microcredentials, where 71.1% (n = 27) of institutions reported activity. This suggests that DE is currently more commonly deployed for continuing education or specialized training rather than in traditional academic degrees. Engagement in broader networks of innovation also appears strong, with 89.5% of institutions (n = 34) participating in educational

innovation networks or partnerships related to DE. This highlights a collaborative approach and openness to adopting and adapting practices in a rapidly evolving educational landscape.

When asked about the presence of a pedagogical model specifically designed for DE, 55.3% (n = 21) reported that such a model is under development, 26.3% (n = 10) already have an established model, while 18.4% (n = 7) have not yet implemented one. These figures suggest that although pedagogical frameworks for DE are still maturing, more than half of the institutions are actively working toward formalizing such models. Support structures are also notable in the data since 71.1% (n = 27) of institutions reported having a technical support team to assist with the development of course materials and curriculum design for DE. Additionally, 78.9% (n = 30) indicate having an accessible and secure virtual campus, which is a critical infrastructure component for delivering a high-quality DE experience. Finally, teacher training emerged as a priority area, with 84.2% (n = 32) of institutions offering training initiatives to prepare faculty to teach in DE modalities. This figure suggests an institutional recognition of the importance of professional development in ensuring pedagogical quality and consistency in online and hybrid education environments.

While the integration of DE in private HEIs appears to be in an advanced developmental phase, evidenced by strategic alignment, investment in technology, and support structures, its application in degree programs remains limited. Instead, DE is more prevalent in short-cycle and continuing education formats. These trends reflect both the opportunities and transitional challenges in embedding digital education more fully within the traditional higher education structure.

To assess the internal consistency of the instrument used in the study, Cronbach's alpha coefficients (α) were calculated for the overall scale and each of its subscales. The results are summarized in Table 3 and indicate an overall satisfactory level of reliability across all components. The main scale measuring DE indicators at the institutional level, composed of 23 items, yielded a Cronbach's alpha of 0.842, indicating good internal consistency. This suggests that the items included in this composite measure reliably assess a coherent set of institutional DE practices and perceptions. Among the subscales, the "Elements of the Pedagogical Model for DE" demonstrated the highest reliability, with an alpha of 0.911 across 6 items. This value reflects excellent internal consistency, implying that the items effectively capture the conceptual coherence of pedagogical strategies and design principles related to digital education. The "Facilitating Factors" subscale, composed of 8 items, produced a Cronbach's alpha of 0.788, while the "Inhibiting Factors" subscale, which includes 9 items, showed an alpha of 0.753. Both values fall within the acceptable to good range for exploratory research, indicating that the items within each subscale consistently measure the respective enabling and constraining elements perceived in the implementation of DE. These results provide evidence for the reliability of the measurement instrument, supporting its use in subsequent analyses and interpretations. All subscales meet or exceed the commonly accepted threshold of 0.70 for internal consistency, and no major concerns regarding the coherence of item groupings were identified.

To better understand institutional engagement with DE, descriptive statistics were calculated for each item in the DE Indicators at the Institutional Level Scale. These

statistics include mean scores (M), standard deviations (SD), and quartiles (Q1, Q2, Q3), providing insight into the perceived relevance and implementation of facilitating factors, inhibiting factors, and elements of the pedagogical model for DE. The results are detailed in Table 4. Note that as the scale items were constructed using a five-point Likert-type agreement scale (1 - Strongly disagree, 2 - Disagree, 3 - Neither disagree nor agree, 4 - Agree, 5 - Strongly agree), for each of them the minimum is 1 and the maximum is 5. Thus, mean between 4 and 5, indicates strong agreement with the item, suggesting a high level of institutional alignment or widespread presence of the evaluated factor; mean between 3 and 3.9, reflects a neutral or moderate stance, possibly indicating variability in institutional experiences, perceived medium relevance, or uncertainty regarding implementation, and mean below 3, suggests a tendency toward disagreement, indicating that the item may be less present, less valued, or perceived as a clearer obstacle within the institutional context.

Table 1. Demographic Characterization of the Sample

	n	%
Subsystem of the HEI		
Polytechnic	22	57.9
University	16	42.1

Number of Students in 2023/24	Mean	St. Dev (SD)	Min	Max
	1479.61	2171.45	153	12000

	n	**%**
Location Region of the HEI		
Lisbon Metropolitan Area	18	47.4
Center	3	7.9
Madeira	1	2.6
North	16	42.1

Therefore, overall items in the Facilitating Factors subscale received high mean scores, indicating strong agreement across institutions regarding the importance or presence of these elements. The highest-rated items were: F1. The institutional strategy ($M = 4.7$, $SD = 0.6$), F3. Professional development and training ($M = 4.7$, $SD = 0.5$), and F2. The proactive participation of faculty, staff, and students ($M = 4.6$, $SD = 0.6$). These findings suggest that institutional alignment and human capital engagement are considered central to the success of DE efforts. In contrast, items reflecting external collaboration or infrastructure were rated slightly lower, though still positively. For example, F4. Large investments in equipment and infrastructure had a mean of 3.9, and F6. Projects with external partners (e.g., industries) had a mean of 3.9, both with moderate variability ($SD = 0.9$ and 0.7, respectively). This suggests that while foundational elements are in place, certain areas, particularly external partnerships and large-scale infrastructure investment, may still present challenges or inconsistencies across institutions.

The Inhibiting Factors subscale displayed more moderate scores, indicating variability in how institutions perceive and experience barriers to DE implementation. The

Table 2. Sample Characterization of DE in Private HEIs

	n	%
Strategic Objectives that Include DE		
Under Construction	12	31.6
Yes	26	68.4
Technology Investment for DE		
No	4	10.5
Yes	34	89.5
Institutional Learning Management System (LMS)		
No	11	28.9
Yes	27	71.1
Courses Taught using DE in 2023/24		
Bachelor's Degrees		
No	37	97.4
Yes	1	2.6
Masters		
No	32	84.2
Yes	6	15.8
Doctorates		
No	37	97.4
Yes	1	2.6
Other Trainings (Postgraduate courses, advanced courses, Microcredentials, among others)		
No	11	28.9
Yes	27	71.1
Participation of the HEI in Educational Innovation Networks and Partnerships Related to DE		
No	4	10.5
Yes	34	89.5
The HEI has a Pedagogical Model for DE		
No	7	18.4
Yes	10	26.3
It is under development	21	55.3
Technical Support Team for Construction of Materials and Curriculum Design for DE Courses		
No	11	28.9
Yes	27	71.1
Accessible and Secure Interactive Virtual Campus		
No	8	21.1
Yes	30	78.9
Teacher Training Actions to Work in the DE modality		
No	6	15.8
Yes	32	84.2

lowest-rated item was: I9. Lack of motivation of the institutional team ($M = 3.1$, $SD = 1.3$). This suggests that while motivation may be a concern in some contexts, it is not

Table 3. Cronbach's Alpha of the Scale and its Subscales

	Cronbach's Alpha (α)	Number of Items
DE Indicators at Institutional Level	**0.842**	**23**
Facilitating Factors	0.788	8
Inhibiting Factors	0.753	9
Elements of the Pedagogical Model for DE	0.911	6

Table 4. Descriptive Statistics Measures of the items of the DE Indicators at Institutional Level Scale in this Study

			Quartiles		
Items of the Scale by Subscales	M	SD	Q1	Q2	Q3
Facilitating Factors					
F1. The institutional strategy.	4.7	0.6	4	5	5
F2. The proactive participation of faculty, staff and students.	4.6	0.6	4	5	5
F3. Professional development and training.	4.7	0.5	4	5	5
F4. Large investments in equipment and infrastructure.	3.9	0.9	3.8	4	4.3
F5. Projects with other higher education institutions.	4.1	0.6	4	4	4.3
F6. Projects with other partners (e.g. industries).	3.9	0.7	4	4	4
F7. Exchanges and international cooperation.	4.1	0.8	4	4	5
F8. National initiatives and/or targeted financial support.	4.2	0.8	4	4	5
Inhibiting Factors					
I1. National regulation.	3.6	0.8	3	4	4
I2. Difficulty in designing a concerted approach for the entire institution.	3.7	0.9	3	4	4
I3. External quality control.	3.2	0.9	3	3	4
I4. Lack of external financing opportunities.	3.7	1.1	3	4	5
I5. Lack of human resources.	3.9	0.8	3	4	4
I6. Lack of support for professional development.	3.7	1.1	3	4	5
I7. Lack of digital infrastructure.	3.3	1.3	2	3	4
I8. Lack of support and maintenance services for digital technologies.	3.5	1.2	2.8	4	4.3
I9. Lack of motivation of the institutional team.	3.1	1.3	2	3	4
Elements of the Pedagogical Model for DE					
E1. The modular design of the contents.	4.5	0.6	4	5	5

(*continued*)

Table 4. (*continued*)

			Quartiles		
Items of the Scale by Subscales	M	SD	Q1	Q2	Q3
E2. Teaching and learning methodologies and activities aimed at making access more flexible.	4.7	0.6	4	5	5
E3. Curricular planning of collaborative processes and participation in virtual communities.	4.5	0.6	4	5	5
E4. Support for curriculum design and development of specific materials.	4.5	0.6	4	5	5
E5. Monitoring learning interactions.	4.5	0.6	4	5	5
E6. Balance between learning outcomes and formative and summative assessment procedures.	4.5	0.6	4	5	5

universally seen as a primary barrier. More consistent concerns were seen in: I3. External quality control (M = 3.2, SD = 0.9), I7. Lack of digital infrastructure (M = 3.3, SD = 1.3), and I8. Lack of support and maintenance services for digital technologies (M = 3.5, SD = 1.2). The highest-rated inhibiting factors were I5. Lack of human resources (M = 3.9, SD = 0.8) and I4. Lack of external financing opportunities (M = 3.7, SD = 1.1), indicating that institutional capacity and funding limitations are prominent concerns. These results reflect a mixture of internal and external challenges affecting DE adoption, with variability indicating different institutional realities.

Finally, the items related to the subscale Elements of the Pedagogical Model for DE were consistently rated very highly, with all items receiving mean scores between 4.5 and 4.7 and relatively low standard deviations (SD = 0.6 across all items). The top-rated item was: E2. Teaching and learning methodologies and activities aimed at making access more flexible (M = 4.7, SD = 0.6). Other consistently high-scoring elements included modular design (E1), curriculum design support (E4), and balanced assessment procedures (E6), all indicating that institutions place a strong emphasis on pedagogical design and innovation in their DE strategies. The interquartile ranges for these items were narrow, with Q1 and Q3 values generally between 4 and 5, indicating low variability and a strong consensus across institutions. These findings suggest that while logistical and structural challenges remain in some areas (e.g., infrastructure, external partnerships), pedagogical innovation and institutional commitment are strong and widely shared across the sample. Moreover, the relatively low variability in pedagogical model items may imply a consistent orientation toward best practices in online and hybrid education.

4 Conclusion

The results of this study offer valuable insights into the current landscape of DE in private HEIs in Portugal. The sample, comprising 38 institutions of varying sizes and regional representation, reflects a sector that is actively engaging with digital transformation, although with different levels of maturity and implementation. A majority of

institutions have already integrated DE into their strategic planning and invested significantly in technological infrastructure, including Learning Management Systems and secure virtual campuses. Support for faculty training and the development of pedagogical models is widespread, indicating a clear institutional commitment to quality in DE. Facilitating factors such as strategic alignment, professional development, and institutional engagement received the highest levels of agreement, suggesting that internal organizational readiness is a strong driver of DE integration. On the other hand, inhibiting factors, particularly related to human resource limitations, funding constraints, and digital infrastructure, highlight structural challenges that may hinder scalability and sustainability. Importantly, external barriers such as regulation and quality control frameworks were perceived as moderately constraining, reflecting the need for policy environments that better support innovation in digital education. The pedagogical dimension of DE was especially well-regarded across institutions, with consistently high scores for elements such as flexible methodologies, modular content design, and balanced assessment strategies. This suggests a strong and shared orientation toward best practices in online and hybrid learning environments. The reliability of the measurement scale, as indicated by the high Cronbach's alpha values, further validates the consistency and coherence of the institutional responses.

Therefore, globally, the findings portray a sector in transition, marked by strategic intent, pedagogical innovation, and infrastructural investment of private HEIs, yet still facing systemic challenges. Continued support, collaborative networks, and targeted policy measures will be essential to foster the full integration of DE into formal degree programs and to ensure its long-term effectiveness and equity.

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Communication and Gender in the Communication Departments of Public Higher Education Institutions of Porto City

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Abstract. Gender issues are still a major topic in the job market today. According to Portuguese law, organizations must put into action plans and objectives to eradicate gender discrimination and implement measures that contribute to the balance between the professional and personal lives of employees. Communication is one of the key areas for promoting and strengthening gender equality in society and organizations, particularly in higher education institutions, with communication departments playing a leading role. For this reason, this study formulated the following research question: What role do gender issues play in the communication departments of public higher education institutions of Porto City? And its main objective was defined as: to study the presence of women in the communication departments of public higher education institutes of Porto City, Portugal. The sample consisted of 21 communication departments of both the Polytechnic and the University of Porto. To conduct the research, a quantitative approach was used, with data being collected through a questionnaire survey. We concluded that public higher education institutions of Porto City need to create and implement action plans and objectives to eliminate gender discrimination and also to disclose them to their employees.

Keywords: Public Higher Education Institutions · Communication Departments · Communication · Digital · Gender equality · Women · Portugal

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 433–448, 2025.
https://doi.org/10.1007/978-3-032-09080-5_43

1 Introduction

There is a growing demand to address the underrepresentation of women in organizations, with stereotypes established in society having a marked impact on female underrepresentation. Stereotypes are generally based on the sex, ethnicity, nationality, religion and sexual orientation of individuals, with the most frequent being based on sex; for this reason, their impact on society should not be underestimated (Wojtowicz 2021). In this context, it is understood that communication and education are the two areas that most help in promoting and reinforcing gender equality, and they are also the ones that have the most power to reshape and question issues related to gender equality. According to this line of thought, the literature review suggests that the topic is relevant and can help to understand trends towards gender issues in the context of organizations, namely in the communication departments of public higher education institutes of Porto City, the focus of this research.

In this sense, the following research question was formulated: What role do gender issues play in the communication departments of public higher education institutions of Porto City? The main objective is as follows: to study the presence of women in the communication departments of public higher education institutes of Porto City, Portugal.

To conduct the study, a quantitative approach was used, with a questionnaire survey for collecting data. Once created and tested, the questionnaire collected data on five dimensions: 1) Sexual Stereotypes; 2) Legal and Normative Framework; 3) Genderized Organizations: 4) Work Family Articulation; 5) Theories of Sexual Segregation.

The sample consisted of the communication departments of both the University and the Polytechnic of Porto. It should be noted that at no point is the work recorded with the intention of drawing representative conclusions, but rather conclusions that contribute to the development of the topic under study. The article begins with a brief literature review, followed by a presentation of the methodological approach, presentation of the data, and discussion of the data, and ends with the presentation of the main conclusions.

2 Background

2.1 Communication, Digital and Higher Education

Technological advances have brought about changes in the communication paradigm in organizations (Pereira, 2022), particularly with the advent of digital media. Organizations were driven to migrate to the digital environment, which changed the way they communicate with the market and customers (Pereira, 2022). Thus, it became necessary, first of all, to analyze the organization's communication in order to select the appropriate digital media and strategically plan communication, as many organizations and brands focus on content related to the company and not on the needs of consumers.

The public has become a crucial element for corporate communication, since everything can be commented on and shared on the internet (Pereira, 2022). This scenario, combined with the emergence of the knowledge society, which values knowledge, information and technology, has given rise to new demands, particularly on higher education institutions, such as universities and polytechnics, which have had to reformulate their methods to adopt new management models, especially in communication to give greater

visibility to their identity and image (Gonçalves, 2015). Due to the diversity of the public of institutions, which includes students, teachers, employees, alumni, the press, government agencies and society in general, there was a need to identify and analyze the public in order to understand their information needs and how to communicate to each of them. It is up to a public relations professional to manage advertising in mass media; the organization of events and digital communication, which today are essential in promoting the image of institutions to an increasingly diverse and demanding public (Gonçalves, 2015). In this context, the communication offices are responsible for publicizing and promoting the image of the organization that they wish to convey to the target audience, using the appropriate channels. They are also responsible for planning and developing the communication strategy with the aim of achieving favorable public opinion for the entity itself. Communication offices are active sources that cover both internal and external communication needs and convey a positive image to the public, influencing their public opinion (Borges, 2016).

2.2 2.1.1 Gender and the Labor Market

Increasing female participation in the labor market can be seen as a progressive step towards achieving gender equality, but at the same time, it can result in increased sexual differentiation and segregation. We have been faced with sexual segregation, a phenomenon caused by the exclusion and difficulty of women to integrate into the labor market simply because they are women (Macedo & Santos, 2008), being one of the biggest obstacles for the female active population, causing a decrease in professional choices compared to men, increasing wage differences and preventing women from rising to higher positions (Bento, 2021; Madalozzo et al., 2010). Despite having a participation rate equal to or higher than that of men, women perform lower hierarchical positions, lower salaries and greater job insecurity.

2.3 2.1.2 Work-Family Blance

In recent years, both women and men have faced the challenge of balancing their professional and family responsibilities (Gonçalves, 2015). There are a number of practices that can be implemented to facilitate the balance between the professional and personal spheres, such as working part-time, having flexible working hours and using teleworking (Peters et al., 2009; Gonçalves, 2011). It is also necessary to change mentalities and social conduct regarding social and family roles so that women can focus on their careers without being pressured by family responsibilities. For this to be possible, it is necessary, for example, for someone to share family responsibilities with them, to postpone family projects and motherhood, and to hire domestic workers and childcare workers (Loureiro & Cardoso, 2008; Coelho, 2020). However, representations of women in most organizations are still traditional, with men being more likely to be hired for higher positions with better pay.

2.4 2.1.3 Theories of sexual segregation

The term vertical sexual segregation first appeared in the 1970s, and the most widely used term to describe this phenomenon is *glass ceiling*, which illustrates the existence of invisible obstacles that hinder women's professional progression and helps to understand that, in general, the promotion and development of women's careers is a longer and more difficult process than that of men (Duarte, 2008; Carli & Eagly, 2016; Coelho, 2020; Carvalho, 2021). Vertical sexual segregation is closely linked to institutional, cultural, structural and situational factors. To mitigate this phenomenon, it is necessary to adopt plans and tools that aim at gender equality within organizations (Paço & Casaca, 2021). Measures to incorporate into human resource management in organizations to mitigate these phenomena involve the development of training programs for women and men with the aim of recognizing the difficulties and barriers of the female gender in the organization and in society. Another measure (Coelho, 2020) is the formation of mentoring and contact networks to support women in building and maintaining professional relationships within the organization, in other words: assistance in managing their careers.

2.5 2.1.4 Gendered Organizations

In the late 1970s, author Rosabeth Moss Kanter identified that one of the disadvantageous factors for women in the organizational context was the lower number of women than men in organizations. It was based on the latter factor that the term tokenism emerged, used when in an organizational context a group is extremely underrepresented (Paço and Casaca, 2021; Salvador, 2022). Later, in the 1990s, the scientific community understood that in reality organizations are not gender-neutral. Organizations are gendered. For organizational change to promote gender equality, the following categories must be incorporated into formal procedures: informal patterns of daily social interaction; narratives, rhetoric, languages, and other symbolic expressions; and formal strategy, policies, and procedures. However, many organizations continue to compromise gender equality principles at the strategic level without making changes to internal management processes, expectations, informal work organization patterns, and social interactions. Organizations should formally and explicitly declare the promotion of equality between men and women through formal documents, such as plans, reports, and expressly formulated organizational policies (Paço & Casaca, 2021).

2.6 2.1.5 Legal and Regulatory Framework

Laws and policies implemented by government agencies encourage organizations to implement practices and behaviors to promote gender equality and a more balanced composition of management bodies (Bento, 2021). In this sense, measures have been taken to strengthen female participation in economic decision-making and the progressive elimination of wage differences between men and women, as well as to promote equal opportunities for the sexes in the labor market and eradicate discrimination and facilitate the balance between family and work (DRE, 2012; DRE, 2013b; DRE, 2013c). Measures have been taken to reduce women's pay inequality, implement a plan to promote gender equality, increase women's representation in management and administration bodies, increase pay equality between women and men performing the same or

similar functions, develop a support mechanism for companies to analyze gender pay differences without adding costs to organizations, and even recommend a minimum representation of 40% of each sex in public administration bodies and positions (DRE, 2014a; DRE, 2014b; DRE, 2014c; DRE, 2015; DRE, 2019). Thus, in recent decades, it is possible to see that companies and organizations seek to promote change in business processes by incorporating the gender perspective to respond to the new competitive and challenging labor market. To this end, it is necessary to implement methods and tools directly incorporated into the activities developed by the organization (Bento, 2021).

3 Empirical Research

3.1 Problem and Objectives

In recent decades, the issue of gender in the labor market has increased, but women's participation has not eliminated social gender inequalities (Blass, 2002). There are various obstacles facing women during their professional careers, including: sexual stereotypes (Bento, 2021; Coelho, 2020; Duarte, 2008; Loureiro & Cardoso, 2008; Wojtowicz, 2021); difficulties in articulating family and work (Coelho, 2020; Gonçalves, 2011; Loureiro & Cardoso, 2008; Peters et al., 2009); theories of sexual segregation, which represent women's difficulties in the hierarchy within organizations (Carli & Eagly, 2016; Carvalho, 2021; Coelho, 2020; Duarte, 2008; Paço & Casaca, 2021) and the fact that organizations are not gender neutral (Paço & Casaca, 2021; Salvador, 2022).

Communication and education are the two areas that most influence gender equality (Commission for Citizenship and Gender Equality, no date). It is up to higher education communication offices to give greater visibility to the image and identity of institutes, and they are responsible for conveying a positive image, thus influencing public opinion (Borges, 2016). With this in mind, the following research question was formulated: What role do gender issues play in the communication departments of public higher education institutions of Porto City? To answer the research question, the following general objective was defined: to study the presence of women in the communication departments of public higher education institutes of Porto City, Portugal; and the following specific objectives: to characterize the participants in order to collect data on the percentage of men and women working in the departments, age, academic degree, type of course, marital status; to identify the participants' perception of the role of men and women in society; to identify the participants' perception of gender equality between men and women; to study the participants' perception of organizational positions and functions; to study the participants' perception of work-life balance; to collect the participants' perception of sexual segregation theories.

3.2 Research Design

To carry out the study, we opted for a descriptive study of a quantitative nature. Data was collected through a questionnaire survey based on the literature review, with questions also adapted from the work of Carolina David, entitled (2020). The questionnaire begins with a screening question to ensure that only people working in an education communication department at public higher education institutions of Porto City responded. The questionnaire is made up of 25 questions that sought answers to the five dimensions under study: 1) Sexual Stereotypes; 2) Legal and Normative Framework; 3) Genderized Organizations: 4) Work Family Articulation; 5) Theories of Sexual Segregation, as shown in the analysis matrix - see Table 1. It should be noted that a Likert scale was used, with the number 1 - Totally Disagree and 5 - Totally Agree; there was also the option NS/NR - Don't Know/No Reply. The last question referred to the collection of sociodemographic data - see Table 1.

Table 1. Analysis matrix

Dimension	Questions	Author
Sexual Stereotypes	1.1 Women don't take on managerial positions because they prefer to devote themselves to their families. 1.2 Professional careers are more important for men than for women. 1.3 Companies hire more men than women because they have fewer absences. 1.4. Women tend to be persuaded to join professions that are considered feminine. 1.5 It is better to have men in management than a woman.	(Coelho, 2020) (Loureiro & Cardoso, 2008) (Wojtowicz, 2021)
Legal and Normative Framework	2.1 There must be laws that define gender quotas. 2.2 Gender equality on management and supervisory boards increases company performance. 2.3 There is promotion of gender rquality in my department. 2.4 There are action plans to eradicate gender discrimination. 2.5 Objectives are created for balanced gender representation and policies are created to increase the number of employees from the under-represented sex.	(DRE, 2013b) Resolução do Concelho de Ministros °19/2012 de 8 de março - (DRE, 2012) Decreto- lei, n° 157/ 2014, de 24 de Outubro, artigo 30 Disposições Gerais n°6 - (DRE, 2014b)

(*continued*)

Table 1. (*continued*)

Dimension	Questions	Author
Genderized Organizations	3.1. Jobs are assigned according to the abilities of the employees, whether they are men or women. 3.2 In my organization, being a man or a woman does not interfere with the assignment of jobs. 3.3 Preconceived ideas about men and women define job assignments in my company. 3.4 Certain jobs are designed for a certain gender. 3.5. Senior positions are defined for men.	(Paço & Casaca, 2021)
Articulation Family Work	4.1. Work-life balance is ensured. 4.2. Working hours are flexible in order to reconcile work and family life. 4.3 When necessary, teleworking is permitted in order to reconcile professional and personal life. 4.4. The department where I work defines teleworking days per month. 4.5 It's difficult to reconcile my professional and family life.	(Gonçalves, 2011) (Peters et al., 2009)
Theories of Sexual Segregation	5.1 There are more men in senior positions. 5.2 Women are in lower hierarchical positions. 5.3 Women face more obstacles preventing them from reaching positions of power and authority. 5.4 There are invisible obstacles preventing women from rising to higher positions. 5.5 Promotion and career development are slower for women than for men.	(Paço & Casaca, 2021) (Coelho, 2020)

To collect the data, the questionnaire was sent to the different departments under study via e-mail. Excel and frequency and descriptive statistics were used to analyze the data.

3.3 Sample

This research was focused on the public education institutes of Porto City, Portugal, with the research participants being the employees of the communication departments of the University and the Polytechnic of Porto - see Table 2.

Table 2 – Sample

University of Porto	Polytechnic Institute of Porto
Faculty of Architecture	Porto Higher Institute of Engineering
Faculty of Science	Porto Higher Institute of Accounting and Administration
Faculty of Sport	School of Education
Faculty of Economics	School of Music and Performing Arts
Faculty of Pharmacy	School of Technology and Management
Faculty of Dental Medicine	School of Health
Faculty of Psychology and Educational Sciences	School of Hospitality and Tourism
Faculty of Fine Arts	School of Media Arts and Design
Faculty of Nutrition and Food	
Faculty of Law	
Faculty of Engineering	
Faculty of Arts	
Faculty of Medicine	
Abel Salazar Institute of Biomedical Sciences (ICBAS)	

A total of twenty-two emails were sent asking departments to participate. After the questionnaire was sent by email, some responses were received from the departments with essential information for the research, the communication of ESMAD (School of Media Arts and Design) and ESHT (School of Hospitality and Tourism) is done by the same department and FAUP (Faculty of Law of the University of Law) informed that they could not contribute to the research.

According to the data, the majority of participants who work in the communication departments of Porto's public higher education institutes - universities and polytechnics - are female, aged between 26 and 35, single, have a master's degree, have completed their studies in the field of communication, the role of "team member (collaborator)" is the most commonly held, and have worked there for less than 5 years or up to 10 years. The majority have never been promoted - see Table 3.

Table 3 - characteristics of the participants

Characteristics of the participants	Number of Responses	%
Sex - Female	13	87%
Age between 26 and 35	5	33%
Single	7	47%
Master's degree	9	60%
Studies in the area of communication	12	80%
Team Member (Collaborator)	11	73,3%
Up to 10 years of employment	5	33,3%
Promoted during time with the company	10	67%

4 Results

4.1 Sexual Stereotypes

As the table shows, the majority of employees in the communications departments of public higher education institutions of Porto City area disagree with the attributes attributed to each gender based on stereotypes - see Table 4.

Table 4. – Results of sexual stereotypes

	1	**2**	**3**	**4**	**5**	**I don't know/I don't answer**
1.1 Women don't take on managerial positions because they prefer to devote themselves to their families.	7	6	1	1	0	0
1.2 Professional careers are more important for men than for women.	7	4	3	1	0	0
1.3 Companies hire more men than women because they have fewer absences.	6	0	6	1	1	1
1.4. Women tend to be persuaded to join professions that are considered feminine.	5	1	6	1	2	0
1.5 It is better to have men in management than a woman.	10	3	1	0	1	0

4.2 Legal and normative framework

The responses show that employees are aware of the existence of action plans to promote gender equality, with the aim of eradicating gender discrimination. However, a

considerable number of employees are not aware of the existence of such documents - see Table 5.

Table 5. – Results of the legal and normative framework

	1	2	3	4	5	I don't know/I don't answer
2.1 There must be laws that define gender quotas.	3	3	4	3	1	1
2.2 Gender equality on management and supervisory boards increases company performance	1	0	5	5	3	1
2.3 There is promotion of gender equality in my department.	2	0	2	6	4	1
2.4 There are action plans to eradicate gender discrimination.	2	2	3	5	2	1
2.5 Objectives are created for balanced gender representation and policies are created to increase the number of employees from the under-represented sex.	3	0	5	5	1	1

4.3 Genderized organizations

Most respondents say that roles are not assigned based on gender, only the ability of individuals is considered when assigning roles and roles are not designed specifically for a particular gender. On the other hand, the majority say that senior positions are designed for men - see Table 6.

Table 6. Results of the genderized organizations

	1	2	3	4	5	I don't know/I don't answer
3.1. Jobs are assigned according to the abilities of the employees, whether they are men or women.	2	1	2	2	8	0
3.2 In my organization, being a man or a woman does not interfere with the assignment of jobs.	1	2	2	4	4	2
3.3 Preconceived ideas about men and women define job assignments in my company.	4	3	4	1	1	2
3.4 Certain jobs are designed for a certain gender.	2	6	5	1	1	0
3.5. Senior positions are defined for men.	8	3	1	0	2	1

4.4 Articulation Family Work

According to the results, it is possible to state that the communication departments of public higher education of Porto City deal differently with measures aimed at balancing family life and professional life. However, there is one issue on which the majority agree: "The department where I work defines teleworking days per month." – see Table 7.

Table 7. Results of the articulation family work

	1	2	3	4	5	I don't know/I don't answer
4.1. Work-life balance is ensured.	1	5	3	5	1	0
4.2. Working hours are flexible in order to reconcile work and family life.	2	6	2	3	2	0
4.3 When necessary, teleworking is permitted in order to reconcile professional and personal life.	4	1	3	5	1	1
4.4. The department where I work defines teleworking days per month.	10	1	2	1	0	1
4.5 It's difficult to reconcile my professional and family life.	1	5	3	3	2	1

4.5 Theories of Sexual Segregation

Based on the results obtained, we can see that employees state that women are not in lower hierarchical positions, with half stating that there is a greater proportion of men in higher positions. The opinion of employees regarding the promotion and development of women's careers being slower is divided. The same happens when asked if women face obstacles that prevent them from rising to higher positions and if they face invisible obstacles." – see Table 8.

Table 8. Results of the Articulation Family Work

	1	2	3	4	5	I don't know/I don't answer
5.1 There are more men in senior positions.	2	2	3	5	2	1
5.2 Women are in lower hierarchical positions.	2	7	3	1	2	0
5.3 Women face more obstacles preventing them from reaching positions of power and authority.	2	5	1	5	2	0

(*continued*)

Table 8. (*continued*)

	1	2	3	4	5	I don't know/I don't answer
5.4 There are invisible obstacles preventing women from rising to higher positions.	4	2	3	3	2	1
5.5 Promotion and career development are slower for women than for men.	4	2	3	4	2	0

5 Discussion

One of the results that we consider relevant is the fact that women are more represented in the context of communication departments in public higher education institutions of Porto City, with only two of the respondents being heads of the department, both of whom are women. Thus, we can say that there is indeed a significant difference between the sexes in the communication departments of public higher education institutions of Porto City, with men being the underrepresented group. This result allows us to categorize the context of communication departments as distorted groups, as there is an understanding that there is dominance over the underrepresented gender, where the majority is designated as dominant and the minority is referred to as tokens (Paços and Casaca, 2021; Salvador, 2022).

The data show that participants disagree with the attributes that are associated with each gender based on stereotypes. The literature review indicates that there is disagreement regarding prejudices related to expectations between men and women in society (Coelho, 2020). The majority of respondents state that roles are assigned based on the individual's ability rather than gender and that roles are not specifically designed for a particular gender. However, the majority state that senior positions are specifically designed for men. When asked whether preconceived ideas about gender define the assignment of roles, there is no position that represents the majority. These data corroborate the thinking of Paço and Casaca (2021), when they state that organizations are not gender neutral; preconceived ideas define roles and positions in roles of a particular gender.

There are methods that can be adopted and incorporated into formal procedures in organizations, however, many organizations implement these changes only on paper, not actually changing the way internal processes are formulated. In this sense, it is understood, based on the results, that it is up to public higher education institutions of Porto City to implement new measures so that the institutes' communication departments become gender neutral. The data also allows us to assess that gender equality is being promoted through action plans to eradicate gender discrimination, although there are workers who disagree with its existence, not taking any position and choosing to demonstrate that they did not want to or did not know how to respond. Given this result, we believe that we are able to point out two causes that may be the basis for the result:

1) some institutions do not actually have any action plan to eradicate gender discrimination, nor any objectives outlined for this purpose; 2) the institutions do not disclose or do not make the information/documentation available to their employees. Therefore, we believe we are in a position to state that in the communication departments of public higher education institutions there is still no strong applicability of Council of Ministers Resolution No. 19/2012 of March 8, which refers to the fact that all business sectors must seek to establish gender equality plans, to achieve parity of treatment and opportunities between men and women, to eradicate discrimination in the workplace, facilitate family work, as well as Decree-Law No. 157/2014, of October 24, article 30, General Provisions, no. 6, which points out the internal need to promote the diversity of qualifications and skills for the role performed, set objectives for the representation of women and men and create a policy to increase the number of underrepresented employees.

The data also indicate that there still seems to be work to be done regarding the dimension that concerns the balance between family life and professional life, since, in general, employees are unable to clearly define whether there is in fact a balance between family life and professional life in the workplace, flexible working hours or the practice of teleworking when necessary. Where the majority are in agreement is regarding the stipulation of teleworking days per month, with the majority disagreeing. This context reinforces the idea that, currently, both genders face difficulties in reconciling professional and family life due to the constant changes in the job market (Gonçalves, 2011). The difficulty in reconciling professional and family life can lead to the development of a psychological condition called occupational stress, affecting both aspects of an individual's personal and professional life, as professional demands exceed the individual's capacity. This scenario also leads us to understand that measures that can be implemented to prevent the emergence of this condition and help balance professional and personal life may not be applied in the context of the communication departments of public higher education institutions, namely: implementation of flexible hours, practice of teleworking and working part-time (Peter et al. 2009).

Regarding hierarchical position, the data show that women are not in lower hierarchical positions, with half of the participants stating that there is a higher proportion of men in higher positions. Therefore, it is not possible to determine whether these departments are framed by the theory of vertical sexual segregation (Paço and Casaca, 2011). On the other hand, it is understood that the results are somewhat contradictory, considering that 87% of the respondents are women and only 13.3% are men and when asked about their hierarchical position within their respective departments, only two respondents answered that they were department heads, both of whom were women. It is understood that this context may refer to sexual segregation and at the same time corroborate the thinking described in the literature review, expressed throughout the first part of this work, when considering that the invisible/imaginary ceiling represents a blockage in the progression of women's careers (Coelho, 2020; Paço and Casaca, 2021), and it is not possible to conclude based on the majority whether women in these departments feel "blocked" or "prevented" from progressing in their careers, since the opinion of those surveyed is divided.

6 Conclusion

Among the distinct changes in organizations are the arrival of digital technology and the issue of gender, particularly with the presence of women in the job market. And since communication and education are two areas that influence gender equality, higher education communication offices end up assuming a relevant role in transmitting a positive image, thus influencing public opinion (Borgues, 2016).

In this sense, our work formulated the following research question: What is the role of gender issues in the context of communication departments of public higher education institutions of Porto City? To collect the data, we focused the research on a quantitative approach, with data being collected through a questionnaire survey. After analyzing and discussing the results, it can be concluded that in the case of the communication departments of higher education institutes of Porto City, women represent the predominant gender. There is a significant difference between genders and a lack of knowledge about the existence of action plans to eradicate gender discrimination and the existence of objectives to that effect. If such documentation exists, higher education institutes do not disclose it to their employees. It can also be concluded that working hours are not always flexible; and teleworking is not permitted if necessary; that there are "preconceived ideas" regarding the difference between functions performed in general and functions associated with "higher positions". However, when the function is associated with "higher positions", the data allow us to conclude that these positions in the organizations under study are specifically designated for men and it is men who occupy them.

Let us return to the research question that guided the study: What is the role of gender issues in the context of the communication departments of public higher education institutions of Porto City? We understand that the presence of women in the communication departments of public higher education institutions of Porto City is a reality, but it is urgent to address the practice of gender equality issues in a visible way.

Although it manages to meet the purpose of the work, it is understood that it has limitations, namely a small sample of participants. However, it should be noted that the purpose was never to draw close or representative conclusions, but rather to collect data that would contribute to the development of the theme. This work serves as a starting point for future work, since it can be applied to all communication departments of public and private higher education institutions in Portugal; a work to be developed at a later stage.

Acknowledgments. This work was supported by national funds through the Fundação para a Ciência e a Tecnologia, I.P. (Portuguese Foundation for Science and Technology) by the project UID/05064 – Research Centre for Endogenous Resource Valorization.

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Principles of Neuroeducation in the Educational Thought of José Martí. The Children's Magazine "La Edad de Oro" (The Golden Age)

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Abstract. Although neuroeducation is a modern discipline, where neuroscience, psychology and education are integrated to holistically understand how the brain learns and to better influence the learning process, elements of this discipline can be seen in multiple studies within the Latin American educational thought of the 19th century, revealing its validity.

This paper reflects on some ideas present in the work of José Martí (1853–1895) which, saving the distances, are part of the principles of neuroeducation. For the study we selected the magazine "La Edad de Oro" (The Golden Age), dedicated to the children of America, written in 1889 in New York, which synthesizes all the pedagogical ideology of this great teacher of America.

Through an analysis of a selection of Golden Age tales, elements are identified that anticipate modern concepts of learning, motivation and cognitive development, courage, honesty, loyalty, love of nature and friendship.

The contribution of this work is to bring to light these Martian ideas as a guide for educational action and to value the importance of making this work known in children's education in the present XXI Century for the work of teachers and parents in the current context.

Keywords: Neuroeducation · children's stories · validity of Martian ideas · critical thinking · education · children

1 Introduction. Children's Literature in the 19th Century. A Necessary Analysis to Understand Marti's Stories in this Context.

Although the term "neuroeducation" did not even exist in the 19th century (José Martí's time), many of the principles on education, which he promoted, can be inter-prepared through the approach of this discipline.

Nowadays, the importance of developing critical thinking in children and youngsters, of developing multidisciplinary skills that allow them to interact in an ever-changing context, in the so-called liquid world, where everything is ephemeral, changing every day;

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 449–458, 2025.
https://doi.org/10.1007/978-3-032-09080-5_44

multiple studies show the need to develop research skills to operate with the avalanche of information and where knowledge doubles every 12 h.

UNESCO has spoken out, calling for a change in the way we act, for a new approach to education that puts the student at the center, for a change in old teaching methods and strategies, and for the development of skills for research, learning, communication and harmonious coexistence.

The current Latin American educational system, still permeated by traditional conceptions, tries to survive in this chaos and, on many occasions, tries to impose models brought from other regions distant from our realities that have a counterproductive effect. In this context, the validity of the pedagogical thought of José Martí (1853–1895), which is synthesized in the children's magazine "La Edad de oro" (The Golden Age), written in 1889, is re-signified.

The Golden Age transcends through time, until reaching the present day with its messages, which make great sense in the current context, where the development of critical thinking and, above all, the formation of solid ethical values are becoming increasingly necessary. In this literary jewel are recognized principles that neuroscience as a discipline has at its core for meaningful learning in the present century:

Thus, in this historical moment, Marti's educational project could be read from the perspective of Critical Pedagogy, understood as a horizontal pedagogical practice, where knowledge is constructed in a critical way through a complex reading of reality and whose objective is social transformation and the freedom of the individual [1].

This children's magazine is considered a synthesis of the maturity of this great intellectual, master of America. All his legacy on the need to form the future of men and women of America, "Our America", as he called the classic essay, of obligatory consultation also to understand the American context "from the Bravo River to Patagonia".

Although it is not a question of analyzing the relationship between the Essay Our America and the magazine written for children The Golden Age, it is necessary to point out how in The Golden Age (1889) the need to form a critical thinking in "the children of America" is intended, a critical thinking in the men and women of tomorrow "So we want the children of America (...) to say what they think, and say it well (...)". Critical thinking that will lead to the formation of free, independent men and women for "the hour of reckoning and the united march" [2].

It is known that the 19th century has been characterized as the golden age of children's literature; a great flourishing of it from great works that recreated the folklore of Europe as the Brothers Grimm, or the classic stories of the prince of children's literature Hans Cristian Andersen; the great Carlo Collodi in Italy, with his great work "Pinocchio", among many others.

Children's literature had gone from the rationalism that marked the century of the Enlightenment, to a romanticism that gave free rein to the imagination and fantasies of castles, princes, talking dolls (...). "It appealed to the powers of perception, cognition and creativity of preadolescents and the anxieties of adults to regain their lost child self" [3].

In general, in the 19th century, children were valued as developing beings, small men, "rudiments of life", dependent on the guidance of older people, on the other hand, childhood went unnoticed by public policy services; many times the child was a source of cheap labor in the fields, in factories or as servants; an example is the classic David Copperfield, by Charles Dickens.

In Latin America, on the other hand, children's literature during the 19th century was mainly aimed at learning to read and to teach catechism:

The transmission of moral norms (...) literature operated as a subordinate connection with respect to adults and also participated in the machinery of political and class reproduction. The fundamental addressee of this literature was the bourgeois child, who had to "be prepared to assume his leading role", while the poor needed "to be protected in order to become a labor force..." [4].

In contrast to these 19th century ideas, we can appreciate the teacher's ideas about the need to cultivate reason, critical thinking, and the integral formation of the children of America, expressed in a letter to his friend Manuel Mercado on August 3, 1889, when only the first issue of the magazine had been published:

"(...) it carries a deep thought, and since I am carrying it on my shoulders, which is no small burden, it must be to help what I would like to help, which is to fill our land with original men, raised to be happy in the lands in which they live, and to live according to it, without divorcing themselves from it, nor living unfruitfully in it, as rhetorical citizens, or disdainful foreigners born by punishment in another part of the world. The fertilizer can be brought from other places, but the cultivation must be done according to the soil. We must raise our children to be children of their time, and men of America" (...) We must raise our children to be men of their time, and men of America. If I had not had this dignity in my eyes, I would not have entered into this enterprise" [5].

Specifically at present, the educational institutions in Ecuador, the potential of the stories of the children's magazine "La Edad de Oro" are underestimated, which has been demonstrated in the works of culmination of undergraduate and graduate studies in the area of Education and Pedagogy of the Universidad Tecnológica Israel.

Interesting proposals are made for the development of reading and writing in children; educational strategies are implemented, materials and didactic methods are created for the development of creativity in children and young people, supposedly through children's literature, however, not only its great artistic and literary value is underestimated due to the resources it uses, its language and the high value of its messages, but also the collection of pedagogical principles that are related to the principles of neuroeducation at present.

Based on the above, some questions that served as a guide during the present study are outlined. What are the explicit and implicit messages for the children of the Americas that underlie the current principles of neuroeducation for learning in the present century?

These questions in turn are starting points for the continuity of the present study, the answer to which would imply the validity and relevance of the present study: How do children today receive the stories that José Martí published for them in the last century?

2 Methodological Process.

A descriptive, interpretative study was carried out under a mixed methodological approach, integrating qualitative and quantitative techniques.

The first phase was guided by the question: What stories should be selected from the children's magazine "La edad de Oro" to promote the development of critical thinking and foster values in Latin American children? Under this question, the purposive sample was determined; it consisted of 3 stories:

1. Little finger.
2. Baby and Mr. Don Pomposo.
3. The black doll.

As well as for the front page of the magazine, for its high ethical messages addressed to the recipients of the magazine "the children of America".

The intentionality of the sample is that, in all these stories, messages to children are appreciated, related to current principles of critical thinking and ethical values that are explicitly addressed by UNESCO in its guidelines for education in the present century [6].

Methods and Techniques Used:
For the analysis of the stories, where the historical-hermeneutic method is integrated from an interdisciplinary perspective: integrating neuroeducation, pedagogy and history of education, the following techniques were used:

Key Informant Interview:
From the perspective of the researchers, tutors, and members of the tribunals of the Master's Degree in Education mention in ICT-mediated Learning Management and the Master's Degree in Pedagogy at UISRAEL during the years 2020 to the present 2024, questions were asked at the graduation ceremony to those students who were considered key informants.

The selection of these key informants was made taking into account that their degree works: Estrategias, Acciones y Modelos Pedagógicos, were focused on the area of language and literature and had at least one activity related to children's literature. For this purpose, an interview guide was elaborated using a Likert scale to evaluate the items that made up the questions. This scale assumes certain response options to the question: Do you know the children's magazine written by José Martí for the children of America "La Edad de Oro", and if so, please answer: Do you carry out activities with children based on the stories in this children's magazine? This second question assumes certain response options according to the scale: Always, Almost always, Sometimes, Almost never and Never.

Content Analysis:
Based on the question: What are the explicit and implicit messages for the children of America that underlie the current principles of neuroeducation for learning in the present century? A review and critical analysis of a selection of stories from the children's magazine La Edad de Oro was carried out, using content analysis of the selected stories and

hermeneutics as a tool. The aim was to identify and reflect on the neuro-educational principles present in the texts, and values such as friendship, solidarity, honesty, loyalty, courage, values that are essential to educate children and young people today. In relation to the aforementioned question, the following dimensions were analyzed: explicit messages and implicit messages.

Methodological Triangulation:
The methodological triangulation allowed contrasting the results with primary and secondary sources, in order to understand how José Martí's ideas anticipated principles that today are fundamental in neuroeducation; as well as to contextualize these findings within the historical and cultural framework of 19th century children's literature.

This approach made it possible to highlight the relevance and validity of Martí's thought in the field of contemporary education, exposed in the stories of The Golden Age, and to unveil the need to take advantage of its potentialities within the educational work in the formation of Latin American children and young people, who are the recipients of this jewel of literature.

3 Results and Discussion.

Despite the existence in Quito, the capital of Ecuador, of monuments dedicated to the figure of José Martí, in significant places such as Mariana de Jesús Avenue and La mitad del Mundo, there is a lack of knowledge of his figure, his contributions, his legacy and his children's work "La Edad de Oro" (The Golden Age).

In the degree works that address results aimed at working with children's literature in the Master's Degrees in Education and Pedagogy, works far from our Latin American traditions can be appreciated.

The final expression of this story explicitly synthesizes the very essence of the meaning that the value of her black grimace takes on for Piedad "I love you, because they don't love you!" [14].

The stories of The Golden Age are considered a jewel in universal children's literature for their high ethical and human values; they constitute an invaluable material for the pedagogical work of teachers and parents, however, they are practically unknown in Latin America at present.

In the questions directed to the students in their act of defense about: Do you know the children's magazine La Edad de Oro written by José Martí? 100% expressed their ignorance; only 98% of the interviewees recognize the name of José Martí, although they do not know his work and much less his contributions and validity.

To the question asked, it was made explicit: if yes, please answer: Do you carry out activities with the children based on the stories in this children's magazine? This second question assumes certain response options according to the scale: Always, Almost always, Sometimes, Almost never and Never.

As can be seen in Table 1, there is no evidence of pedagogical work with the children, based on the potential of Martí's stories, since literally, in spite of being moderately aware of the existence of José Martí, they do not know his work and the children's magazine the golden age (The Golden Age).

Table 1. *Do you know the children's magazine written by José Martí for the children of America "The golden age"?*

A total of 30 interventions were analyzed			
Items	Alternative	Frequency	%
1	Always	0	0%
2	Almost always	0	0%
3	Sometimes	0	0%
4	Almost never	0	0%
5	Never	30	100%

Source: Own elaboration. (2025)

On the other hand, in 90% of the works consulted in which contributions related to children's literature are appreciated, it was revealed that the selection of works to work with children is done at random, which showed, first of all, a total ignorance of the need to start from the age for whom such pedagogical work is intended; in another order, the stories selected are very well known and respond to European contexts; 75% of the selected works were found to have no literary value for pedagogical work because they are well below the age of the children for whom the educational actions are intended.

Similar results are corroborated in the literature consulted; in other Latin American countries, for example in Costa Rica, a study is identified that also recognizes the need to deepen in the values and relevance of the study of Marti's work; therefore, "it is necessary that the new generations know and identify themselves with thoughts, ideas and values of Latin American roots and universal character" [7]. Only in Cuba is there a large number of studies that do assert the validity of Marti's thought in the work directly with children, among which the following stand out: [8]; [9]; [10]; [11].

These reasons are due to the fact that the Cuban education system declares Marti's thought within its epistemic foundations.

The content analysis of the stories was focused on the messages addressed to the receiver of the magazine; more than answers, questions are left about the communication established by the author with the children of America; why can we say that these messages transcend through the centuries and reach our times loaded with symbolisms that acquire great importance for education today; what resources does the author use to establish this dialogue with the children; why can we say that more than a work written for children, The Golden Age is a guide for teachers in their educational work? Why can it be said that more than a work written for children, The Golden Age is a guide for teachers in their educational work?

These questions are re-signified through the contexts as The Golden Age goes through them, and that is the value of this literary jewel, always open to new interpretations; where the text-context relationship makes the messages alive, whether explicitly or implicitly (Table 2).

Table 2. *Dimensions: explicit messages and implicit messages*

DIMENSIONS	INDICATORS
Explicit messages about the neuro-educational principles present in the texts, and values such as friendship, solidarity, honesty, loyalty, courage, etc.	They appear directly as messages from the author, or in the mouths of the characters.
Implicit messages about the neuro-educational principles present in the texts, and values such as friendship, solidarity, honesty, loyalty, bravery, etc.	They appear in the texts through the parliaments of the characters or through literary devices.

Source: Own elaboration. (2025)

Current Principles of Neuroeducation in the Stories Selected in the Study.
This magazine not only has a great literary artistic value due to the resources it uses, its language and the high value of its messages, but also as a very important element is the collection of pedagogical principles that are related to the principles of neuroeducation today:

From the first page, the first words of the author, explicitly mention the recipients of the magazine "For boys is this newspaper, and for girls, of course" [12]. Already in this first line, she breaks with the conceptions of the 19th century that relegated women to the background and clarifies with direct language, full of respect and tenderness, that she intends to capture the attention of an audience that she treats as a friend, emphasizing who her readers will be and emphasizing with some touches of tenderness and affection: "without girls you cannot live, just as the earth cannot live without light" [12].

These messages addressed to girls are of extraordinary value in the context of the 19th century because "little is known about them except for a few notable examples, they were clearly educated in the domestic sphere by their mothers and their prestige depended on the male scale of values" [13]; However, in this first page of The Golden Age he openly expresses:

Girls should know the same as boys, so that they can talk to them as friends when they grow up; as it is a pity that a man has to go out of his house to look for someone to talk to, because the women of the house do not know how to tell him about anything but amusements and fashions [12].

The education of women, in a clear break with the social orders established in the 19th century, remains extraordinarily relevant in Latin American contexts, where very strong patriarchal ideas that minimize the social role of women still persist.

There are several stories in The Golden Age whose main characters are girls, such as Nené in the story "Nené traviesa"; Pilar in "Zapaticos de Rosa"; or Pie-dad, a very symbolic name, in the story "La muñeca negra" (The Black Doll).

The story "The Black Doll" reflects ideas in favor of respect, diversity and against racism and social inequality. In this story, Martí displays all his masterly skills as a psychologist, it is not the author talking to children: it is Piedad, talking to her doll like any other girl who plays, who gives life to her favorite doll; Martí is able to penetrate the conscience of a girl, who, in this soliloquy, exalts the values that make us see how inner beauty, the depth of love, is in the interior and not in the physical or the superficial. When we make this analysis of the implicit messages, in the light of the principles of neuroeducation today, we can see how these personal experiences of Piedad, are transferred to the emotional level of the young reader, causing a significant learning in children, who are able to fully identify with the context of the story helping them to understand their own.

The story "The black doll" is loaded with symbolism; the contrast as a literary resource is used to contrast ideas that mark social inequality and discrimination: On the one hand, tenderness, true love, emanating from the black doll, a worn, old doll, but that embodies affection versus the blonde doll that represents the superficial, devoid of emotional meaning. This message is implicit but is reiterated in different ways in the magazine, where the most important thing is not the physical appearance, nor the material, but love, the interior of the human being. This is also read directly in the dedication:

But never is a child more beautiful than when he carries in his strong man's little hands a flower for his friend, or when he carries his sister on his arm, so that no one will offend her: the child then grows up, and looks like a giant [15].

This idea is reinforced in the characterization of Little Pinky: small but full of wit and attributes "he was cute as a woman, and lighter than a spring, but so small that he could hide in his father's boot" [16]. Implicitly we can appreciate the internal characterization of Littlefinger as brave, honest, intelligent, creative, which makes him win the fight against the giant and as a trophy to marry the Princess. Explicitly Martí makes it clear from the beginning that "the story of the wise Littlefinger is told, and it is seen that knowledge is worth more than strength" [17].

This story can be characterized as many others that deal with travel themes, so popular in 19th Century children's literature "to promote the spiritual and physical development of young heroes (...)" [18], classics such as Robinson Crusoe, Tom Sawyer and Huckleberry Finn, among many others. However, in Littlefinger we see a very peculiar journey where a paradox is revealed between the magic of its environment, its characters and situations in the midst of castles and enchanted forests and its plot loaded with messages for the development of critical thinking in the middle of the 19th century (Table 3).

Table 3. *Explicit messages related to neuroscience principles through the story Littlefinger*

Explicit messages in the story "Littlefinger"	Current principles of neuroscience related to the messages of the story "Littlefinger"
"At every step he had something new to ask his brothers and sisters: why did the bees stick their little heads in the flowers, why did the swallows fly so close to the water, why didn't the butterflies fly straight (...)." I would like to know why they are up there cutting firewood, "said Meñique (...)". "I'm going to see what they're doing up there," said Littlefinger." "I'd like to know who's out there chopping rocks," said Littlefinger." "I'm going to see what's going on out there." "I'd like to know," said Littlefinger," where does so much water come from in a valley as flat as this one?" "Hush, servant," said Littlefinger;" well you know that strength is not good for everything. Let me think." "But it must not be said that Littlefinger was good. Good had to be a man of such great wit; for he who is stupid is not good, and he who is good is not stupid." "To have talent is to have a good heart; he who has a good heart, that is the one who has talent."	✓ Curiosity; discovery as an essential element in learning, personality development. ✓ The importance of intelligence and the search for solutions; creativity, as an essential element within critical thinking for problem solving based on motivation as an essential element for learning. ✓ The relationship between the cognitive and the affective as an essential element for developmental learning. ✓ The importance of Active Learning; the active role for a developmental learning. The search for answers: the question is the first step to find solutions and solve environmental problems, improve the context from innovative solutions. The real learning comes from the involvement of the child in learning, when he/she takes an active role. ✓ The value of knowledge, intelligence, cunning over brute force. ✓ The need to develop values such as justice and honesty. ✓ The relationship between human values and time, between instructive and educational, goodness is only an attribute of people who have knowledge. ✓ The relationship between knowing and knowing how to be as an inseparable part of the integral formation of the child's personality.

Source: Own elaboration. (2025)

4 Conclusions

From the methodological triangulation, in the analysis of the selected texts within the sample of the present study, it was possible to confirm that the children's magazine "La Edad de Oro", written by José Martí in the 19th century and aimed at Latin American children, is closely related to the current principles of neuroeducation:

Emotional learning, the development of critical thinking, creativity and motivation as an essential element for problem solving and social transformation; the formation of ethical values such as honesty, courage, honesty, solidarity, love for what is essential, empathy.

In the current Latin American context, characterized by the loss of values and the breakdown of sensitive structures of society, it is essential the ethical, harmonic and integral formation of the personality as proposed by UNESCO for the nineteenth century and where knowledge, know-how and know-how to be are integrated and where "The Golden Age" is relevant for educators who seek to apply these principles in the formation of children to whom the teacher of America, José Martí dedicated this important work of world literature.

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Digital Learning Ecosystems and Pedagogical Innovation in Higher Education – Emerging Perspectives on Teaching Practice

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Abstract. This chapter explores digital learning ecosystems in higher education, analyzing their intersection with pedagogical innovation from teaching perspectives. Based on a qualitative study with 12 graduates of a microcredential in technology-mediated education, the text highlights the compatibility of these ecosystems with various disciplines, emphasizing advantages such as flexibility, personalization and access to diverse resources. Participants reported experiences with hybrid models (such as flipped classroom) and digital tools (platforms, AI, virtual reality), which promote interactivity and student autonomy. However, limiting factors were identified such as: technological limitations (inadequate infrastructure), pedagogical (resistance to change) and organizational (teaching overload). The results highlight that technologies only become transformative when integrated into intentional pedagogical strategies, mediated by trained teachers and aligned with specific contexts. The analysis reinforces the need for balance between innovation and humanization, preserving the relational dimension of teaching. It is concluded that the effectiveness of digital ecosystems depends on investments in teacher training, infrastructure and public policies, in addition to a holistic approach that harmonizes "biotic" (learning communities) and "abiotic" (technologies) factors. The chapter suggests ways to rethink educational practices, highlighting the potential of digital ecosystems to promote active, inclusive and sustainable learning, as long as systemic barriers are overcome.

Keywords: Digital learning ecosystems · Pedagogical innovation · Active learning · Hybrid models · Higher education

1 Introduction

Digital transformation in higher education has redefined educational paradigms, driving the creation of digital learning ecosystems that integrate technologies, pedagogical methodologies and human interactions in dynamic virtual environments. This chapter

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 459–469, 2025.
https://doi.org/10.1007/978-3-032-09080-5_45

explores the intersection between digital ecosystems and pedagogical innovation, analyzing how emerging teaching practices are shaping the future of higher education. Based on a rigorous theoretical review and recent case studies, we discuss the challenges and opportunities associated with the implementation of these ecosystems, with an emphasis on their capacity to promote meaningful, collaborative learning adapted to the demands of the 21st century.

Higher education currently faces unprecedented pressures to adapt to the demands of a globalized and technologically advanced society. The COVID-19 pandemic has accelerated the adoption of remote and hybrid teaching modalities, revealing both their potential and limitations of digital tools (Hodges et al., 2020). In this scenario, digital learning ecosystems emerge as integrated structures that go beyond the mere provision of online content, integrating pedagogical, technological and social dimensions (Moreira & Schlemmer, 2020).

It is therefore important to deepen the understanding of how these ecosystems can be designed to foster pedagogical innovation, ensuring educational quality and equity in access to teaching and learning environments and activities. As Bitar and Davidovich (2024) argue, the implementation of digital learning strategies requires a holistic approach that considers educational, cultural and institutional factors.

According to Almeida, L. et al. (2022), pedagogical innovation must be understood as a dynamic and contextualized process, centered on the continuous improvement of teaching-learning practices, and not just on the introduction of new technologies or methodologies. Authentic innovation involves a break with traditional transmissive models, promoting active student involvement and the reconfiguration of teaching roles. In this context, student-centered pedagogical models gain relevance, which place students as active agents in the construction of knowledge. Models such as project-based learning, flipped classroom or educational design thinking propose more flexible, collaborative and personalized learning environments. These models, as reinforced in the document Pedagogical Innovation in Higher Education - Scenarios and Paths of Transformation (Almeida, L. et al., 2022), require rethinking assessment and curricular practices and the institutional teaching culture itself, promoting more meaningful learning aligned with contemporary challenges.

The concept of a digital learning ecosystem emerges as a way of understanding complex and adaptive structures that transcend the mere digitization of content. Inspired by the ecological metaphor, this concept describes networked educational environments where human and non-human actors (technologies, content, networks) interact as interdependent functional units (Moreira & Schlemmer, 2020; DigitalEcosystem, 2007).

In this framework, a digital learning ecosystem is understood as a "living system" that supports cooperation, knowledge sharing, methodological innovation and the development of information-rich environments. Its creation and maintenance depend on the interrelationship between biotic and abiotic factors, whose dynamics constitute the basis of its functioning (Fig. 1).

In a digital learning ecosystem Biotic factors refer to learning communities composed of two main species:

a) The human species, represented by teachers, students and tutors, who interact and organize themselves around common learning objectives.

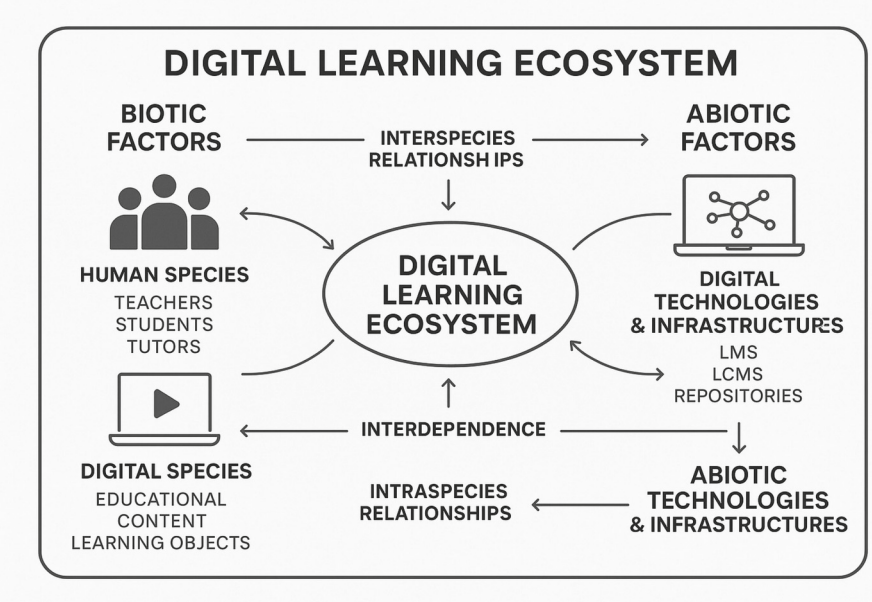

Fig. 1 – Digital learning ecosystem (OpenAI. *ChatGPT* generated)

b) The digital species, consisting of digital educational content, learning objects, simulations, games and other digital artifacts. These elements, despite not being living organisms, behave as such in an evolutionary sense: they can be created, modified, selected and even eliminated, depending on their relevance and usefulness in the digital environment (Moreira & Schlemmer, 2020).

In turn, abiotic factors correspond to the digital technologies and infrastructures that enable and sustain interactions between the living elements of the system. Examples of these factors include learning management systems (LMS), content management systems (LCMS), learning object repositories, simulation engines, assessment engines, synchronous and asynchronous communication tools, as well as interoperability protocols that ensure the integration of different components (Moreira et al., 2020, Wilkinson, 2002).

The interdependence between biotic and abiotic factors is manifested in the way in which the existence of significant interactions depends on the presence of an appropriate technological environment. As in a natural ecosystem, without environmental conditions — here translated into technologies and networks — species do not interact, and the system collapses. On the other hand, the digital environment only becomes functional and meaningful when inhabited and dynamized by learning communities and educational content.

Interspecies relationships are particularly revealing of this interdependence: human beings consume digital content (interact, modify, construct meaning), but they also produce it (create new digital objects). Furthermore, the contents themselves interact with

each other, through interoperability and articulation between learning objects on different platforms. Intra-species relationships, in turn, involve collaborations between teachers and students, in collective knowledge construction practices, as well as automated interactions between content systems.

The architecture of digital learning ecosystems is therefore open, flexible, scalable and evolutionary, behaving like a living organism in constant adaptation. The boundaries of this system are delimited by internal factors — such as educational objectives, assessment practices and pedagogical models adopted — and external factors, including sociocultural and institutional constraints (Moreira et al., 2020, UNESCO, 2020).

The implementation of digital ecosystems presents multifaceted challenges and a high transformative potential for higher education. Regarding challenges, the most significant are those of a nature such as:

a) Pedagogical, associated with resistance to changing traditional teaching paradigms (Ertmer, 2005);
b) Technological, especially regarding disparities in access to digital infrastructure and skills (Marinoni et al., 2020);
c) Emotional, linked to work overload and teacher isolation (Bitar & Davidovich, 2024).

Regarding the transformative potential of digital learning ecosystems, the following aspects are emphasized:

a) Personalization, that is, the possibility of adjusting and adopting learning paths to individual needs (Chvanova, 2024);
b) Global collaboration, facilitating the connection between students, teachers and researchers through platforms such as ResearchGate or Virtual Labs (Chvanova, 2024);
c) Sustainability, referring to the reduction of costs with physical resources and the democratization of access to education (UNESCO, 2020).

Thus, digital learning ecosystems represent not only a response to the demands of the digital age, but an opportunity to reinvent higher education as a space for continuous innovation and collaborative knowledge construction. This chapter, by articulating theory and practice, aims to contribute to critical reflection on ongoing transformations, suggesting theoretical and operational clues for teachers and researchers committed to pedagogical excellence in digital contexts.

2 Context and Methods

The study presented here focused on the perspectives of trainees of the micro-credential in Teaching and Learning with Technological Mediation, which is part of the Postgraduate Course in Pedagogical Training in Digital Environments and Technologies at the Polytechnic Institute of Portalegre, regarding the theme of digital learning ecosystems and pedagogical innovation in higher education.

It is worth noting that from the universe of graduates of the aforementioned micro-credential, only the responses of the 12 graduates who worked as teachers in higher education were considered within the scope of the study.

Trainees were asked to reflect on two groups of questions posted on the Moodle discussion forum for the microcredential:

1. Is this concept of "digital education ecosystem" compatible with the learning objectives and contents of your curricular units/disciplines? Can the aforementioned concept be operationalized with advantage in these curricular units/disciplines? In what way? How can hybridization enrich teaching and learning processes in the specific context of your curricular units/disciplines? What limitations can you anticipate?
2. To what extent can technologies "be transformative environments" and not "mere tools" in teaching-learning contexts? What is your role in pedagogical innovation processes?

The study data were therefore collected through content analysis of trainees' responses to the questions indicated above. It should also be noted that, in order to make the content analysis more focused, question 2 was divided into two autonomous questions, as follows: question 2 - *To what extent can technologies "be transformative environments" and not "mere tools" in teaching and learning contexts?;* and question 3 - *What is your role in pedagogical innovation processes?* and are therefore treated in the following section regarding the presentation of results.

The nature of the methodological approach of this study is, therefore, eminently qualitative, in a case study matrix, as it is the approach that best corresponds to its purpose. According to Yin (2004), it is the "(…) preferred strategy when asking questions of the "how" and "why" type, when the researcher has little control over events and when the focus is on contemporary phenomena inserted in some real-life context" (p. 19). The case study approach, by definition, gives the study an interpretative character to which attributes of a descriptive and exploratory study will also be added.

As previously noted, the trainees' responses were subject to content analysis, with the information being systematically categorized into a system of categories and subcategories emerging from the analysis process (i.e., created a posteriori). In this way, the category system was developed through a "collection procedure" (Bardin, 2011).

3 Results and Discussion

The emerging results of the content analysis of the students' responses are presented with reference to the questions already stated in the previous section. The results are organized in tables where the analysis categories are identified as well as the emerging data in each one. At the end of each table, a global analysis is presented on the perspectives emerging from the trainees' practice.

Question 1 (Table 1) - Is this concept of "digital education ecosystem" compatible with the learning objectives and contents of your curricular units/disciplines? Can the aforementioned concept be operationalized with advantage in these curricular units/disciplines? In what way? How can hybridization enrich teaching and learning processes in the specific context of your curricular units/disciplines? What limitations can you anticipate?

In summary, from the trainees' responses we can infer that they recognize the potential of the digital ecosystem, seeing it as a facilitator of active, flexible and inclusive

Table 1. Results of content analysis of trainees' responses to question 1

Categories of Analysis	Emerging Data
Global Perspective	Overall, all trainees emphasize the relevance of the digital ecosystem, and the need to consider its limitations in a systemic way.
1. Compatibility of the concept of "digital education ecosystem" with the objectives and contents of the curricular units/disciplines.	All trainees consider the concept compatible with their curricular units/disciplines, although with specific nuances. For example: . Trainee 1 (Teacher Training areas) highlights motivation and the development of reading and writing skills; . Trainee 2 (English Teaching area) states that he aligns himself with the actional approach and linguistic interactions; . Trainee 3 (Biology/Geology area) reports practical experience with digital platforms and hybrid teaching; . Trainee 6 (Special Education area) highlights the potential for inclusion and personalization of teaching for students with educational needs; . Trainee 9 (Entrepreneurship area) addresses challenges related to inequality in access to technology; . Trainee 11 (Psychology area) emphasizes experiential learning and the balance between face-to-face and digital.
2. Advantages of operationalizing the concept for learning within the scope of the Curricular Units	- Flexibility (Trainees 1, 4, 8). - Personalization (Trainees 6, 7). - Access to diverse resources (Trainees 3, 10).
3. Forms of operationalization	a) Integration of Environments: - Combination of in-person and online activities (Trainees 2, 5). - Use of technologies for individual (Trainee 2) and collaborative (Trainee 5) tasks. b) Tools and Methods: - Digital platforms (Classroom, Meet, Flipgrid, Genially) are mentioned by multiple trainees (Trainees 1, 2, 3, 6). - Hybrid models such as flipped classroom and station rotation are highlighted (Trainees 2, 5). - Resources such as videos, interactive quizzes and virtual museum visits (Trainee 5). c) Practical Examples: - Digital spelling correction (Trainee 1). - Oral production tasks via Flipgrid (Trainee 2). - Virtual laboratories in Biology (Trainee 3).

(*continued*)

Table 1. (*continued*)

Categories of Analysis	Emerging Data
4. Enrichment of teaching and learning processes through hybridization	a) Interactivity and Motivation: - More dynamic learning (Trainees 1, 5). - Student as protagonist (Trainees 5, 11). b) Flexibility: - Access to content at different times/places (Trainees 4, 8). - Trainee autonomy (Trainees 5, 9). c) Pedagogical Innovation: - Using AI for immediate feedback (Trainee 5). - Virtual reality in practical subjects (Trainee 9).
5. Advance limitations	a) Technological: - Lack of access to equipment or internet (Trainees 5, 9, 12). - Infrastructure obsolescence (Trainee 5). b) Pedagogical: - Resistance to paradigm change (Trainees 6, 7). - Difficulty in balancing technology and humanism (Trainee 11). c) Organizational: - Work overload for teachers (Trainee 4). - Synchronous/asynchronous time management (Trainee 8).

learning, with an emphasis on personalization and interaction. However, trainees also identify challenges to its operationalization, notably the necessary investments in infrastructure, teacher training and the search for balance in the use of technological/digital environments and more traditional pedagogical environments. In terms of recommendations, trainees generally refer to continuous digital training for teachers and students, the adaptation of hybrid models to the specificities of different scientific areas and curricular units, and also to the care of the education system and organizations in order to reduce inequalities in technological access.

Based on the analysis carried out, there appears to be consensus among trainees regarding the relevance of the digital ecosystem, but also regarding the need to address its limitations in a systemic way.

Question 2 (Table 2) - To what extent can technologies "be transformative environments" and not "mere tools" in teaching-learning contexts?

Question 3 (Table 3). What is the role of technologies in pedagogical innovation processes?

Considering their interdependence and articulation, we will consider questions 2 and 3 simultaneously in this summary. Overall, the trainees' responses allow us to deduce that, from their perspective, technologies are transformative environments when they integrate active methodologies, such as project-based learning or gamification. In this sense, ongoing teacher training is essential to critically plan and operationalize the integration of technologies, combining emerging technologies (such as Artificial Intelligence

Table 2. Results of content analysis of trainees' responses to question 2

Categories of Analysis	Emerging Data
Global Perspective	Globally, learners agree that technologies transcend the role of "tools" when they are integrated pedagogically and strategically, creating dynamic and personalized learning ecosystems.
1. Transformation of the Educational Environment	a) Interaction and Collaboration: - Technologies, such as digital platforms (Moodle, Classroom), allow continuous communication between teachers and students, breaking down physical barriers (Trainees 1 and 3). - The coexistence of organizational, pedagogical and technological dimensions so that technologies become transformative environments (Trainee 4). b) Personalization and Inclusion: - Adaptive technologies (such as AI and virtual reality) promote the individualization of teaching, catering to different learning styles (Theory of Multiple Intelligences, Gardner) (Trainees 5 and 6). - Valuing the use of technologies in Special Education, ensuring accessibility and equity (Trainee 6). c) Active Learning and Autonomy: - Possibility for students to create content (peer learning) and explore resources beyond the classroom (simulation games, global connections) (Trainees 2 and 9).
2. Conditions for Transformation	a) Role of the Teacher: - Technology is only transformative if mediated by the teacher, who must be trained to use it critically (Trainees 1, 5, 7, 11). b) Infrastructure and School Culture: - Need for public policies (such as the EU Digital Action Plan) and cultural changes in schools for technology adoption to be effective (Trainees 6 and 9).

or Virtual Reality) with student-centered pedagogical approaches, without losing sight of ethical issues and inclusion.

The predominant view among graduates is to seek innovation with balance, assuming that technologies are partners in pedagogy, not substitutes. As Form 11 summarizes, "*Technology must be seen as a partner of expanded human intelligence.*"

Table 3. Results of content analysis of trainees' responses to question 3

Categories of Analysis	Emerging Data
Global Perspective	Globally, learners agree that technologies are catalysts for innovation, but their effectiveness depends on intentional pedagogical approaches.
1. Methodological Innovation	a) Hybrid Models: - Blended learning (combination of face-to-face and digital) as a way to make teaching more flexible (Trainees 3 and 8) - The flipped classroom and station rotation to promote autonomy (Trainee 5). b) Immersive Tools: Potential of virtual and augmented reality and AI to create practical experiences (e.g., simulations in Entrepreneurship) (Trainees 7 and 9).
2. Challenges and Limitations	a) Risks of Technology without Pedagogy: - The superficial use of technology (e.g.: replacing classes with digital slides) does not innovate, it merely replicates traditional methods. (Trainees 11) b) Structural Barriers: - Inequalities in access to devices and the internet, in addition to teachers' resistance to change. (Trainees 9 and 12) c) Humanization vs. Technology - Innovation must preserve the humanistic dimension, where the teacher is the "conductor" of the process. (Trainees 4, 8 and 11) - Balance between "human and non-human actors" (technologies) in direct communication. (Trainee 11)

There therefore seems to be a consensus on the transformative potential of technologies, as long as their use is aligned with well-founded and intentional pedagogical strategies, as well as with the specificity of educational contexts.

The results of this study reinforce the idea, presented in the introduction, that digital learning ecosystems transcend the mere use of technological tools, assuming themselves as dynamic environments that integrate pedagogical, technological and social dimensions. Analysis of learners' responses confirms that these ecosystems are seen as facilitators of active, flexible and inclusive learning, aligning with student-centered models such as the Community of Inquiry (Garrison et al., 2000) and blended learning. However, the challenges identified — such as pedagogical resistance, technological inequalities and teacher overload — echo the barriers highlighted by authors such as Ertmer (2005) and Marinoni et al. (2020), highlighting the need for systemic approaches to overcome it.

The compatibility of the digital ecosystem concept with different disciplinary areas, from Special Education to Entrepreneurship, demonstrates its versatility. For example, the personalization of teaching for students with special educational needs (Trainee 6)

and the use of virtual laboratories in Biology (Trainee 3) illustrate how technology can adapt to specific contexts, corroborating Chvanova's (2024) view on the importance of flexibility. However, the persistence of technological and organizational limitations, such as lack of access to equipment or management of synchronous/asynchronous times, highlights the urgency of public policies and investments in infrastructure, as advocated by UNESCO (2020).

The transformative role of technologies, highlighted by learners, goes beyond their instrumental function, assuming the role of a catalyst for pedagogical innovation when mediated by trained teachers. This perspective aligns with the notion of Almeida et al. (2022) that authentic innovation requires a break with traditional models, promoting the active participation of students. The emphasis on the humanization of teaching (Trainee 11) emphasizes, however, that technology must be a "partner" of pedagogy, not a substitute, preserving the relational and ethical dimension of education.

4 Conclusion

In conclusion, this study shows that from the perspective of students, digital learning ecosystems represent an opportunity to reinvent higher education, promoting collaboration, personalization and sustainability. However, its potential can only be realized if:

a) the need for continuous teacher training, to critically integrate emerging technologies (such as AI and virtual reality) into intentional pedagogical strategies;
b) the necessary investments in infrastructure and public policies, ensuring equity in access and reducing technological disparities;
c) the balance between innovation and humanization, ensuring that technology amplifies, but does not replace, human interaction and educational values.

Returning to the ecosystem metaphor, as in nature, the interdependence and balance between "biotic" (learning communities) and "abiotic" (technologies) factors is essential for the sustainability of the system and for the successful implementation of digital learning ecosystems, requiring a holistic approach involving institutions, educators and policy makers. In this sense, taking as a reference the teachers' perspectives emerging from this study and its theoretical framework, it is recommended that:

a) institutions should develop structured mentorship programs pairing tech-savvy educators with hesitant colleagues to foster a culture of collaborative innovation, as resistance to change was a key barrier identified in the study;
b) educators must adopt reflective practice frameworks to critically evaluate how technologies like AI or VR align with their pedagogical goals, ensuring tools enhance (not replace) human interaction;
c) policy makers should mandate interoperability standards for digital platforms and fund localized pilot projects to address infrastructural disparities, ensuring equitable access aligns with the ecosystem's "biotic-abiotic" interdependence.

Finally, considering the limitations of the study, namely the small number of participants (twelve) and all trainees from the same microcredential, future research should expand to larger, diverse populations, incorporate mixed methods, and explore longitudinal impacts of digital learning ecosystems on pedagogical innovation.

Funding. Fernando Rebola, Luísa Carvalho and Amélia Marchão acknowledge the financial support of Fundação para a Ciência e a Tecnologia (grant UID/6173/2025). Paulo Ferreira and Rui Castanho acknowledge financial support from Fundação para a Ciência e a Tecnologia (grant UID/05064/2025).

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The Technology Acceptance Model (TAM): A Meta-Analytic Structural Equation Modeling (MASEM) Approach to Explaining the Adoption of GenAI Tools in Higher Education

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Abstract. This study examines factors affecting the adoption of Generative AI (GenAI) tools in higher education through the Technology Acceptance Model (TAM). A Meta-Analytic Structural Equation Modeling (MASEM) was utilized to analyze studies centered on TAM variables—Perceived Usefulness, Perceived Ease of Use, Attitude, and Continuance Intention—selected via the PRISMA protocol from databases like IEEE, Scopus, and Emerald, with analysis conducted using IBM SPSS. Findings confirm that Perceived Ease of Use strongly impacts Perceived Usefulness and Attitude, while Perceived Usefulness significantly influences Continuance Intention and Attitude. These results validate TAM's relevance in explaining GenAI adoption and highlight growing acceptance due to enhanced learning and administrative efficiency. Institutions must create policies for responsible AI use, promoting academic integrity and skill development in higher education for effective integration.

Keywords: Artificial Intelligence (AI) · Generative AI (GenAI) · Large Language Model (LLM) · Technology Acceptance Model (TAM) · Higher Education · Meta-Analysis · PRISMA

1 Introduction

The release of ChatGPT in 2022 was a watershed moment in the Generative Artificial Intelligence (GenAI) revolution [1–4]. Students and educators rapidly adopted these innovations, drastically changing the face of higher education. Few technological developments have been the subject of so much fanfare and pessimism in the field of education [5–7]. Many authors express concern that the rapid adoption of GenAI in education would disrupt established educational practices, increase the levels of plagiarism and academic fraud and reduce the cognitive ability of students [8, 9]. As a result, they advocate for the modernization of the university system through the application of emerging technologies

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 470–480, 2025.
https://doi.org/10.1007/978-3-032-09080-5_46

like AI and Machine Learning (ML) [10, 11]. Arguing that the transformative potential of GenAI should be embraced, such authors and institutions have sought to explore ways AI technologies can bring tangible benefits to the educational community [12]. Indeed, Gen AI allow students to summarize complex materials, educators to automate grading, redesign curricula, and track the performance of their students and university administrators to streamline administrative processes and increase overall productivity [8, 13]. The paper is structured as follows: it begins with theoretical background on TAM and the proposed model, followed by Methodology using MASEM. Results will address publication bias and effect size, concluding with key findings and limitations.

2 Theoretical Background: Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a widely used theoretical framework that explores how users come to accept using a technology [14]. This theory posits that user adoption of new technologies is driven by two main factors—perceived usefulness (PU) and perceived ease of use (PEOU)—that shape students' attitudes. Perceived Usefulness (PU) relates to the belief that GenAI tools increase productivity and performance, whilst Perceived Ease of Use (PEOU) relates to the extent to which GenAI tools are easy to use and interact with [15]. In turn, users' positive or negative feelings and attitudes (A) towards new technologies shape their continuance intention (CI) to use these new technologies in the future. Therefore, the current meta-analysis tests the following hypotheses to verify the original notions of TAM in the context of AI in higher education:

- H1: Perceived Ease of Use positively impacts Perceived Usefulness.
- H2: Perceived Ease of Use has a positive impact on Attitude.
- H3: Perceived Usefulness has a positive impact on Continuance Intention.
- H4: Perceived Usefulness has a positive impact on Attitude.
- H5: Attitude has a positive impact on Continuance Intention.

3 Methodology

3.1 Meta-Analytic Structural Equation Modeling (MASEM)

Meta-Analytic Structural Equation Modeling (MASEM) is a statistical methodology that combines meta-analysis and structural equation modeling (SEM) to combine the results from several independent studies [16]. The meta-analysis process involves defining the research scope, systematically identifying and screening studies, coding data, evaluating study quality, calculating the effect sizes and testing for heterogeneity [17]. This approach is beneficial for examining complex relationships between variables across several studies [18].

3.2 Literature Search

First, the search and selection of studies for this meta-analysis was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) protocol, ensuring a systematic and comprehensive approach to identifying relevant literature [19].

Rayyan QCRI was used for the literature review, and IBM SPSS was used for statistical analysis. Three databases (IEEE, Scopus and Emerald) were chosen for their comprehensive coverage and credibility: IEEE provides access to cutting-edge technological research; Scopus offers a broad interdisciplinary index with strong citation tracking; and Emerald is well-regarded for education and management studies. Candidates for inclusion had to meet these criteria: empirical research with TAM variables, focus on GenAI tool adoption in higher education, report necessary statistics for meta-analysis (effect size, sample size, Pearson correlation), and be peer-reviewed publications.

Fig. 1 shows the PRISMA flowchart summarizing the entire process.

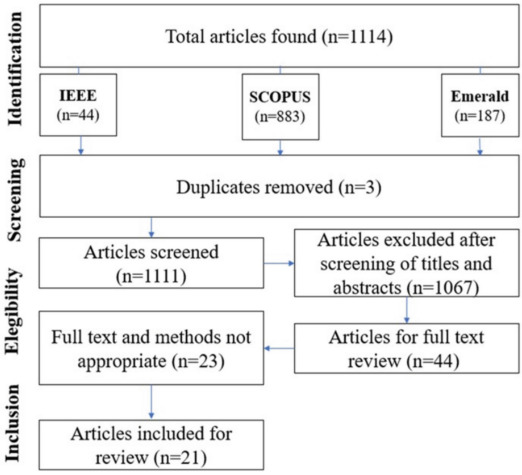

Fig. 1. PRISMA Flowchart

The initial search yielded 1114 studies. After removing the duplicates and studies that failed to meet the selection criteria, 44 studies were selected for full-text analysis. Finally, after a rigorous screening of the complete text, 21 studies were coded for key variables, including their sample size, correlation coefficients, and study characteristics.

3.3 Data Coding and Literature Quality Assessment

Data coding involves systematically extracting relevant information from the selected studies. Using the procedure recommended by [20], the data were coded according to the authors, year of publication, sample size, context of the application of AI technologies, correlation coefficient, and % of female respondents. Table 1 shows the criteria used to assess the quality of the studies included in the meta-analysis. Based on these criteria, the final sample received a quality rating of 76%, highlighting the selected studies' high quality.

Table 1. Criteria used to gauge the quality of the literature

Criterion	Condition	Score
Subject Selection	Random sampling Nonrandom sampling	2 points 1 point
	Unreported	0 points
Data Validity	Validity score $\geq$ 0.8 Validity score between 0.7–0.8	2 points 1 point
	Validity score $<$ 0.7 or unreported	0 points
Completeness of Reporting	Fully reported sample and outcome data Partially reported	2 points 1 point
	Not reported	0 points
Measurement Reliability	Reliability coefficient $\geq$ .8 Reliability coefficient between 0.7–0.8	2 points 1 point
	Reliability coefficient $<$ 0.7 or unreported	0 points

4 Results and Discussion

4.1 Sample Description

A total of 21 articles met the requirements for inclusion with a total sample size of 6756. Only studies published since 2023, the year of the release of ChatGPT, were included. The studies were conducted in a total of 18 different countries and four different regions: South Asia (m = 4), Far East and Pacific (m = 6), Europe (m = 4) and Middle East and North Africa (MENA) (m = 8). The percentage of women included in the samples ranges from 78,5% to 20%. More descriptive information about the sample can be found in the Appendix.

4.2 Publication Bias

Also known as the "file drawer problem", publication bias refers to selecting published studies and rejecting studies with insignificant results [21]. Table 2 summarizes the main measures of publication bias. Fail-safe numbers ($N_{fs} > 5k + 10$) are higher than the criterion, revealing the absence of publication bias [21]. The results of Egger´s test are insignificant for each relationship, meaning a lack of publication bias in our analysis [22]. The results from the application of Duval and Tweedie's Trim and Fill method also confirm the absence of publication bias [23].

Table 2. Measures of Publication Bias

Hypothesis	m	*Nfs*		Egger's Regression		Trim and Fill	
		Rosenthal	Criterion	Intercept	*p*	LL	UL
H1: PEOU → PU	16	17132	90	0.847	0.003**	0.531	0.800
H2: PEOU → A	7	2870	45	1.495	0.034*	0.169	2.820
H3: PU → CI	15	17232	85	0.837	0.011*	0.550	0.857
H4: PU → A	7	3499	45	2.256	0.002**	0.027	1.012
H5: A → CI	8	5240	50	1.443	0.015*	0.374	0.969

Funnel plots help identify publication bias, with effect size on the X-axis and precision on the Y-axis; symmetric and inverted shape indicates no bias (Fig. 2).

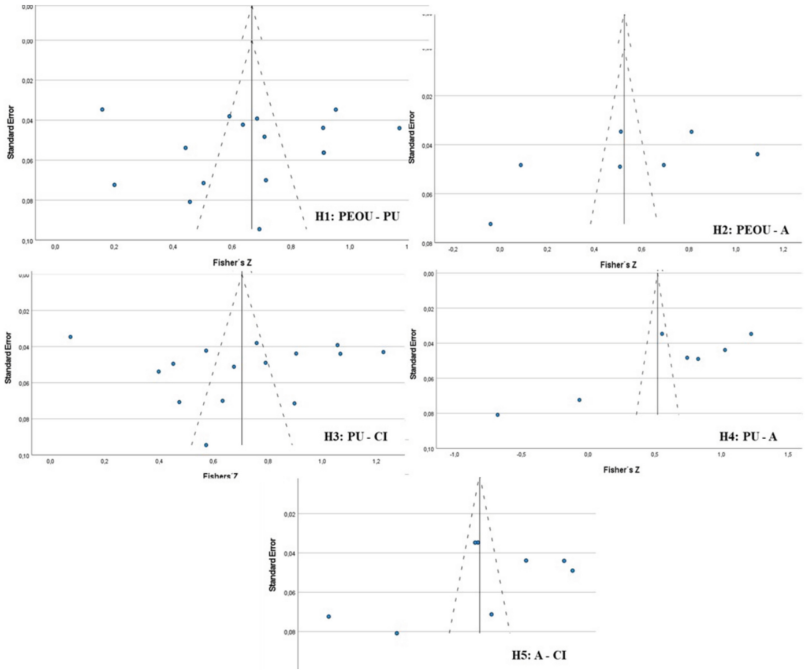

Fig. 2. Funnel Plots

4.3 Heterogeneity

Heterogeneity reflects variability in effect sizes across the studies and was assessed using measures such as Cochran's Q value and Higgins and Thompson's statistic I^2. The results presented in Table 3 suggest that heterogeneity is present in the data, indicating high levels of inter-study variability [24]. All hypotheses exhibit high Q_w and I^2 values above 75%, which is typically interpreted as substantial heterogeneity [25]. The τ (Tau) statistics

indicate considerable variability in true effect sizes. The presence of such heterogeneity suggests that a random-effects model should be employed instead of a fixed-effect model [26].

Table 3. Measures of Heterogeneity

Hypothesis	m	Q_w	*df*	*I2*	*p*	Tau^2	Tau
H1: PEOU - PU	16	553.6	15	97%	0.000***	0.070	0.265
H2: PEOU - A	7	366.9	6	99%	0.000***	0.150	0.387
H3: PU - CI	15	741.4	14	97%	0.000***	0.090	0.300
H4: PU - A	7	697.8	6	100%	0.000***	0.440	0.663
H5: A - CI	8	349.6	7	99%	0.000***	0.180	0.424

4.4 Main Effect Sizes

Table 4 presents a pooled correlation matrix for structural equation modeling (SEM) to analyze relationships between constructs in a meta-analytic context. Diagonal values are 1, indicating perfect self-correlation, while values above show the number of studies and total sample size, and below indicate correlation coefficients.

Table 4. Meta-Analytically Pooled Correlation Matrix

Hypothesis	PEOU	PU	A	CI
PEOU	1	6756 (16)	3238 (7)	7251 (16)
PU	0.667	1	3238 (7)	4677 (15)
A	0.520	0.530	1	3682 (8)
CI	0.581	0.700	0.670	1

The matrix reveals several important findings regarding the interrelationships among the TAM constructs. First, there is a strong positive correlation between Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) ($r = 0.667$), indicating that users who perceive AI tools as easy to use are more likely to find them useful. This supports the foundational TAM proposition that ease of use enhances perceptions of usefulness (Table 5).

5 Main Conclusions

PU exhibits a strong correlation with Continuance Intention (CI) ($r = 0.700$), highlighting its importance in ensuring the continued use of GenAI tools. Attitude (A) correlates moderately with both PEOU ($r = 0.520$) and PU ($r = 0.530$), indicating that ease and usefulness affect user evaluations. The connection between A and CI ($r = 0.670$) reveals how positive attitudes lead to continued usage intentions, while PEOU's moderate link to CI ($r = 0.581$) underscores usability's impact on future behaviors.

This study reviewed 21 published articles comprising a total sample of 6756 participants that utilized the Technology Acceptance Model (TAM) to examine the key factors influencing the adoption of AI technologies in the corporate sector. The analysis demonstrated that TAM constructs—perceived usefulness, perceived ease of use — exert a strong and positive influence on AI adoption with 95% statistical confidence.

However, this study has notable limitations, namely the exclusion of unpublished studies that may provide valuable insights and omitting certain studies lacking critical statistical data necessary for meta-analysis, such as reliability and mean values. Additionally, while prior research has utilized the TAM model with extra variables like privacy and social influence, these could not be incorporated. Future research should address these gaps, explore underutilized variables, and include subgroup analyses to improve the findings' generalizability across different contexts.

Appendix

Table 5. Summary of Reviewed Studies on AI Adoption in Higher Education

Study	n	Country	Region	% Female
(Al-Abdullatif 2023) [27]	432	Saudi Arabia	MENA	72.20%
(Algerafi et al. 2023) [28]	348	China	Asia-Pacific	37.93%
(Alzoubi 2024) [29]	523	Jordan	MENA	68.30%
(Arachchi and Samarasinghe 2024) [30]	836	Sri Lanka and India	South Asia	–
(Bilo˘s and Budimir 2024) [31]	694	Croatia	Europe	56.30%
(Bilquise et al. 2024) [32]	207	UAE	MENA	38.65%
(Boubker 2024) [33]	319	Morocco	MENA	52.98%
(Camilleri 2024) [34]	654	Italy	Europe	51.68%
(Hernandez et al. 2023) [35]	520	Philippines	Asia-Pacific	54.80%
(Huang and Zou 2024) [36]	203	China	Asia-Pacific	58.62%
(Ivanov et al. 2024) [37]	319	Morocco	MENA	52.98%
(Kanont et al. 2024) [38]	833	Thailand	Asia-Pacific	61.30%
(Labrague et al. 2023) [39]	200	Philippines	Asia-Pacific	78.50%

(*continued*)

Table 5. (*continued*)

Study	n	Country	Region	% Female
(Li et al. 2024) [40]	199	Taiwan and Vietnam	Asia-Pacific	45.30%
(Polyportis and Pahos 2024) [41]	420	Netherlands	Europe	45.92%
(Prameka et al. 2024) [42]	194	India	South Asia	29.90%
(Sabeh 2024) [43]	115	Iraq	MENA	35.70%
(Saif et al. 2024) [44]	156	Pakistan	South Asia	20.00%
(Salloum et al. 2024) [45]	563	UAE	MENA	44.94%
(Sharma et al. 2024) [46]	411	India	South Asia	38.69%
(Strzelecki and ElArabawy 2024) [47]	385	Egypt	MENA	48.83%
(Strzelecki and ElArabawy 2024) [47]	543	Poland	Europe	42.73%

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Organizational Communication as a Cross-Cutting Vector in Corporate Crisis Management

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Abstract. Organizational communication plays a crucial role in corporate crisis management, influencing public perception, decision-making, and business recovery. In an era marked by uncertainty and volatility, companies must develop strategic communication approaches to mitigate reputational damage and maintain stakeholder trust. This essay analyzes the transversal role of organizational communication in crisis management through case studies such as Coca-Cola's response to the economic crisis in Spain, the University Rey Juan Carlos' reputational crisis, and British Petroleum's handling of the Gulf of Mexico oil spill. These examples highlight the consequences of poor communication and the benefits of proactive, transparent messaging.

The study employs a theoretical approach based on literature review and case analysis, identifying key dimensions of crisis communication: internal coordination, external messaging, and strategic use of media channels. Effective crisis communication not only minimizes misinformation and public distrust but also strengthens corporate resilience. The findings emphasize the importance of a well-structured crisis communication plan, leadership in messaging, and the adoption of best practices, such as consistent narratives and transparency. The essay concludes that organizations integrating communication as a core component of crisis management can better navigate challenges and enhance their long-term reputation.

Keywords: Organizational Communication · Crisis Management · Corporate Reputation · Stakeholder Trust · Strategic Messaging

1 Introduction

In a business world characterized by uncertainty and volatility, crisis management has become a constant challenge for organizations. From reputational crises to internal conflicts, a company's success or failure in these critical moments depends largely on the

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2025
J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 481–492, 2025.
https://doi.org/10.1007/978-3-032-09080-5_47

quality of its organizational communication. The lack of an effective communication strategy can aggravate the crisis, deteriorate the corporate image, and affect stakeholder trust [1].

Recent cases demonstrate that a poorly managed crisis can irreparably damage an organization's reputation. For example, the crisis at Rey Juan Carlos University showed how poor internal communication intensified the negative impact of an academic scandal, undermining the trust of the university community [2]. Similarly, the case of Coca-Cola in Spain during the economic crisis demonstrated how a company can use advertising communication strategies to strengthen its image in times of difficulty [3].

Organizational communication is a key factor in crisis prevention, control, and resolution. Its impact is not limited to corporate reputation management but also affects strategic decision-making, internal cohesion, and public perception of the company [4]. Through effective communication, organizations can minimize rumors, build trust among their audiences, and facilitate post-crisis recovery.

An illustrative example is the case of Guillermo Lasso during the political crisis in Ecuador, where digital strategy played a fundamental role in managing his public image amid impeachment and early elections [5]. Corporate narrative and strategic message management were instrumental in rebuilding his image and mitigating the negative impact of the crisis.

On the other hand, when companies fail in organizational communication during a crisis, they can face serious consequences. A paradigmatic case was the oil spill in the Gulf of Mexico, where the late and contradictory response of British Petroleum (BP) increased the distrust of the public and the authorities, demonstrating that poor communication can aggravate corporate damage [6].

This essay aims to demonstrate that organizational communication is a cross-cutting factor in corporate crisis management, influencing public perception, decision-making, and business recovery. Various organizational communication approaches and strategies used in recent crises will be analyzed, highlighting their impact on mitigating damage and rebuilding corporate reputation.

Through the study of different organizational experiences and crisis cases, it will be evident that proper communication management not only protects a company's image but also strengthens its response and recovery capacity in the face of adverse situations [7].

2 Metodology

For the development of this essay, a theoretical approach was adopted based on a literature review and the analysis of relevant case studies. Various research and academic articles addressing organizational communication and its role in crisis management were used as reference.

The sources used include case studies such as the communication management of the Coca-Cola crisis [3], the analysis of the crisis at the Rey Juan Carlos University [2], and crisis communication in the cooperative sector [8]. Strategic communication approaches in political crises, such as the case of Guillermo Lasso in Ecuador [5] and environmental crises, such as the management of the oil spill in the Gulf of Mexico [6],

will also be reviewed. From the analysis of these sources, key principles of organizational communication in crisis contexts will be extracted, highlighting best practices and the most common mistakes in corporate crisis management.

3 Development

3.1 Conceptualization of Organizational Communication and Crisis Management

Organizational communication is a fundamental element in business management, as it enables internal coordination, strategic brand positioning, and the strengthening of relationships with different stakeholders. In times of crisis, its relevance intensifies, as the way an organization manages information and communication directly influences its ability to face challenges, mitigate reputational damage, and regain the trust of its stakeholders [7].

The concept of organizational communication can be divided into two main areas: internal communication and external communication. The former relates to the flow of information within the company, encompassing aspects such as team coordination, leadership, and managing uncertainty among employees. Well-structured internal communication keeps employees informed, aligns efforts, and avoids the misinformation that can arise in times of crisis. External communication, on the other hand, encompasses the company's interactions with its environment, including customers, the media, investors, regulators, and society in general. An effective external communications strategy helps control public perception and minimize the negative impact of the crisis on corporate reputation [9].

When a crisis erupts, the role of organizational communications becomes even more crucial, as it allows the company to act strategically at different levels:

- Provide clear and accurate information to employees and managers to ensure a coordinated response aligned with organizational objectives.
- Control the public narrative and minimize reputational damage through strategic messaging that demonstrates transparency, commitment, and management skills.
- Mitigate rumors and misinformation, preventing misinformation from spreading and further impacting the organization's credibility.
- Strengthen the company's trust and credibility with its stakeholders by demonstrating responsibility and commitment to crisis management.

On the other hand, crisis management is understood as the set of strategies and actions that an organization implements to prevent, control, and overcome adverse situations that may affect its operational stability and public image. Crisis management not only involves a reactive response to unforeseen events, but must also include advance planning, which includes the development of action protocols, the training of internal teams, and the creation of contingency plans to reduce the room for improvisation in critical moments [10].

Within this planning, organizational communication not only functions as an immediate response mechanism but also plays a crucial role in prevention and recovery. A poorly managed crisis at the communications level can lead to irreparable consequences,

affecting public confidence, investor relations, and the company's market positioning. In contrast, a well-designed communication strategy can become a key tool for business resilience, allowing the organization not only to overcome the crisis but also to strengthen its reputation in the process [9]. The importance of organizational communication in crisis management is reflected in various case studies. For example, in the reputational crisis at the Rey Juan Carlos University, the lack of a clear communication plan and the lack of coordination between internal and external messages contributed to the deterioration of trust within the university community and public opinion. The absence of a coherent narrative and poor communication management intensified the crisis, amplifying the negative impact on the institutional image [2].

In contrast, organizations that have successfully managed communication during times of crisis have managed to strengthen their reputations and consolidate the trust of their stakeholders. A prominent example is Coca-Cola in Spain during the economic crisis, where the company used a communication strategy focused on positive messages and resilience. Instead of reducing its media presence, Coca-Cola reinforced its corporate identity with campaigns that appealed to its proximity to its consumers and the positive social impact of the brand, managing to maintain its positioning even in an adverse context [3].

Ultimately, organizational communication is a cross-cutting vector in crisis management, whose proper handling can determine a company's resilience and the consolidation of its long-term reputation. Implementing preventive strategies, establishing effective internal and external communication channels, and acting with transparency and consistency in the messages issued are fundamental aspects to ensuring organizational resilience in crisis contexts.

Errors in Crisis Communication Management

There are multiple examples of organizations that have failed in crisis communication management due to the lack of an adequate strategy. One of the most emblematic cases is that of Rey Juan Carlos University, whose reputational crisis was exacerbated by poor internal communication and a lack of clear and timely messages among members of the university community. The lack of coordination in information and a coherent narrative generated uncertainty and mistrust, amplifying the negative impact of the scandal [2].

Similarly, the 2010 British Petroleum (BP) oil spill in the Gulf of Mexico is a clear example of poor communication management. The company issued contradictory messages and was slow to assume responsibility, leading to a credibility crisis and severe reputational damage [10].

Good Practices in Organizational Communication During Crises

On the contrary, some organizations have shown that a proactive communications strategy can help strengthen brand identity and maintain a positive connection with the public even in times of crisis. A relevant case is that of Coca-Cola in Spain during the economic crisis, where the company used advertising campaigns focused on values of optimism and resilience to strengthen consumer confidence [3]. Unlike other companies that reduced their investment in communications, Coca-Cola opted for a strategy of emotional proximity with its audience, using messages aligned with the social needs of the moment.

Another notable case is that of Guillermo Lasso during the political crisis in Ecuador, where the digital communications strategy played a key role in managing his public image. Through the use of social media, his communications team managed to control the narrative and minimize the negative media impact during the impeachment trial and the early elections [5].

3.2 Conceptualization of Organizational Communication and Crisis Management

In the context of corporate crisis management, organizational communication plays a decisive role in the organization's stability and recovery. It's not just about responding to a crisis, but also about effectively managing internal and external information to ensure organizational alignment, credibility, and public trust. Communication in these times must be strategic, clear, consistent, and based on principles of transparency.

Three key dimensions can be distinguished in organizational communication during a crisis: internal communication, external communication, and the strategic use of communication channels. Each of these dimensions influences how the crisis is perceived and how quickly the company can mitigate its negative effects.

Internal Communication: Coordination Between Teams, Effective Leadership, and Managing Uncertainty Among Employees

Internal communication is the first line of defense in crisis management. Proper implementation allows the organization to ensure the cohesion, coordination, and alignment of employees and management teams around an action plan. A lack of internal communication in times of crisis can lead to misinformation, conflicting views, mistrust, and organizational chaos.

An exemplary case of a poorly managed internal crisis is that of the Rey Juan Carlos University, where the lack of clear information among management, faculty, and students exacerbated the corruption scandal, causing a crisis of institutional trust [2]. The lack of communication leadership generated a clear lack of coordination in the university's response, which intensified the perception of opacity and contributed to the deterioration of its reputation.

To ensure effective internal communication during a crisis, three key elements must be considered:

Coordination Between Teams

Crisis management requires a rapid and structured response. To achieve this, it is crucial to have a crisis management team that establishes clear protocols and centrally manages information [7].

An example of successful internal coordination can be seen in the cooperative sector, where successful organizations have implemented clear internal communication strategies that reinforce corporate identity and foster employee trust [1].

Coordination Between Teams

In times of crisis, organizational leadership becomes a determining factor for the stability and continuity of a company. Leaders' ability to convey clear messages, maintain internal

cohesion, and act decisively directly influences employee perceptions and how they respond to adversity. Effective leadership not only facilitates strategic decision-making but also strengthens team morale and reinforces trust in the organization [7].

The role of the leader in a crisis is not limited to operational decision-making; they also play a crucial role in managing communication. When leaders communicate clearly and transparently, they establish an environment of security and trust within the organization. However, when there is a lack of leadership or poor communication, employees can feel disoriented, increasing uncertainty and the possibility of making mistakes that worsen the crisis [6, 8].

A leader who evades responsibilities or fails to communicate effectively generates confusion and a feeling of abandonment among their team. This lack of direction can lead to the spread of rumors, a loss of trust in the organization, and a decrease in productivity. In the case of Rey Juan Carlos University, the absence of effective leadership and the lack of a unified message regarding the academic crisis generated an environment of mistrust between students and faculty, exacerbating the negative impact on the institutional image [2].

On the other hand, proactive and strategic leadership can make a difference in how an organization faces a crisis. An example of this is the case of Coca-Cola in Spain during the economic crisis, where the company implemented leadership based on communication and motivation. Instead of reducing internal communication for fear of uncertainty, senior management reinforced the company's values and promoted a discourse of resilience, ensuring that both employees and customers felt confident in the brand [3].

Effective leadership in a crisis also involves the ability to adapt and make timely decisions. In the political sphere, Guillermo Lasso's communication strategy during the political crisis in Ecuador is a clear example of how a leader can use strategic communication to mitigate the impact of a crisis. His communications team implemented a unified discourse and actions aimed at maintaining his public image, which helped reduce the negative impact of his impeachment and the early elections [5].

Managing Uncertainty

Managing uncertainty in times of crisis is key to employee stability and engagement. A lack of clear information generates anxiety, speculation, and a loss of trust in the organization. If employees perceive that information is being withheld, rumors can intensify, affecting morale and internal cohesion [9].

To avoid this problem, companies must adopt effective internal communication, ensuring transparency and constant updates on the crisis, the measures taken, and future expectations. Information gaps can be filled with misinformation, affecting the organizational climate and weakening trust in senior management [2].

Clear and strategic communication reduces uncertainty and strengthens team morale. When employees are aligned with the company's values and goals, they become trusted ambassadors, conveying consistent messages inside and outside the organization [3].

External Communication: Relationships with Stakeholders, the Media, and Customers During the Crisis

External communication plays a crucial role in how a crisis is perceived by the public. Poor management in this area can cause irreparable damage to an organization's

reputation, while a well-executed strategy can reduce the negative impact and facilitate recovery.

There are multiple examples of crises poorly managed in terms of external communication. One of the most emblematic cases is the oil spill in the Gulf of Mexico, where British Petroleum (BP) attempted to downplay the magnitude of the disaster in its initial public statements, generating a wave of criticism and a credibility crisis. In contrast, Guillermo Lasso's strategy in Ecuador demonstrated how well-structured communication management on social media can control the narrative and strengthen the public image in times of political crisis [5].

Key elements in External Communication During a Crisis:
In the context of crisis management, the media plays a central role in how the situation is perceived by the public. Media coverage of a critical event can significantly influence an organization's reputation, either by amplifying the negative effects or, conversely, by helping to position the company as a responsible actor committed to solving the problem. Due to this impact, it is crucial that the organization adopt a communication strategy based on transparency, proactivity, and consistency in its messages [4].

When a crisis occurs, the media seeks immediate and verified information about what happened. In this sense, the company must ensure it establishes a direct and reliable communication channel with journalists and news media, avoiding crisis coverage based on speculation or unofficial sources. To this end, it is recommended that the organization have well-trained institutional spokespersons capable of providing clear and accurate information without generating confusion or transmitting uncertainty. One of the most common mistakes in crisis communication management is information secrecy. When a company chooses not to comment on a critical situation or restricts access to information, a communication vacuum is created, which is often filled by speculation, rumors, and unofficial versions. This not only increases public distrust but also intensifies the negative impact of the crisis, as the company loses control of the narrative [2].

An example of poor media management occurred during the British Petroleum (BP) oil spill in the Gulf of Mexico. In the early days of the disaster, the company publicly downplayed the magnitude of the problem and was slow to offer a clear and coherent version of events. This lack of transparency had an adverse effect on media coverage, causing a credibility crisis that seriously affected the company's reputation [6].

In contrast, when media relations are managed proactively and structured, the organization can reduce the negative impact and project an image of responsibility and commitment. To achieve this, it is recommended that the company:

Designate official spokespersons: Statements to the media should be made by individuals prepared to answer questions clearly and accurately, avoiding contradictions or vague information.

Prepare press releases and conferences: It is important that the organization issue official information at the appropriate time to prevent the spread of misinformation.

Adopt a stance of transparency: Hiding information or downplaying the crisis can have the opposite effect, affecting public and media trust.

Monitor media coverage: Analyzing how the media is addressing the crisis allows the company to adjust its communication strategy and respond effectively to emerging concerns.

When companies properly manage their relationship with the media in times of crisis, they are more likely to control the narrative and project an image of responsibility and leadership.

Interaction with Clients and Stakeholders

Interaction with customers and stakeholders is a key aspect of crisis management, as it directly affects perception and trust in the organization. In situations where customers experience product failures, service interruptions, or customer service issues, the company must respond quickly, clearly, and with effective solutions to minimize dissatisfaction and avoid damage to its corporate image [4].

One of customers' greatest fears in times of crisis is a lack of information or the perception of inaction on the part of the company. Therefore, it is essential to establish accessible and effective communication channels, such as hotlines, social media, and digital platforms, where customers can express their concerns and receive timely responses. Communication with stakeholders must adhere to four essential principles: rapid response, demonstrating priority in solving the problem; empathy and commitment, with a friendly and understanding tone; clarity of information, avoiding ambiguities; and efficient contact channels, reducing wait times and ensuring effective assistance. An example of good practice in customer communication was Coca-Cola's strategy in Spain during the economic crisis. Instead of reducing its communication presence, the company strengthened its brand identity with optimistic messages and emotional communication campaigns based on values such as unity and hope, managing to maintain its reputation and connection with consumers [5].

In contrast, inadequate management of customer communication can generate a crisis of trust, as occurred at Rey Juan Carlos University, where the lack of clear responses to student and faculty concerns contributed to a reputational crisis within the academic community [2].

Interaction with customers and stakeholders should be approached as a trust management strategy. If the company acts with transparency, speed, and empathy, it can turn the crisis into an opportunity to strengthen its audience's loyalty and demonstrate its corporate commitment.

3.3 Use of Channels and Strategies: Importance of Clear, Transparent and Timely Messages

The appropriate use of communication channels is crucial in crisis management. Depending on the nature of the crisis and the target audience, the organization must choose the most effective means to convey its message.

Main Channels of Communication in Crisis

In crisis management, the choice of communication channel is key. Traditional media (TV, radio, and print) allow for reaching a broad audience, so the use of official communications and well-structured conference calls is recommended. Social media and digital platforms offer immediacy and direct contact with stakeholders, but must be handled with caution to avoid misinformation. Internal communications and corporate newsletters ensure team alignment and reduce uncertainty. To guarantee effectiveness, messages

must adhere to three fundamental principles: clarity, to avoid ambiguity; transparency, to maintain credibility; and consistency, ensuring coherent communication.

The case of Rey Juan Carlos University demonstrated that the lack of clear and coherent messages can lead to confusion and reputational damage [2]. In contrast, Coca-Cola's communication strategy during the economic crisis was an example of how well-structured messages can strengthen brand identity and maintain consumer trust [3].

3.4 Organizational Communication Strategies in Crisis Management

Organizations continually face crisis situations that can compromise their operational stability and reputation. In these contexts, organizational communication plays a crucial role not only in mitigating the negative effects but also in building trust and credibility with their audiences. The lack of a clear and well-structured strategy can aggravate the crisis, generating uncertainty and weakening the corporate image.

Effective crisis communication management is not only about responding to a problem, but also about anticipating and preparing for it with adequate planning. To achieve this, it is essential that organizations have a well-defined crisis communication plan, establish a coherent and clear corporate narrative, effectively control the information they transmit, learn from poorly managed crises, and adopt good practices that allow them to improve their response to adverse situations.

3.5 Crisis Communication Plan: Importance of Pre-Planning, Institutional Spokespersonship, and Simulations

One of the fundamental aspects of organizational communication in times of crisis is advance planning. Having a crisis communication plan allows companies to respond quickly and effectively, avoiding improvisations that could worsen the situation. This plan must be designed before any crisis occurs and must include response protocols, defined roles and responsibilities, and internal and external communication strategies that allow the organization to act in a structured and effective manner.

A well-designed crisis communication plan must consider several essential elements to ensure its effectiveness. First, it is crucial to conduct a risk and potential scenario analysis to identify potential crises and predict the impacts they could have on the organization's various stakeholders. This anticipation is key to designing appropriate responses and reducing the margin of error in critical moments.

Another fundamental aspect is the definition of a crisis management team, made up of executives, communications experts, human resources, and legal advisors. This team will be responsible for coordinating the communication response and ensuring that the messages conveyed are clear, coherent, and aligned with the organization's strategy. Institutional spokespersons are also a central component of crisis management. Having a trained and well-informed spokesperson is essential for conveying messages of trust and credibility. In times of crisis, the image and tone of the communicator can make the difference between an effective response and a poorly managed crisis. A well-prepared spokesperson will know how to handle media pressure, answer questions clearly, and project a message of calm and responsibility.

Finally, the crisis plan should include simulations and training to assess the team's readiness and identify potential weaknesses in the response strategy. Conducting practical exercises allows the organization to improve its response capacity and adjust its crisis plan based on simulated scenarios.

The importance of planning in crisis communication is evident in several cases. A paradigmatic example is the British Petroleum (BP) oil spill in the Gulf of Mexico, where the lack of a structured communication plan and the issuance of contradictory messages aggravated the crisis, generating significant reputational damage (Ramírez, 2005).

3.6 Corporate Storytelling and Message Control: How to Structure Messages to Avoid Misinformation and Minimize Negative Impacts

During a crisis, the way an organization structures its narrative and manages the message it conveys is critical to controlling public perception and minimizing negative impacts. When a company fails to establish a clear and well-founded narrative, it runs the risk of generating misinformation, contradictions, and loss of trust among its stakeholders.

Building an effective corporate narrative must be based on three essential pillars. First, consistency and unification of the message is key to avoiding misunderstandings and ensuring that all company spokespersons communicate the same information. Contradictory statements generate confusion and can amplify the crisis rather than resolve it.

The second pillar is transparency and truthfulness. An organization that hides information or downplays the severity of a crisis risks losing the trust of its stakeholders. Admitting mistakes, taking responsibility, and providing accurate information are essential to maintaining credibility and projecting an image of integrity.

The third pillar of corporate narrative is empathetic and solution-focused language. During a crisis, an organization must adopt a tone that demonstrates sensitivity to public concerns and focus on the measures it is taking to resolve the situation.

An example of how corporate narrative can influence public perception is the case of Guillermo Lasso in Ecuador, where a well-structured digital communications strategy minimized the negative impact of the political crisis and strengthened its public image among citizens [5].

3.7 Cases of Poorly Managed Crises Due to Poor Communication

There are multiple examples of organizations that have faced crises that were exacerbated by poor communication. One of the most representative cases is the oil spill in the Gulf of Mexico, where British Petroleum (BP) issued contradictory messages and was slow to assume responsibility, generating public outrage and an unprecedented credibility crisis [6].

Another emblematic case is the crisis at Rey Juan Carlos University, where the lack of effective internal communication and transparency in the management of an academic scandal led to confusion and reputational damage. The crisis intensified due to uncoordinated messaging and the perception of opacity.

These cases reflect the importance of acting quickly, establishing a clear message, and managing the crisis strategically to avoid long-term damage.

3.8 Good Practice in Crisis Communication Management

Organizations that effectively manage communication in times of crisis can turn an adverse situation into an opportunity to strengthen their reputation. An exemplary case is that of Coca-Cola in Spain during the economic crisis. Instead of reducing its investment in communication, the company used advertising strategies based on resilience and optimism. Its campaigns reinforced the emotional connection with consumers, projecting the brand as a symbol of unity and hope [3].

Another example is that of cooperatives, which have faced economic crises through communication based on transparency and social commitment. Instead of withholding information, they have strengthened dialogue with their members, building trust and ensuring their long-term sustainability [1].

Both cases demonstrate that a well-managed crisis can strengthen corporate identity. Coca-Cola opted for emotional communication aligned with its values, while cooperatives used transparency as a pillar of their strategy. In conclusion, effective crisis communications management is based on coherence, empathy, and messages aligned with the corporate identity, consolidating public trust and ensuring organizational stability.

4 Discussions

Throughout this essay, it has been demonstrated that organizational communication is a determining factor in crisis management. Its impact is evident in the way a company or institution can control the narrative, mitigate reputational damage, and maintain the trust of its stakeholders. When communication is managed effectively, the organization not only manages to overcome the crisis but can also strengthen its image and credibility in the long term. However, if communication is deficient or inconsistent, the negative impact can be prolonged and seriously affect the stability of the entity.

An analysis of cases such as that of Coca-Cola in Spain during the economic crisis, where the company used a communication strategy based on optimism and resilience, demonstrates that a well-managed crisis can even consolidate brand identity and public loyalty [3].

On the other hand, the crisis at Rey Juan Carlos University demonstrated how a lack of clear messages and disorganized internal communication can deepen reputational damage and generate a credibility crisis [2]. To strengthen communication in times of crisis, organizations are recommended to implement preventive strategies, such as creating a crisis communication plan, establishing trained institutional spokespersons, and using effective communication channels. Furthermore, it is crucial to ensure that messages are clear, consistent, and aligned with corporate values, avoiding misinformation and improvisation in critical moments [7].

Finally, it is essential to develop an organizational culture based on transparency and communication preparedness. Public and employee trust in the organization is built through open and strategic communication. Companies that integrate organizational communication as a fundamental pillar of their management not only cope better with crises but also consolidate their long-term reputation.

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Innovating Inclusive Education Through Gamification, Co-design, and Augmented Reality: A Study in the Ecuadorian Context

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Abstract. Inclusive education faces substantial challenges in the Ecuadorian context, particularly concerning accessibility and equitable participation. This article explores how the triad of Gamification, Co-design, and Augmented Reality can address educational inequality, enhancing the learning experience for students with diverse disabilities in the Design Program at the Universidad Israel in Ecuador. The purpose of this study is to design and evaluate pedagogical strategies incorporating Augmented Reality in instructional materials supported by biomimicry to promote 3D design learning.

The methodology employed follows the principles of Design Thinking, facilitating an empathetic approach towards students by involving educators and experts in educational technology in the inclusivity process. A blend of qualitative and quantitative research methods was used: semi-structured interviews and focus groups to gather insights into student's needs, surveys and experimental tests to measure the impact of the proposed solutions.

Preliminary results indicate that the Gamification, Co-design, and Augmented Reality triad significantly increases engagement and participation among students with special needs, mainly those with learning difficulties. The implications of these findings suggest that implementing these technologies can transform inclusive education by creating more accessible and adaptable environments tailored to individual needs. This study advances the discourse on educational innovation in Ecuador by offering a strategic framework to guide future technological interventions.

Keywords: Inclusive Education · Gamification · Co-Design · Augmented Reality

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 493–509, 2025.
https://doi.org/10.1007/978-3-032-09080-5_48

1 Introduction

Inclusive education has been recognized by international organizations as a fundamental human right and a priority for the social and economic development of nations. Its implementation remains a challenge, particularly in developing countries like Ecuador, where cultural, technological, and pedagogical barriers hinder the creation of truly inclusive learning environments. This article aims to explore these barriers through the integration of Gamification, Co-design, and Augmented Reality (AR) in Inclusive Education, with the goal of promoting greater participation and equity in the educational process. In this regard, inclusive education requires innovative approaches to overcome both pedagogical and technological barriers, fostering the active participation of all students, regardless of their abilities or limitations [1].

Current educational systems aim for inclusive and innovative education, addressing student diversity through active participation in learning. This approach requires equitable policies, modern resources, and strategies focused on inclusion, such as leadership, collaborative teaching, and family involvement [2]. The inclusion of interactive technologies such as gamification and augmented reality has proven to enhance student engagement and facilitate personalized learning. Globally, these technologies have been successfully applied to motivate and improve academic performance, yet their potential in inclusive education, particularly in countries like Ecuador, has not been sufficiently explored. This article seeks to fill this gap and offer pedagogical technological solutions that can be adopted in similar contexts.

In the context of higher education in Ecuador, the integration of technological resources remains limited, mirroring trends observed in other sectors, primarily due to the ongoing debate surrounding their implementation [3]. Nevertheless, collaborative initiatives and complementary strategies have been promoted to address learning challenges, thereby enhancing student engagement and motivation. In the current educational landscape, institutions face the continuous challenge of adapting to rapid technological advancements, fostering inquiry, and embracing innovative pedagogical approaches that contribute to a learning conducive environment.

The objectives of this study are threefold. First, to evaluate the impact of gamification and augmented reality on the participation and performance of students with di- verse abilities through biomimicry (design and production of materials, structures, and systems that are modeled on biological entities and processes found in nature. It involves studying how organisms and ecosystems solve complex problems and applying those strategies to human innovation). Second, to explore how participatory co-design can facilitate the creation of more inclusive and culturally appropriate educational tools. Third, to generate practical recommendations based on empirical data for the implementation of these technologies among students with different abilities in the Graphic and Digital Design program at the Universidad Israel in Ecuador in 2024.

1.1 Gamification in Inclusive Education

Inclusive education aims to ensure that all students, regardless of their abilities or specific needs, have access to quality education. In this context (Ecuadorian), the goal of creating inclusive classrooms in primary education is to provide a learning environment that

meets the needs of all students, ensuring equal opportunities, including for those with functional diversity [4]. The cognitive demands of creative disciplines like design are particularly challenging for individuals with attention deficit, affecting their ability to concentrate and manage the emotional stress linked to innovative processes [5] In recent years, gamification has gained prominence as an effective pedagogical approach, offering innovative strategies to address diverse learning challenges and foster increased student engagement [6]. This approach is proving to be transformative within the educational landscape, demonstrating the effectiveness of integrating game-like elements—such as rewards, challenges, and competition—into the learning process to significantly enhance student engagement and motivation. By appealing to intrinsic and extrinsic motivators, gamification not only makes learning more interactive and enjoyable but also helps address specific educational challenges, such as maintaining student attention, fostering collaborative learning, and enhancing knowledge retention.

Nowadays advancements in gamification have opened up new avenues in educational settings, offering solutions to overcome traditional learning obstacles and foster a more interactive learning experience [7]. The adoption of gamification in education has equipped educators with a flexible approach to tackle issues related to student engagement and motivation, turning the learning experience into a more interactive and lively process [8]., this flexibility in design allows educators to tailor gamified experiences to diverse learning styles and preferences, making education more inclusive.

Students with attention deficits can significantly benefit from gamification, which has demonstrated considerable potential due to its interactive and engaging game-like elements that enhance focus and reduce distractions [9]. The establishment of clear objectives and the provision of instant feedback through gamification can greatly enhance students' focus and improve their ability to organize tasks effectively [10]. Personalizing learning through gamification, by tailoring challenges and rewards to meet individual needs, is crucial in the design field, where creativity and self-expression play vital roles [11].

This article examines the effective implementation of gamification in inclusive education, specifically targeting students with attention deficits enrolled in design programs. Building upon the findings of [12], which highlight the positive outcomes of gamification in comparable contexts, this study evaluates the applicability of such approaches within the design discipline, with particular emphasis on fostering creativity and improving time management. By addressing these issues, this study aims to provide a comprehensive perspective on how gamification can enhance inclusion and academic success for these students.

1.2 Augmented Reality as an Educational Tool

Augmented Reality (AR) technology integrates virtual elements into real-world environments, creating interactive experiences that substantially enrich the educational process [13]. In the Ecuadorian context, AR presents considerable opportunities for promoting educational inclusion by enabling the development of visual and sensory resources that improve information accessibility for students with diverse disabilities.

A study conducted at an inclusive school in Quito found that the use of AR improved the understanding of abstract concepts for students with cognitive disabilities, allowing

them to interact tangibly with classroom content [14]. The ability to overlay digital information onto the physical environment enables students to visualize concepts more clearly and comprehensively, thereby reducing cognitive barriers.

1.3 Co-design in Educational Development

Co-design has emerged as a recognized approach for developing educational tools tailored to the specific needs of users. Within inclusive education, it facilitates the active involvement of students with diverse abilities in the design process, thereby ensuring that the resulting solutions are both accessible and contextually relevant. Despite its potential, the integration of co-design with gamification and Augmented Reality (AR) remains underexplored—particularly in contexts such as Ecuador.

Collaboration and co-participation through design constitute a participatory approach in which multiple stakeholders—including students, educators, families, and designers—actively contribute to the development of educational resources [15]. In the Ecuadorian context, co-design has been employed in community-based projects to create educational content in indigenous languages, thereby supporting cultural preservation and advancing inclusive education in rural communities [16].

When applied to educational technology, co-design allows gamification and AR tools to be tailored to the specific needs of students with disabilities, enhancing their accessibility and effectiveness. By involving students in the creation process, it ensures that the developed solutions are truly inclusive and user-centered.

For collaborative creation to occur within a group, a structured process must be in place. In other words, a defined methodology is essential. Without such a methodology, each individual is likely to rely on personal intuition, past experiences, or ad hoc decisions, leading to inconsistent and potentially inefficient outcomes. This assertion underscores a fundamental principle of the co-creation process: the necessity of a structured methodology. In the absence of a clear methodological framework, participants are likely to rely on personal intuition or individual experiences, leading to fragmented efforts, inconsistencies, and diminished collaborative coherence. A well-defined methodology not only provides a systematic structure to coordinate efforts and align participants toward shared objectives but also offers a replicable and adaptable process that supports long-term innovation. By balancing creative freedom with procedural order, such methodologies enhance both the efficiency and effectiveness of collaboration. Additionally, standardized processes help mitigate internal conflicts, streamline decision-making, and foster continuous learning by enabling reflection and refinement over time. Ultimately, a robust methodological foundation in co-creation not only facilitates organized teamwork but also amplifies creative potential and improves the quality of outcomes.

According to a study conducted in Ecuador, co-design in community contexts not only involves the active engagement of social actors, but also redefines the designer's role as a cultural mediator and facilitator of knowledge exchange across diverse worldviews [17].

1.4 Gamification, Co-design, and Augmented Reality as a Pedagogical Strategy

Despite notable advancements in educational technologies, a significant knowledge gap persists regarding the effective integration of gamification, co-design, and Augmented Reality (AR) to support inclusive education in developing countries. Much of the existing literature centers on educational contexts in Western or developed nations, leaving a substantial void in understanding how these tools can be adapted to the cultural, social, and technological realities of countries such as Ecuador

Within this context, this study seeks to address the following research questions: (1) How do gamification and Augmented Reality (AR) influence the performance and participation of students with diverse abilities in the Ecuadorian educational context? and (2) How can participatory co-design contribute to the development of inclusive educational tools in environments characterized by technological limitations?

By addressing these questions, this article contributes to the literature on inclusive education and emerging technologies, providing empirical data on their application in a Latin American context and generating recommendations for their effective implementation in low-resource educational systems.

To answer these questions, a pedagogical strategy based on the G + CD + RA triad (Gamification, Co-design, and Augmented Reality) was designed and implemented for a group of students with attention deficits and disabilities in the Design program at Universidad Israel. As illustrated in Table 1, the process was structured into six stages:

Table 1. Implemented Pedagogical Process

Stage	Description
1. Diagnosis and Preparation	Initial assessment of the students' needs, abilities, and technological infrastructure. Identification of key challenges.
2. Collaborative De- sign (Co-design)	Active participation of students, educators, and experts in the co-design of educational tools, tailored to the students' specific needs.
3. Gamification Implementation	Introduction of game mechanics, such as points, rewards, and challenges, to foster engagement and motivation in learning.
4. Augmented Reality Integration	Incorporation of AR elements into educational content to enhance visualization and interaction with abstract concepts.
5. Evaluation and Feedback	Continuous assessment of the effectiveness of the implemented tools, gathering feedback from students and educators.
6. Consolidation and Final Adjustments	Refinement of the strategy based on feedback and evaluation data, ensuring the tools meet the students' needs effectively.

1) Diagnosis and Preparation, 2) Collaborative Design (Co-design), 3) Gamification Implementation, 4) Augmented Reality Integration, 5) Evaluation and Feedback, 6) Consolidation and Final Adjustments.

Table 1 summarizes the pedagogical process implemented, from the diagnostic phase to the consolidation of the educational strategy based on gamification, co-design, and augmented reality.

2 Methodology

Based on the principles of design thinking (Empathize, Define, Ideate, Prototype, Test), this study employed a mixed-methods approach that integrated both qualitative and quantitative techniques. The qualitative component focused on assessing user empathy and satisfaction levels, utilizing a mix of pre- and post-implementation surveys, discussions in focus groups, behavioral observations, and an immersive augmented reality exploration of co-design, gamification and augmented reality.

The methodology consists of 3 stages: *Participant selection, Experimental design, and Intervention.*

2.1 Participant Selection Stage (Empathize)

The Israel University has approximately 4,800 enrolled students in various undergraduate and postgraduate programs with projected 3.8% increase by 2025, according to 2024 student population data. The study focuses on the Digital Design program, which consists of 124 students, of whom 8 have different abilities, including Attention Deficit Hyperactivity Disorder (ADHD), mild to moderate hearing impairment, and speech problems. Therefore, the study proceeded with a sample size of 8 students with different abilities. The demographic segmentation in Table 2 indicates the characteristics of the students studied.

Table 2. Demographic Segmentation

Demographic Segment	**Description**
Number of people	8
Age	18–22 years old
Gender	Male and female
Educational Level	University education (Digital and Graphic Design).
Occupation	Students, employed, unem- ployed
Marital Status	Single
Income Level	Low, medium,
Location	Quito, Ecuador

The initial data regarding the projected 3.8% increase in student enrollment at Israel University reflects a positive trend in terms of access and educational expansion. However, when focusing on the Digital Design program—with only 124 students—the study reveals a significant reality: functional diversity within academic environments remains a challenge requiring comprehensive attention.

The fact that 8 students (approximately 6.5%) have conditions such as ADHD, mild to moderate hearing impairment, and speech disorders is not a minor detail. This group, though small in number, represents a crucial opportunity to rethink inclusion beyond access: the goal must be to ensure effective participation, equity in learning processes, and adapted pedagogical strategies. Using this group as the study sample is methodologically valid given the specific focus, but it also raises a critical question: is the university institutionally prepared—in terms of infrastructure, teacher training, and educational policies—to sustain a truly inclusive environment?

The presence of 8 students with conditions such as Attention Deficit Hyperactivity Disorder (ADHD), hearing impairment, and speech disorders within the Digital Design program should not be seen as a marginal fact, but rather as a wake-up call to move toward truly inclusive education. These students, though small in number (due to the relatively low enrollment in the Digital Design program)), highlight a structural issue: while physical or administrative access to education may be guaranteed, effective participation and equitable learning are often not.

For students with ADHD, for example, traditional educational environments are frequently highly distracting and inflexible, making it difficult for them to stay engaged and achieve academically. Similarly, students with hearing or speech impairments may face communication and sensory barriers in both in-person and virtual classes, especially if there are no support mechanisms such as interpreters, accessible visual resources, or multisensory teaching methodologies.

The cited paragraph rightly points out that inclusion must go beyond merely allowing access—it requires adapting teaching methods, training faculty, and redesigning institutional policies to meet the needs of all students. Asking whether the university is truly prepared is not only appropriate, but urgent. Preparation does not only involve having infrastructure or technological tools, but also implies an ethical pedagogical commitment, where educators understand neurodiversity, implement differentiated teaching strategies, and foster environments in which each student can learn according to their own pace and abilities.

The group of students with disabilities and ADHD does not represent a minor challenge or an exception, but a critical opportunity for the institution to transform itself and ensure that all academic programs are based on principles of equity, accessibility, and educational justice.

Presenting the demographic data in a table (referred to as Table 2) reflects a clear quantitative intent, but it would be essential to complement this approach with qualitative insights that give visibility to the students' experiences. Beyond numbers, narratives and analyses are needed to humanize the data and understand how Digital Design—a highly visual and technical field—can adapt to the specific needs of these profiles.

The urgency of integrating inclusive design into higher education, not as an exception but as a standard. This small sample, if approached with institutional commitment and

a willingness for structural change, can be the starting point for a deeper pedagogical transformation.

Moreover, several students with different abilities have reported feeling discriminated against or marginalized during 3D Design classes. This perception often stems from difficulties in understanding complex spatial concepts, technical terminology, and software-based tasks that are not adapted to their specific learning needs. Without inclusive instructional strategies or adequate support tools, these students may experience frustration, isolation, and a sense of inferiority compared to their peers. The lack of differentiated pedagogical approaches contributes to a learning environment where neurodivergent or disabled students struggle not because of their condition, but because the teaching methods fail to accommodate diverse cognitive and sensory profiles.

In Table 3, we explore the reasons why Students with Different Abilities Face Difficulties in Studying Graphic Design

Table 3. Why Students with Different Abilities Face Difficulties in Studying Graphic Design

Student Characteristic	**Reasons for Difficulty in Studying Graphic Design**
Attention Deficit Hyperactivity Dis- order (ADHD)	- Difficulty in focusing for long periods on complex tasks, affecting the creation of design projects. - Tendency towards impulsivity, leading to errors in planning and executing designs. - Problems with time management and organization, making it hard to meet deadlines. - Distractions in visually or auditorily
	intense environments like design studios or labs.
Mild to Moderate Hearing Impairment	- Challenges in following oral instructions or feedback from instructors, especially in noisy classrooms or without hearingsupport resources. - Barriers in communication and collab- oration with peers in group design projects. - Difficulty accessing multimedia learning materials if they are not captioned or adapted for hearing-impaired individuals.
Speech Problems	- Difficulty in clearly expressing ideas and design concepts during presentations and project critiques. - Reluctance to participate in group or class discussions due to social anxiety or lack of confidence in verbal communication skills. - Challenges in building professional and social networks in the design community, which are crucial for career development in this field.

2.2 Experimental Design Stage (Define)

An analysis of teacher reports and notes from students with special educational needs revealed that the 3D Design course—specifically the use of Autodesk Maya—posed significant epistemic challenges for this group, positioning it as an ideal context for the application of Augmented Reality, co-design, and gamification. To address these challenges, the ideation phase of the design thinking process incorporated the biomimetics technique, which facilitated the teaching of 3D modeling by drawing inspiration from the behavioral patterns of wasps in their natural ecosystems. This approach guided students through the learning process in the following manner:

a) Biomimetic Gamification: Creation of scenarios and challenges based on nature to teach key concepts of 3D modeling. Students modeled structures inspired by biological organisms (such as shells, honeycombs, or insect wings), promoting a problem-solving approach based on natural patterns.

b) Co-Design: Students were involved in the design process of the gamified activ- ities, allowing them to propose and adjust the challenges according to their abilities.
c) Augmented Reality: AR applications were developed to enable students to interact with 3D models in a physical environment, facilitating the visualization and manipulation of objects.

2.3 Intervention Stage

Through the use of Augmented Reality, the Prototyping phase of the Design Thinking process was implemented, requiring students to observe and replicate the aesthetics of a bee and its natural environment—the hive—in 3D. As outlined in Table 4, this activity was structured into distinct stages aligned with the Testing phase of Design Thinking. Each stage involved the application of geometric structures and visual design elements inspired by bees and their hive, enabling students to develop and refine their 3D modeling skills.

Table 4. Intervention State and Prototype Design Thinking Phase

Phase Details	**Description**
Phase	Bee Modeling (Phase 1 - “Explorer Bee”)
Description	Students begin by modeling a bee in 3D. The bee must have distinctive visual characteristics.
Segmented body	Students will model the thorax, abdo- men, and head.
Transparent wings	Techniques of texturing and transpar- ency will be used to create the wings.
Detailed antennas and legs	Students are expected to work on fine details like antennas, compound eyes, and segmented legs.
Objective	Create a realistic bee using visual references. The level of detail, use of textures, and ability to represent organic shapes will be evaluated.

The application of gamification consisted of bringing 3D modeling into a playful and fun context, so the rules of the game were as follows:

Point Dynamics

Detailed Bee: Points are awarded for each well-modeled part (wings, antennas, eyes, etc.).

Geometric Hive: Extra points for accuracy in constructing the hexagonal cells.

Final Scene: More points are given if the bee and the hive are correctly integrated, and if the scene has a clean and professional visual finish.

Benefits

Visual Learning: Through the observation and modeling of natural elements.

Geometry Mastery: Application of organic geometry and precision in modeling.

Technical Development: Use of texturing and rendering to create realistic 3D compositions.

Figure 1 shows the product developed by students following the 3D Design class intervention in the Design program at Universidad Israel is presented. This outcome reflects the integration of gamification, co-design, and augmented reality (G + CD + AR) strategies, which were specifically tailored to support students with attention deficits and learning disabilities. The process involved the application of biomimetic principles, enabling students to conceptualize and model natural forms using Autodesk Maya. The resulting 3D artifact not only demonstrates technical skill development but also evidences increased engagement, creativity, and autonomy achieved through the inclusive and interactive pedagogical framework.

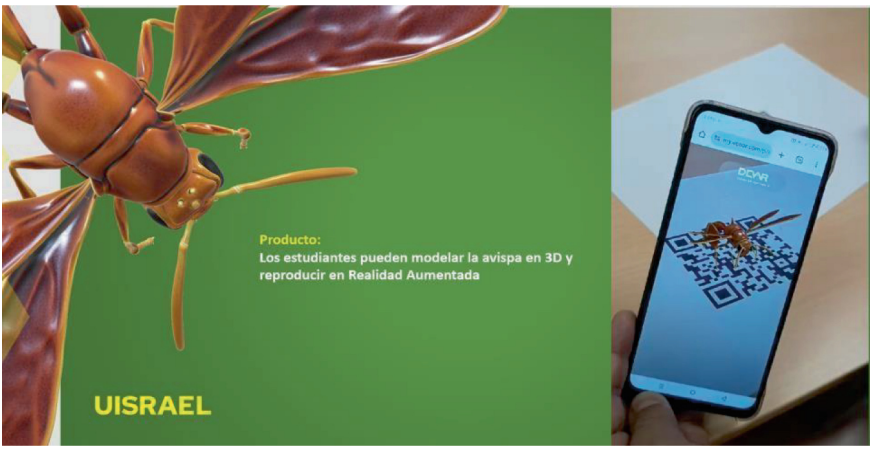

Fig. 1. *Three-dimensional Augmented Reality product*

created by students with attention deficit.

3 Results

3.1 Perceptions of Students and Teachers

From the semi-structured interviews and focus groups, several key themes emerged regarding the needs and experiences of students in the 3D Design class using Autodesk Maya:

Increased motivation: Gamification was perceived as a key motivating fac- tor. Students reported that game elements, such as rewards, levels, and im- mediate feedback, helped them focus better and stay engaged with 3D mod- eling tasks. One student noted: *"With points and levels, I felt like I had some- thing concrete to strive for, and that helped me not lose focus as much."*

Better adaptation to learning needs: Co-design allows students to actively participate in the creation of activities tailored to their cognitive abilities. Students expressed feeling more understood by the teachers, which im- proved their participation and the perception of being in an inclusive envi- ronment. One teacher remarked: *"It was valuable to see how students take ownership of the design process and make suggestions about how they prefer to learn."*

Conceptual clarity through AR: Students affirmed that augmented reality (AR) facilitated the understanding of abstract concepts related to three-di- mensional forms. The ability to visualize models in real-time and manipulate them using mobile devices provided a more tangible and intuitive learning experience. As one student expressed: *"Augmented reality helped me under- stand how 3D figures look from all angles, without having to imagine it."*

Technical difficulties with AR: Some students mentioned technical issues when using AR devices, such as lack of compatibility or slow rendering. Alt- hough most appreciated the experience, the technological aspect posed a challenge for those with less digital proficiency.

Overstimulation from gamification: A small group of students expressed that while the gamification elements were motivating, they sometimes caused anxiety when competing for points or reaching levels, which diverted their attention from conceptual learning.

3.2 Pre- and Post-Implementation Surveys

The surveys administered before and after the implementation of the G + CD + RA Triad revealed a significant positive impact on several key aspects of learning. Results were compared using a 5-point Likert scale, where 1 represented "Strongly disagree" and 5 "Strongly agree."

Table 5 shows the significant improvements identified in the Pre- and Post-Implementation Surveys:

Table 5. Pre-Implementation Vs Post Implementation

Indicator	Pre-Implementation	Post-Implementation	Experimental Group	Cotrol Group	Significant Difference
Motivation to learn 3D Design	2.8/5	4.3/5	-	-	-
Understanding of 3D concepts	2.9/5	4.1/5	-	-	-
Satisfac- tion with the methodology	3.0/5	4.5/5	-	-	-
Average grade in 3D modeling projects	-	-	8.5/10	6.9/10	$p < 0.05$
Average grade in technical skills exam	-	-	8.0/10	7.2/10	$p < 0.05$

Motivation to learn 3D Design: A notable increase in student motivation was observed, rising from 2.8 (pre-implementation) to 4.3 (post-implementa- tion) on a 5-point scale.

Understanding of 3D concepts: There was a substantial improvement in the comprehension of 3D concepts, with scores increasing from 2.9 to 4.1 after implementation.

Satisfaction with the methodology: Student satisfaction with the methodology showed a marked increase, from 3.0 to 4.5.

Average grade in 3D modeling projects: Students in the experimental group achieved a significantly higher average grade (8.5/10) compared to the control group (6.9/10).

*Average grade in the technical skills exam***:** The experimental group also outperformed the control group in the technical skills exam, with an average score of 8.0/10 versus 7.2/10, showing statistically significant differences ($p < 0.05$).

Analysis of Table 6

Grade in 3D Modeling Projects: The experimental group, which employed the G + CD + RA strategy, achieved an average grade of 8.5/10, compared to the control group, which used traditional methods and obtained an average of6.9/10. The 1.6-point difference is statistically significant, indicating that the innovative approach improved performance in practical projects.

Table 6. Experimental Group vs. Control Group Test Results

Test	Experimental Group (Mean)	Control Group (Mean)	Diffe- rence	Signifi- cance
Grade in 3D Model- ing Projects	8.5/10	6.9/10	1.6 points	$p < 0.05$
Grade in Autodesk Technical Exam	8.0/10	7.2/10	0.8 points	$p < 0.05$
Average Time to Complete Tasks	2 h	3.5 h	−1.5 hours	$p < 0.05$
Retention of Con- cepts (Retest Score)	85%	70%	15%	$p < 0.05$

Grade in Autodesk Technical Exam: The experimental group also outper- formed the control group in the technical skills exam, with an average score of 8.0/10 compared to 7.2/10 for the control group. The 0.8-point difference reflects a higher understanding and mastery of Autodesk Maya tools in the experimental group.

Average Time to Complete Tasks: Students in the experimental group completed their tasks in an average of 2 h, while the control group re- quired 3.5 h. The 1.5-h reduction in task completion time suggests that the gamification and augmented reality tools helped streamline the learning process and application of knowledge.

Retention of Concepts (Retest Score): In a knowledge retention test con- ducted several weeks later, the experimental group demonstrated an 85% re- tention rate compared to 70% in the control group. The 15% difference high- lights that students exposed to the G + CD + RA strategy not only learned faster but also retained the information more effectively over time.

Analysis of Table 7

Usability: Overall, the usability of the AR system was well-received, with average scores above 4 for most heuristics. The visibility of system status was particularly highlighted, as students always knew their progress and how to advance. However, areas for improvement include providing more control over the interface, particularly to enable easier undoing of actions.

Table 7. Heuristic Evaluation Results

Heuristic	Average Score (Scale 1–5)	Observations
1. Visibility of sys- tem status	4.2	Students valued the constant feedback on task progress and errors.

(*continued*)

Table 7. (*continued*)

Heuristic	**Average Score (Scale 1–5)**	**Observations**
2. Match between system and the real world	4.5	The 3D AR representation provided intuitive visualization close to real objects, though some commands were ambiguous.
3. User control and freedom	3.8	Most options were clear, but some students found it challenging to undo actions, causing frustration.
4. Consistency and standards	4.0	Most interface elements were consistent, but some icons did not meet student expectations.
5. Error prevention	3.5	Although AR prevented many common er- rors, the lack of prior tutorials increased the likelihood of mistakes.
6. Recognition rat- her than recall	4.3	The interface provided clear menus and options, reducing cognitive load, but some commands were forgotten.
7. Flexibility and efficiency of use	3.9	Advanced students utilized AR effectively, while novices found the tool somewhat com- plex initially.
8. Aesthetic and minimalist design	4.7	The interface was appreciated for its visual simplicity and clean design, facilitating fo- cus on modeling tasks.
9. Help with error recognition and re- covery	3.6	There were comments about insufficient explanations for errors, although some mes- sages were helpful.
10. Help and docu- mentation	3.4	Students felt the system lacked adequate documentation or integrated tutorials for user guidance.

Navigation: The tool was mostly intuitive for navigation, though some stu- dents reported confusion with specific icons and commands. The match be- tween the system and the real world received high scores, as students could easily relate the tools to their physical counterparts. Improving the visual consistency of icons and adding guided tutorials could enhance ease of use.

Interaction: Interaction with 3D models via AR was described as smooth, allowing students to visualize and manipulate objects in real-time. The tool's flexibility was appreciated by advanced users, though some beginners found initial functionalities poorly

explained. The tool could benefit from customi- zable features for different experience levels and better error prevention, such as proactive guidance during use.

Documentation and Support: The system received the lowest score in the help and documentation heuristic. While most students found the main func- tionalities intuitive, those with less technical experience struggled to access information or help during critical moments. This underscores the need for integrating accessible tutorials or documentation within the tool.

The Augmented Reality system implemented in the 3D Design course was generally well-received by students, particularly with respect to usability, navigation, and interaction. However, several areas for improvement were identified, including the need for more robust error-handling functionalities (e.g., undo features), greater interface consistency, and improved user documentation. Addressing these issues could significantly enhance the overall user experience, especially for students with learning disabilities.

The implementation of an Augmented Reality (AR) system in the 3D Design course represents a significant step toward democratizing visual and spatial learning. For students with disabilities or Attention Deficit Hyperactivity Disorder (ADHD), AR is not merely a complementary tool—it is an urgent pedagogical necessity. Its immersive, interactive, and multimodal nature allows abstract 3D modeling concepts—such as scale, volume, or perspective—to be translated into tangible and manipulable experiences, thus fostering deeper and more sustained understanding, especially for those who do not learn in linear or text-based ways.

However, the seemingly positive reception of the tool by students should not overshadow the structural deficiencies that persist. The absence of critical functions such as an "undo" feature, inconsistencies in the interface, and poor user documentation reveal a lack of inclusive thinking in the design of the technology itself. These shortcomings are not minor technical issues—they are cognitive barriers that amplify exclusion and perpetuate the gap between students with and without special educational needs.

What is most concerning is that, although AR can be a transformative catalyst for learning, if not properly adapted, it risks becoming an exclusionary tool—paradoxically sophisticated yet inaccessible. In this context, the critique must not only address the technology but also the institutional model that implements it without fully understanding the neurodiverse realities of the classroom. It is imperative that the design of AR-based learning experiences integrates principles of universal accessibility from the outset, not as a retroactive adjustment.

AR has the potential to revolutionize 3D design education for students with disabilities or ADHD, but only if approached with an ethical, inclusive, and pedagogically sensitive vision. Otherwise, there is a serious risk of reproducing old exclusions with new technologies.

4 Conclusion

The implementation of the pedagogical strategy based on the G + CD + AR triad (Gami- fication, Co-Design, and Augmented Reality) for students with attention deficits and disabilities in the Design program at Universidad Israel in Quito, Ecuador represents a substantial progression in inclusive and technology-adapted education. This

methodology aims not only to overcome traditional learning barriers but also to foster a participatory and personalized environment that addresses the individual needs of students. Firstly, the combination of gamification and co-design offers an innovative approach to motivating students. Gamification, by incorporating game dynamics into the educational setting, facilitates active participation and sustained engagement from students, who often struggle to maintain attention in a traditional academic context. The use of mechanics such as points, badges, and rewards not only promotes interaction but also establishes clear and achievable goals that allow students to visualize their progress tangibly. The playful narrative adds an intrinsic motivational component, making students feel like protagonists in a story, which reinforces their interest in continuing to learn.

Second, co-design becomes a key tool to ensure that the pedagogical strategy is inclusive. By allowing students to participate in creating their own learning process, a sense of belonging and responsibility is promoted. This collaborative approach not only helps tailor content to students' preferences and needs but also fosters the development of social and teamwork skills, which are essential in their training as designers. By having the opportunity to propose activities, choose game mechanics, and design parts of the course, students with disabilities or attention deficits feel their voices are heard, and that the educational environment is truly adapted to them.

Furthermore the integration of augmented reality (AR) in this context adds an immersive component that enhances the understanding and retention of key design concepts. AR allows students to interact with three-dimensional objects, dynamic visualizations, and interactive environments, enriching their learning experience. This technology, besides making the process more engaging, facilitates the comprehension of abstract con- tent through a visual and tactile experience that accommodates various learning styles, particularly those of students with special needs.

Finally, the importance of continuous and personalized evaluation in this pedagogical model must be emphasized. By continuously monitoring students' progress and providing timely feedback, adjustments can be made to activities and game mechanics to ensure that all students, regardless of their limitations, can progress at their own pace and achieve the proposed objectives. The gamified system offers clear metrics that help identify areas for improvement and adjust the pedagogical approach as needed.

In conclusion, the G + CD + AR strategy not only optimizes the learning experience for students with attention deficits and disabilities but also promotes a more inclusive, collaborative, and adaptive educational model. By integrating advanced technological tools and participatory methodologies, the teaching-learning process is transformed, generating a positive and lasting impact on the training of future designers.

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From Dialogue to Transformation: Pedagogical Foundations of Inclusive Leadership

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Abstract. The present research contributes significantly to the field of educational leadership by proposing an innovative approximation between the principles of contemporary pedagogy and the practices of inclusive leadership, in the context of people management in educational environments. From a qualitative and interpretative approach, based on content analysis and integrating the legacies of Paulo Freire, Maria Montessori and John Dewey, with current organizational challenges, the research offers a theoretical and practical perspective that values human potential, democratic participation and the construction of more equitable and meaningful educational environments. The critical analysis of foundational texts and international recommendations provides a solid basis for reconfiguring the management of people in educational institutions, revealing creative and ethical paths for the formation of more conscious, collaborative and transformative leaderships. The research also proposes practical suggestions for the formation of inclusive teams and for the strengthening of organizational cultures oriented towards justice, diversity and well-being.

Keywords: Inclusive Leadership · Contemporary Pedagogy · People Management · Continuous Training · Democratic Participation

1 Introduction

In a context marked by profound social and organizational transformations, it is imperative to rethink leadership models in the light of principles that value inclusion, diversity, and social justice. A leader plays a crucial role in planning, organizing, guiding, and

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 510–525, 2025.
https://doi.org/10.1007/978-3-032-09080-5_49

overseeing operations. By embracing a proactive leadership approach, an organization becomes more adaptable to change and uncertainty, fostering visionary and well-structured initiatives [1].

Inclusive leadership has emerged as a particularly relevant approach in educational organizations, as it seeks to ensure the participation of all community members and promote environments founded on belonging, listening and valuing difference [2, 3]. This conception, of an ethical and political nature, goes beyond the merely technical dimension of leadership, assuming itself as an instrument of institutional transformation [4, 5].

In this context, the present research proposes the articulation between the principles of contemporary pedagogy and the practices of inclusive leadership, recognizing that authors such as Paulo Freire, Maria Montessori and John Dewey offer fundamental contributions to the construction of more humane, participatory and development-oriented organizational cultures. The pedagogy of dialogue, experience and autonomy thus constitutes a fertile theoretical framework for the leadership of people in educational environments [4, 6, 7].

The choice of the theme is justified by the growing appreciation of continuous training, collaborative participation and relational ethics as structuring dimensions of leadership in education. This work aims, therefore, to understand how pedagogical principles can contribute to more inclusive leadership practices, committed to the dignity of professionals and to the promotion of more cohesive and creative organizational contexts. This study contributes significantly to the field of educational leadership by proposing an innovative approach between the principles of contemporary pedagogy and the practices of inclusive leadership. By integrating the legacies of thinkers such as Paulo Freire, Maria Montessori, and John Dewey with current organizational challenges, the research offers a theoretical and practical perspective that values human potential, democratic participation, and the construction of more equitable and meaningful educational environments.

A qualitative approach of an exploratory nature was adopted [8, 9], framed in an interpretative perspective that values the meanings, relationships and contexts in which the phenomena are inscribed [10]. The methodology was based on content analysis [11], conducted on the specialized literature, the foundational texts of the authors under study, and relevant international recommendations.

For a better understanding of the subject, in the first part a literature review is made to contextualize the concepts addressed. The methodological note and discussion of the results are presented below. Finally, the final considerations will be presented as well as limitations and future suggestions.

2 Inclusive Leadership: Fundamentals and Challenges

Inclusive leadership has gained prominence in educational organizations as a response to the demands of social justice and appreciation of diversity. This model is based on intentional action that guarantees the participation of all, promoting belonging and recognition [2]. By valuing differences as an enriching potential, it favors well-being, commitment, and organizational performance [3].

School leadership, exercised by principals and management teams, is strategic in building inclusive cultures. As Peterson and Deal [12] as well as Schein and Schein [5] point out, leadership influences institutional values and behaviors, mediating between external orientations and the concrete reality of each school. This mediation allows practices to be adjusted to the context and to strengthen internal cohesion [13].

Inclusion is embodied in differentiated policies and practices that meet individual needs. The Organisation for Economic Co-operation and Development [14] stresses that equity implies eliminating barriers related to gender, origin or social context. These principal guides leadership that combats inequalities and promotes fair opportunities [15, 16].

The relationship between leadership, inclusion, and equity is manifested in collaborative and participatory practices. Inclusive leaders create safe environments, actively listen, and foster collective engagement [2]. Transformational leadership, because of its visionary and motivating nature, is particularly effective in educational contexts [5, 17, 18].

Still, the transition to inclusive cultures faces resistance. Schein and Schein [5] points out the need to unlearn established practices, while Fullan [17] refers to the lack of training on diversity as an obstacle. Many schools adopt superficial approaches, without reconfiguring pedagogical and organizational practices [16]. To overcome these challenges, a leadership open to dialogue is essential, capable of mobilizing the community through participatory and contextualized processes.

Considering this, inclusive leadership is not only a technical competence, but an ethical and political dimension of educational action, requiring a critical view, sensitivity to inequalities and commitment to social transformation. In addition, it recognizes continuous training as an essential means for the development of people and the organization. As Chiavenato [19] states, learning organizations invest in the growth of their teams in a systematic and integrated way, promoting not only technical skills, but also creativity, cooperation and adaptation to change. Thus, training becomes an integral part of a people management committed to human enhancement and continuous improvement.

3 Principles of Contemporary Pedagogy in Training and Leadership

3.1 Paulo Freire: Critical and Emancipatory Education

Paulo Freire's work is one of the pillars of contemporary pedagogy, recognized for its critical and emancipatory approach to education [20, 21]. His conception of education as a practice of freedom challenges traditional and hierarchical models, proposing an action focused on social transformation, valuing experience and justice [4].

Breaking with banking education (a concept developed by Paulo Freire to criticize the traditional teaching model, in which the teacher deposits knowledge in students as if they were empty containers, without stimulating critical reflection), Freire proposes a dialogical pedagogy based on the collective construction of knowledge. This idea can be transposed to educational leadership, where the leader acts as a facilitator of participation and promoter of active listening [22]. It is a leadership with pedagogical and political

intent, aimed at the development of critical awareness and the capacity for collective action [23].

The concept of awareness, central to Freire's thought, implies stimulating environments in which critical reflection and joint mobilization are encouraged as an expression of human dignity. This perspective is close to inclusive leadership approaches, which promote the empowerment, listening and appreciation of professionals [2].

Dialogue, conceived as a founding practice of Freire's pedagogy, also inspires leadership models based on trust, collaboration, and the joint construction of organizational culture [5, 20]. In addition, current studies reinforce the positive impact of active participation on perceptions of fairness and team engagement [24].

Finally, Freire highlights autonomy as an objective of education. A Freire-inspired leader promotes self-regulation, critical thinking, and accountability, replacing the logic of control with formative and ethical leadership [4, 25]. This view is consistent with contemporary perspectives focused on integrity, collective well-being and shared purpose [26], and is also supported by recent studies that highlight the positive effects of organizational cultures guided by human values in promoting the well-being and commitment of employees [27].

3.2 Maria Montessori: Autonomy and a Prepared Environment

Maria Montessori's pedagogy, developed at the beginning of the twentieth century, offers significant contributions to rethinking leadership in contemporary educational contexts. His method is based on autonomy, respect for individual rhythm and conscious preparation of the learning environment [6, 28].

The concept of a prepared environment refers to the creation of physical, social, and emotional spaces that favor initiative, self-discipline, and critical thinking [29]. This notion can inspire leaders who promote the well-being and creativity of teams. Just as the educator is a facilitator of the educational process, the leader can also assume a posture of support and guidance, promoting the autonomy and responsibility of the members of the organization. As Qi et al. [30] state, "(…) managers may offer other kinds of support, such opportunities, resources, and autonomy to employees to stimulate more innovative behavior" (p. 12). This perspective reinforces the idea of inclusive leadership oriented towards the development of people, in line with pedagogical principles that value integral development and the creation of environments that enhance initiative and co-responsibility.

Montessori understood development as an integral process – physical, cognitive and emotional – and valued direct and active experience in the learning process [31]. This perspective can inspire leadership that recognizes the diversity of paths, respects individual rhythms and promotes a culture of trust, autonomy and co-responsibility, through the creation of prepared environments.

3.3 John Dewey: Experience, Democracy and Participation

John Dewey's educational philosophy, rooted in pragmatism, offers essential contributions to leadership in educational and organizational contexts. For Dewey, education is a

continuous process of growth, centered on experience, social interaction and democratic participation [7, 32, 33].

By conceiving the school as a microcosm of society, Dewey advocated educational environments based on cooperation, shared decision-making, and collective responsibility [34, 35]. In this logic, the leader is no longer just a manager and becomes a facilitator of organizational learning, someone who creates conditions for autonomy, critical reflection and transformative action [36, 37].

The emphasis on experience as the basis of learning inspires models of reflective leadership, where experimentation, error, and adaptation are valued. In this sense, leading is also learning continuously, creating flexible and collaborative environments [38, 39].

In short, by arguing that democracy is learned and lived in everyday life, Dewey proposes an ethical conception of leadership, based on inclusion, listening and the co-construction of solutions. As in Freire, to lead, in this context, is to educate for freedom.

3.4 Continuous Training as a Practical Expression of Inclusive Leadership

Inclusive leadership, when inspired by the pedagogy of authors such as Freire, Montessori and Dewey, values continuous training as a fundamental process for the development of people and the organization. More than a technical function, training implies guiding and mediating pedagogical processes that promote the integral development of trainees, through the construction of meaningful pedagogical relationships and the encouragement of autonomy and participation [40]. From this perspective, training is a practical expression of leadership, integrating a people management that respects diversity, promotes growth and consolidates cohesive educational communities.

The proposals of Freire, Montessori and Dewey converge in valuing education as a continuous, situated and human process. In each approach, training goes beyond technical instruction, assuming itself as personal, social and ethical development [4, 7, 28].

For Freire, education is inseparable from critical awareness and ethical responsibility in the world [4]. In Montessori, autonomy and self-discipline are embodied in a prepared environment [6, 41]. For Dewey, it is a process of learning through experience and democratic participation [33, 34].

In the field of leadership and people management, it is increasingly important to develop organizational cultures that integrate continuous training as part of the institutional identity. In this regard, Camara et al. [42] argue that training should be a dynamic process, which includes technical, relational and motivational dimensions.

The same view is shared by Chiavenato [19], when he stresses that organizations must become spaces for continuous learning, promoting creativity, motivation and constant adaptation. Thus, continuous training is no longer just the responsibility of human resources and starts to assume a strategic role in strengthening the organizational culture and responding to changing contexts.

4 Between Pedagogy and Leadership: Strategies for Transformative Management

Pedagogical principles are the theoretical and philosophical foundations that guide educational practice. They express values, conceptions of the world, of the subject and of knowledge, being essential to define how one teaches, why one teaches.

According to Libâneo [43], pedagogical principles are "general guidelines that underlie the objectives, contents, methods and evaluation of the educational process" (p. 32). These principles, understood as foundations that intentionally guide the teaching-learning process, are not restricted to the formal educational field. With the growing appreciation of human capital in organizational environments, many of the pedagogical principles have been incorporated into leadership practices, especially in models that promote lifelong learning, autonomy and experimentation. In this context, Edmondson [44] highlights that the creation of psychologically safe environments is essential to foster participation and development. As he says:

In psychologically safe workplaces, people know they might fail, they might receive performance feedback that says they're not meeting expectations, and they might lose their jobs due to changes in the industry environment or even to a lack of competence in their role. [44, p. xv]

Thus, psychological safety, far from eliminating professional demands, allows employees to take interpersonal risks and contribute in a more active, critical and innovative way.

The articulation between pedagogical principles and leadership practices has been gaining prominence in contemporary reflection on education and management. Although once treated in different fields, these two domains are deeply intertwined when a critical and interdisciplinary approach is adopted, such as that which emerges from the contributions of Paulo Freire, Maria Montessori and John Dewey. While pedagogy seeks to train individuals with critical thinking and autonomy [4, 6, 33], contemporary leadership aims to develop skills, create collaborative environments and promote continuous learning within organizations [45].

When guided by pedagogical principles, leadership tends to assume interactive, cooperative, participatory and ethical characteristics, as advocated by Dewey [33] and Freire [4] in their proposals for transformative and democratic education. According to Day et al. [46], effective leaders act as facilitators of the growth of their teams, promoting psychologically safe, reflective and innovative environments.

Paulo Freire [4], for example, proposes a pedagogy based on dialogue, active listening and the problematization of reality. Maria Montessori [6], in turn, defends the autonomy of the child and the importance of a structured environment that favors spontaneous learning. For Dewey [33], experience is the starting point and center of the educational process, criticizing traditional paradigms based on the mere transmission of content and arguing that knowledge is built from the interaction of the individual with the environment. As the author summarizes: "Education is not preparation for life; education is life itself" [33 , p. 239].

The transposition of pedagogical principles to the field of leadership requires a comprehensive reading of Education, which recognizes its complexity and multidimensionality. Therefore, both leaders and educators are formative agents who guide, inspire

and develop people [45]. According to Freire [4], teaching requires humility, listening and dialogue. This perspective, of Freirean inspiration, implies building horizontal relationships, listening to and valuing the contributions of all members of an organization. It is a model that promotes active participation and co-responsibility, principles that converge with the proposals of inclusive leadership [2]. All these skills are present in transformational and participatory leadership, in which the leader acts with empathy, promotes active listening, inclusion, and critical thinking. These dimensions are also identified by Waters et al. [47], who highlight responsibilities of effective leadership such as intellectual stimulation, valuing the contribution of others, clear communication and building relationships of trust – practices that reflect the transposition of pedagogical principles into organizational leadership contexts.

If we allude to Montessori principles, we can establish a conceptual bridge with a leadership that values the "prepared environment" and confidence in human potential, suggesting that leaders should create conditions conducive to their teams learning, experimenting, and growing autonomously [6, 28]. Based on Montessori's pedagogy, evidenced by Cesário [41], the centrality attributed to the child's autonomy and self-regulation is highlighted, which can be analogously transposed to leadership models that are based on trust, delegation of responsibilities and appreciation of individual potentialities.

As for Dewey [7, 33], his pedagogical principles are guided by active, continuous and meaningful learning, allowing reflection and the reconstruction of knowledge. This requires a dynamic learning environment, in which learners' previous experiences are valued as a starting point for new learning. Learning occurs, therefore, through the principle of "learning by doing". Transposing these principles to the field of leadership, it is possible to infer that they must be based on active participation and the implementation of exploratory, democratic and collaborative practices [46, 47].

The integration between pedagogical principles and leadership practices thus points to an ethical, inclusive and emancipatory conception of the act of leading. By recognizing that leading is also educating, the role of the leader is expanded beyond task management: he becomes an agent of training and transformation. The contributions of Freire, Montessori and Dewey offer distinct but convergent ways to think about human-centered leadership, which values knowledge, dialogue, autonomy and democracy as axes for the development of people and organizations.

5 Methodological Approach

The present research adopts a qualitative approach of exploratory nature [8, 9], with the objective of analyzing the interactions between inclusive leadership and the principles of contemporary pedagogy in the context of people management in educational contexts. This methodological choice fits into an interpretative perspective, as underlined by Denzin and Lincoln [10], for whom all qualitative research is anchored in ontological and epistemological beliefs that shape the understanding of phenomena. As stated: "qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world" [10 , p. 43].

More than collecting data, this research seeks to interpret meanings and relationships present in the analyzed texts, valuing the theoretical and pedagogical contributions in the

light of the contexts in which they were produced. The methodological option allowed a critical and articulated reading of the ideas of Paulo Freire, Maria Montessori and John Dewey, in convergence with contemporary models of leadership and people management practices.

Content analysis [11] constituted the basic methodological framework, applied to the review of the specialized literature, to the founding texts of authors such as Freire, Montessori and Dewey, and to international guiding documents, namely OECD reports [14] on equity and quality in education. The analysis was carried out without the previous definition of formal categories, opting for an interpretative reading that values conceptual problematization, the identification of convergences and tensions between different perspectives, and the critical articulation of ideas within the framework of a proposal for the renewal of people management practices in education. This methodology allowed the construction of a solid theoretical base, the systematization of relevant principles for inclusive leadership and the elaboration of applied proposals, aligned with the values of critical pedagogy and continuous learning.

6 Analysis and Discussion

6.1 Creative Proposals for People Management

Strategies for Building Inclusive Teams

An inclusive team is distinguished by valuing the diversity of skills, experiences and perspectives of each of its members, promoting an environment where everyone feels recognized, respected and fully capable of contributing to the collective goals of the organization. In an ideal inclusive culture, leaders and employees actively commit to the elimination of barriers – whether they are social, cultural or structural in nature – ensuring equitable access to opportunities [48]. Aligned, Krause et al. [49] argue that building truly inclusive teams should start with anonymous recruitment processes, in which information such as name, gender, age or ethnic origin is hidden in the early stages. This method focuses on professional skills and experiences, reducing unconscious biases and promoting diversity.

After selection, the onboarding phase plays an essential role in consolidating an inclusive culture. This should include socialization practices that actively address diversity, such as orientation sessions on organizational culture, mentoring programs with experienced colleagues, and workshops on intercultural communication and implicit biases [50].

These diverse perspectives on leadership help to understand how leaders can act at different stages of team development. Tuckman's [51] model describes this path in four stages (formation, conflict, standardization, and performance), requiring the leader to have an adaptive capacity that articulates active listening, strategic vision, appreciation of diversity, and cultural cohesion. Inclusive, distributed, and transformational leadership is key to ensuring that teams evolve collaboratively and innovation-driven [2, 17, 22].

As Silva [52] points out, leading multicultural teams implies much more than integrating people from different backgrounds. Inclusive leadership requires actively promoting mutual respect and collaboration, creating an environment where each individual

feels valued and motivated to contribute their best. This positioning not only strengthens internal cohesion, but also enhances the benefits of organizational diversity.

Dynamics of Participatory Leadership, Relational Ethics and Active Listening
Participatory leadership is characterized by the effective inclusion of employees in decision-making processes, promoting a more democratic and collaborative work environment. This model values listening, active involvement and the sharing of responsibilities, contributing to the strengthening of the commitment and motivation of the teams. According Robbins [53], participatory leadership is based on open dialogue and power sharing, a perspective that Rodrigues [54] complements by highlighting the role of the leader as a facilitator, capable of creating conditions for the appreciation and involvement of all.

This vision echoes in the principles of contemporary pedagogy, namely in the proposals of John Dewey, whose emphasis on participation, reflection and experimentation can inspire leadership practices. For Dewey [33], the educational process and, by extension, the action of leading, should be based on the collective construction of meaning, cooperation and mutual accountability. From this perspective, to lead is to create contexts that favor growth and autonomy, establishing an ethical relationship with the members of the organization.

Relational ethics is an essential dimension of leadership, based on respect, trust and transparency. To lead is, fundamentally, a moral act, guided by a commitment to the common good and to the dignity of those who make up the educational community [23]. It is also important to highlight the importance of ethical practices in leadership and communication, as they directly influence the organizational climate and the well-being of teams [55].

Thus, active listening is an essential competence for inclusive and participatory leadership. More than listening, listening involves understanding the needs, emotions, and experiences of others, creating space for genuine dialogue. Robbins [53] points out that "Listening is just capturing sound vibrations. Listening is giving meaning to what we hear" (p.116). Paulo Freire [4] it also considers listening as the basis of transformative dialogue, an indispensable condition for respect and co-responsibility between subjects. In the same vein, Montessori [6] values attentive and silent observation as a way of listening to the other, respecting their rhythm and promoting self-regulation.

Active listening, when combined with empathy and humility, becomes an instrument for building trust and strengthening human relationships. Creating psychologically safe environments allows employees to express themselves without fear, take interpersonal risks, and contribute more creatively and authentically [44]. Psychological safety, therefore, is a pillar of leadership that listens, welcomes, and values.

In addition, transformational leadership, by fostering high expectations, collaboration and continuous development, contributes to the consolidation of organizational cultures centered on learning and inclusion [17, 22]. For Waters et al. [47], these leaders stand out for their ability to intellectually stimulate teams, communicate clearly, strengthen trust and promote mutual recognition.

In summary, participatory leadership, relational ethics and active listening are not only operational strategies, but expressions of a pedagogical and ethical conception of leadership. These are dynamics that create the conditions for cohesive, motivated teams

capable of innovating, while reinforcing the values of inclusion, justice and dignity in the organizational context. It is, as Freire [4] points out, a leadership that educates, dialogues and transforms.

Suggestions for Formative Practices Based on the Pedagogies Studied

The implementation of effective training practices requires an integrated approach that combines pedagogical innovation with strategic management oriented towards human development. The design thinking model, as proposed by Seevaratnam et al. [56], is user-centered, promoting empathy, idea generation, and hands-on experimentation as essential phases for the creative resolution of problems and the development of adaptive skills.

In this logic, it is relevant to recover the contributions of Montessori, Freire e Dewey. Montessori [6] defends the creation of training environments prepared to stimulate autonomy and self-learning, principles that can be applied in training programs with a strong practical component and centered on the trainee. Freire [4], in turn, it proposes an approach centered on dialogue, in which the training starts from the concrete reality of the participants and values the knowledge built from the lived experience. Dewey [7], By emphasizing experience as the axis of learning, it inspires practices that articulate theory and action in the work context.

In addition, Sousa et al. [57] underline the importance of aligning training with the organization's strategic objectives, using tools such as job analysis and description, performance appraisal and the Balanced Scorecard to identify skills gaps. In line with the above, Camara et al. [42] argue that training should be conceived as a strategic process, capable of responding to the demands of the organizational environment, promoting continuous development and adapting the competence profiles to the emerging needs of the institution.

The operationalization of the approaches presented can be achieved through proposals such as: co-learning workshops, based on the experience of the employees themselves and inspired by Freirean pedagogy; flexible training environments, anchored in the Montessori method, which promote autonomy and integral development; or even collaborative solutions built from real problems, aligned with Dewey's principles and the design thinking process. These practices favor an organizational culture of continuous learning, centered on participation, practical relevance and human growth, reinforcing the articulation between people management and contemporary pedagogy.

7 Discussion

The present research sought to deepen the principles of contemporary pedagogy and how they relate to the practices of a leadership inclusive. This relationship reinforces the idea that people management can achieve a new meaning when approaches that place dialogue, experience and autonomy at the center of action are valued.

Authors as Freire [4], Montessori [6] and Dewey [7] argue, education – understood as a space of freedom, personal growth and active participation – offers very relevant clues to rethink the role of those who lead within educational organizations.

One of the most striking aspects of this research was to realize that leadership goes far beyond technical or administrative tasks: it is, above all, an ethical practice with a

formative impact. This perspective is in line with authors such as Schein and Schein [5] and Sergiovanni [23], who see leadership as something deeply linked to the culture of the organization and the relationships that are built there.

In this context, attitudes such as knowing how to listen, involving people in decisions and valuing differences are no longer just good practices – they become concrete expressions of a more humane and conscious leadership, as Randel [2], Roberson [3] and other researchers point out. Finally, the contributions of pedagogy revealed important points of contact with more current leadership models, such as those that promote transformation and the active participation of all.

Dewey's [33] idea of learning by experience and the importance of democratic sharing, as early as 1930, today finds a strong parallel in leadership practices that focus on co-creation, joint deliberation and learning within the organizations themselves [17, 46]. The concept of the "prepared environment", proposed by Montessori, also reinforces the need to create organizational spaces where people feel safe, motivated and free to act with autonomy and initiative.

What the literature shows us is that leaders who integrate these pedagogical principles – especially the most critical and reflective ones – are able to foster environments of belonging and innovation. Researchers such as Qi et al. [30] and Edmondson [44] highlight that inclusive environments, where psychological safety is promoted, tend to generate more committed, creative and satisfied teams.

This vision is also present in the proposals explored in the previous chapter, which suggest more creative ways of thinking about teamwork – through co-learning, shared problem solving, and valuing the experiences that each professional brings with them.

One point that deserves special attention is that of continuing training. More than a simple updating of technical skills, it can – and should – be understood as a profoundly human, pedagogical and transformative process. For authors such as Chiavenato [19] and Camara et al. [42], training is also a way of leading: it is accompanying, inspiring and sustaining the growth of people in its various dimensions.

When education is thought of as a space where one truly listens, where there is space to reflect together and build knowledge collaboratively, it is no longer just a functional instrument. It becomes a cornerstone of truly inclusive leadership – one that fosters ongoing growth and a genuine sense of belonging. Yet, putting these ideas into practice isn't easy. Old-school management habits, underinvestment in relationship-building, and a reluctance to embrace deep change all get in the way. As Fullan [17], along with Schein and Schein [5], remind us, shifting toward a more inclusive culture means more than tweaking structures; it means transforming mindsets. That's why we need leaders who combine critical insight with ethical courage and a real passion for developing others. In summary, the results of this research underline the importance of reconfiguring educational leadership in the light of contemporary pedagogy. By bringing to light the contributions of Freire [4, 20], Montessori [6] and Dewey [7, 33], the study shows that educational leaders must be, above all, educators: promoters of dialogue, freedom and the collective construction of knowledge. It is in this direction that the foundations for a new paradigm of people management are found – a paradigm that combines organizational effectiveness with social justice, development with dignity, and leadership with pedagogy.

The present research allowed us to critically reflect on the articulation between the principles of contemporary pedagogy and the models of inclusive leadership, with particular focus on the management of people in educational contexts. Starting from a qualitative and interpretative approach, we sought to understand how the contributions of Paulo Freire, Maria Montessori and John Dewey can inspire leadership practices centered on listening, participation and human development.

Throughout the work, it was evident that inclusive leadership is not limited to operational strategies, but constitutes an ethical and political dimension of organizational action, promoting justice, recognition and belonging. The pedagogical principles addressed – such as dialogue, autonomy, experience and co-responsibility – proved to be fundamental for the construction of more participatory and creative organizational cultures, reinforcing the importance of continuous training as an instrument of individual and collective transformation.

The creative proposals presented in the penultimate chapter – such as co-learning workshops, flexible training environments and collaborative solutions oriented to real problems – point to concrete paths for the renewal of people management practices, aligning them with the values of inclusion and continuous learning.

In the light of the above, it is essential to make a number of suggestions. It is important that educational institutions invest in sustained and relevant training. That encourage individual autonomy, stimulate critical thinking and favor collaborative and reflective work.

It is equally essential that organizational contexts be able to offer real conditions for listening and welcoming. Environments where each person feels legitimized to share doubts, contributions and experiences, without fear of being silenced or judged, tend to generate more authentic and productive relationships. This psychological security is not built by decree, but by the constant practice of attentive, ethical and profoundly human leadership. Such spaces, marked by psychological safety, tend to welcome diversity as a value – not as an obstacle – and to recognize plurality as a driver of transformation and innovation.

In addition, it is urgent to rethink the leadership models adopted. More horizontal leadership, open to dialogue and anchored in genuine listening can create conditions for more ethical, participatory and lasting relationships. The construction of an organizational culture consistent with these principles also involves the effective integration of pedagogy in management processes, namely in strategic planning and in the definition of institutional policies. In doing so, a leadership that not only generates, but educates and transforms is affirmed.

8 Conclusion

The research has identified relevant contributions to the renewal of leadership practices in educational contexts. However, at the end of this journey, it is important to reflect on its limitations and point out possible future developments.

As it was conducted based on an essentially theoretical and interpretative approach – which proved adequate in view of its objectives – it was not possible to collect empirical evidence that would allow validating, in the field, the concrete effects of the proposals presented. The methodological option for a critical, broad and articulated reading,

without the previous construction of rigid analytical categories, favored depth and interpretative freedom. However, this same trait can hinder the systematic replication of the results in other educational or research contexts.

We believe it is relevant to carry out empirical studies in schools or educational institutions that choose to implement some of the proposals developed in this work, which would allow a more concrete evaluation of their effectiveness and applicability. Likewise, it is urgent to deepen the reflection on the impact of inclusive leadership on the well-being and professional development of educators, as well as to analyze how different organizational cultures welcome – or resist – the introduction of practices inspired by critical pedagogies.

Other possible pathways include the development of participatory methodologies, which actively involve teachers, leaders and educational teams in the joint construction of inclusive and creative solutions. Research in contexts marked by greater social vulnerability or diversity also deserves attention, as the role of inclusive leadership can take on even more transformative contours. Finally, it would be pertinent to explore and compare different models of continuous training that are based on autonomy, listening and critical reflection, in order to understand to what extent they contribute to the strengthening of more dialogical, horizontal leaderships committed to human development.

To sum up, leading in educational contexts requires more than technical competence: it requires a pedagogical and ethical vision of leadership, capable of mobilizing individuals around common projects of transformation and social justice. Valuing continuous training, diversity and human potential is, therefore, an imperative for building more cohesive, innovative organizations committed to the common good.

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Designing and Evaluating Serious Board Games for Cultural Heritage: Student Perspectives from an International Learning Context

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Abstract. This study investigates the potential of serious board games as educational tools for cultural heritage learning within an international, multicultural classroom setting. Drawing on theoretical foundations from game-based learning, cultural heritage education, intercultural collaboration, and design-based learning, the research engages university students in the co-creation and evaluation of board games centered on heritage themes. By designing games collaboratively, students not only explore cultural narratives and values but also reflect on how interactive play can foster dialogue across generations and cultures. Through three complementary surveys—focused on learning outcomes, intergenerational perceptions, and team collaboration—the study captures students' perspectives on both the educational and social dimensions of the process. Preliminary findings suggest that when students act as designers, they develop deeper engagement with heritage content while enhancing essential soft skills such as communication, creativity, and teamwork. The board games function not only as instructional tools but also as catalysts for intercultural exchange, making heritage more accessible and personally relevant. Overall, the research demonstrates that integrating serious games into educational contexts offers a dynamic, student-centered approach to heritage education, one that supports active learning, critical thinking, and the development of 21st-century competencies.

Keywords: Serious Board Games · Design and Evaluating · BIP International learning concept

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 526–538, 2025.
https://doi.org/10.1007/978-3-032-09080-5_50

1 Introduction

This study explores how educational board games can foster cultural heritage learning and intergenerational dialogue through international student collaboration. The research is based on four interconnected theoretical frameworks: game-based learning, cultural heritage education, intercultural and collaborative learning, and design-based learning. Game-based learning (GBL) theory suggests that games provide meaningful, engaging contexts for learners to explore knowledge through active problem-solving and reflection (Gee, 2007; Prensky, 2001a). In this study, students designed and evaluated educational board games that teach cultural heritage concepts. The research examines how game mechanics, narratives, and play experiences can contribute to a deeper understanding of cultural heritage and values. To implement it three surveys will be applied. The first and second surveys, assessing how effectively the games promote learning outcomes, are grounded in this theoretical framework.

Moreover, Cultural Heritage Education emphasizes participatory and effective engagement with Cultural Heritage. It encourages learners to reflect on identity, place, and historical continuity (Hooper-Greenhill, 2007). This research uses games as tools to make heritage accessible and personally relevant, particularly in intergenerational and intercultural contexts. A focus group survey will investigate how students perceive the role of educational games in stimulating interest in Cultural Heritage and fostering dialogue between generations.

The collaborative design process is set in a multicultural classroom where students from different backgrounds bring unique perspectives to interpretate heritage (Vygotsky, 1978; Deardorff, 2006). The third survey, a self-assessment of student collaboration, explores how working in diverse teams influenced students' communication skills, creativity, and understanding of heritage and the game design process.

Design-based learning emphasizes experiential, student-centered learning by creating real-world products (Kolodner et al., 2003). This framework underpins the entire Erasmus+ BIP course structure (*Board and Serious Games & Vivanta Kulturo*) and provides the rationale for involving students as creators and evaluators.

At the end, this research will conclude that Table and Serious Games when implemented at the cultural level constitute a pedagogic active tool, above and beyond facilitating intercultural dialogue and critical engagement with heritage themes. Besides this, develop in students' human capacities and soft skills such as creativity or team work.

2 Theoretical Framework

2.1 Serious and Board Games in Cultural Heritage Education

In contemporary education, digital and analogue games are increasingly used to foster engagement, motivation, and experiential learning. Serious games are not merely for entertainment; they are designed to convey knowledge, develop skills, and support attitudinal change (Abt, 1970; Michael & Chen, 2006). Grounded in constructivist theory, games promote situated learning, problem-solving, and reflection (Gee, 2007; Aldrich, 2009).

GBL embeds educational content into structured play environments to encourage critical thinking, collaboration, and learner agency (Prensky, 2001b); Squire, 2006; Haiman, 2025; Rye, Sousa & Sousa, 2025).

Key design elements such as feedback, challenge, and narrative can enhance flow and personalize learning (Csikszentmihalyi, 1990 Kiili, 2005; Melero et al., 2015).

Board games, as analogue serious games, offer specific benefits through face-to-face interaction, negotiation, and cooperative engagement (Vlachopoulos & Makri, 2017). Their accessibility supports intergenerational learning and makes them effective tools for exploring heritage (Mäyrä et al., 2015; Perim, Sousa, Damásio, 2024; Cès, Duflos, Giraudeau, 2025).

Through narrative and symbolic structures, they invite players to engage with history, cultural values, and ethical dilemmas (McCall, 2016; Anderson et al., 2018), fostering empathy, memory sharing, and heritage literacy (Teng, 2018; Cooper, 2020).

An extension of GBL is game design-based learning (GDBL), which involves students in creating or modifying games. This process deepens understanding through creative expression, problem-solving, and critical reflection (Kafai, 2012; Wu & Wang, 2012). Designing games fosters skills such as analysis, synthesis, collaboration, and hypothesis testing (Saldarriaga, 2025).

In this study, students developed educational board games as a collaborative activity to explore cultural narratives and intergenerational dialogue. The process positioned them as co-creators of meaning, highlighting the potential of GBL and GDBL in inclusive heritage education.

2.2 Evaluating Serious Games: Theoretical Models and Educational Implications

Evaluating serious games is central to understanding how effectively they support learning and engagement (Bellotti et al., 2013; Ghannem & Khemaja, 2013; Fokides et al., 2019). While assessment focuses on individual learner progress, evaluation examines the broader educational impact of a program or tool, often summatively. In serious games, evaluation should include outcomes and iterative development, examining functionality, narrative quality, engagement, and learning impact.

Serious games operate as hybrid environments merging play and pedagogy (Abt, 1970; Gee, 2007; Kowsari and Garousi, 2025). Their evaluation requires integrated frameworks capturing cognitive, affective, and behavioral outcomes. Three such models are particularly relevant: the Kirkpatrick Model, Dehaene's Four Pillars of Learning, and the RETAIN model.

The Kirkpatrick Model (Kirkpatrick and Kirkpatrick, 2006) evaluates four levels (Rucks et al., 2024): reaction, learning, behavior, and results. In serious games, this supports analysis of motivation, knowledge gain, behavioral change, and cultural understanding, helping ensure that board games are engaging and educational.

Dehaene's Four Pillars: attention, active engagement, error feedback, and consolidation, offer a neuroscience-based framework for designing impactful learning experiences (Dehaene, 2020; Rivera, 2024). In board games on cultural heritage, these pillars help sustain attention, embed feedback into gameplay, and promote long-term retention through narrative and repetition. The model aligns with constructivist learning theory, where

knowledge is actively constructed through problem-solving and experience (Bruner, 1966).

The RETAIN model (Gunter et al., 2008) emphasizes Relevance, Embedding, Transfer, Adaptation, Immersion, and Naturalization. It aids in evaluating whether a game aligns with learning goals, integrates content meaningfully, and fosters transferable understanding, elements crucial for heritage education. RETAIN also supports formative evaluation, guiding prototype iteration and design refinement. Gros and Mayer (2012) emphasize that high-quality learning tools should be grounded in cognitive science and instructional theory.

De Freitas and Oliver's model (2006) broadens the evaluation lens to include context (institutional and technological), learner characteristics, game design (diegesis), and learning process. This flexible framework supports inclusive, experiential learning aligned with curricular goals, especially valuable when addressing complex topics like cultural heritage.

3 Methodology

This is an exploratory study based on a limited sample. This study employed a mixed-methods approach combining quantitative and qualitative data collection techniques to evaluate the design, impact, and collaborative process of developing educational games for cultural heritage. The research was conducted through three complementary studies using different survey instruments, each addressing specific aspects of the project. Students played and later designed serious board games about cultural heritage during the international course. They design prototypes of four games that incorporate the cultural significance of Slovenia, Croatia, Latvia, Spain, Portugal, and Slovakia.

3.1 Research Aims and Research Questions

The primary objectives of this study were threefold. First, the research aimed to explore the educational potential of board and serious games in fostering cultural heritage awareness and intergenerational learning. Second, it sought to evaluate students' perceptions and experiences of participating in developing and using an educational board game, particularly how game-based learning supports cultural engagement. Third, the study aimed to examine students' self-assessment of collaboration and learning outcomes during the game development process within an international academic setting, highlighting the role of teamwork, creativity, and intercultural exchange in educational innovation.

According to the mentioned aims, the following research questions are set:

RQ1: How do students perceive the impact of the educational board game on cultural heritage learning?

RQ2: How do students evaluate the quality, educational value, and cultural relevance of the board game prototypes developed during the project?

RQ3: How do students reflect on their contributions, teamwork, and learning outcomes in the collaborative educational game design process?

3.2 Participants

The participants were international students enrolled in the joint Erasmus+ BIP course named as *Board and Serious Games & Vivanta Kulturo: Bridging Generations through Cultural Heritage.* A total of 18 students from five European countries participated in the study, enrolled in art or cultural heritage management programs.

The demographic data indicates a predominantly young and gender-diverse group, with 55.6% aged 20–24 and 44.4% aged 25–30. In terms of gender, 66.7% identified as female (n = 12), 27.8% as male (n = 5), and one participant (5.6%) chose not to disclose their gender. The educational level was evenly distributed, with 50.0% undergraduate and 50.0% graduate students.

3.3 Instruments, Procedures, and Data Analyses

Three surveys were used as research instruments: the Focus Group Survey (https://forms.gle/LnUrd9q7yLYPiCcT6), the Educational Game Prototype Assessment Survey (https://forms.gle/shLVmmiDEVACdReg9), and the Self-Assessment Survey (https://forms.gle/ubiMFRnESWjv2pDZA). They were analyzed with non-parametric methods combined with an interpretative-descriptive approach because of a small sample size (n = 17).

The design of the survey questions integrated three conceptual frameworks. Kirkpatrick's model guides outcome-based evaluation, RETAIN focuses on design quality and instructional integrity, and Dehaene's pillars inform the underlying cognitive mechanisms that support learning.

1. Focus Group Survey is aimed at Evaluating the Impact of the Educational Board Game on Cultural Heritage and Intergenerational Learning. To analyze participants' responses to open ended questions, Thematic Analysis was employed, allowing the identification of patterns and themes relevant to the research aims.

2. The Educational Game Prototype Assessment Survey evaluates the quality and educational effectiveness of the game prototypes developed by student teams. This instrument focused on several key components of game design, including didactic elements, structural elements, originality, and creativity, that are rated with Likert-type scale.

The survey data were analyzed using descriptive statistics, and The Friedman test was employed to determine whether participants' ratings differed significantly across various categories of game evaluation.

3. Self-Assessment Survey focuses on Student Collaboration in the Educational Game Project. The survey included Likert-scale items focusing on Team Dynamics and Communication, Participation and Contribution, Problem Solving and Decision-Making, Reflection and Group Learning. As with the previous instrument, the data were analyzed using descriptive statistics, and Correlational analysis was conducted using Spearman's rho to explore potential relationships between different aspects of student self-assessment.

3.4 Results

The Focus group survey results about reasons for applying to the course show that the most frequently cited reason was the opportunity to do Erasmus mobility in Porto

(75%), indicating that the international context and location of the course were highly attractive factors. This was closely followed by the desire to improve knowledge in game-based learning (68.8%), suggesting a strong educational interest in innovative pedagogical approaches. In addition, 43.8% of participants indicated that they were motivated to meet students from other nationalities, and the same number expressed interest in playing games, reflecting both intercultural and personal interests. A smaller proportion of respondents 18.8%, noted that they wanted to learn how to implement games in daily life.

The thematic analysis of focus group responses reveals generally positive attitudes toward using educational board games. Most participants reported high levels of enjoyment and novelty, indicating the potential of games to increase engagement in non-traditional learning environments. Board games were frequently perceived as effective educational tools, particularly in promoting critical thinking, collaboration, and intercultural dialogue. Participants also reflected on the role of games in fostering cultural heritage awareness, though responses varied depending on the thematic depth of each game. Some emphasized that heritage content was well-integrated, while others found it insufficient or lacking contextual background. A recurring theme was gameplay's intergenerational potential. Many participants noted that games facilitated interactions across age groups, suggesting their value in promoting inclusive and collaborative learning. However, several challenges emerged, particularly regarding rule complexity and accessibility. Difficulties understanding game instructions and the pace of play were common, especially for first-time or older participants.

Overall, participants emphasized the experience's social and cognitive benefits while suggesting improvements such as more explicit rules, more time for gameplay, and stronger integration of cultural content. The evaluation of the game elements reveals generally high satisfaction levels across most categories, indicating a well-designed and pedagogically practical game experience (Table 1).

Table 1. Thematic themes

Theme	Number
1. Enjoyment and Novelty of the Experience	12
2. Games as Educational Tools	10
3. Cultural Heritage Awareness	9
4. Bridging Generational Gaps	8
5. Social Interaction and Collaboration	11
6. Challenges with Rules and Complexity	7
7. Accessibility for All Generations	6
8. Desire for More Cultural Content	5
9. Personal and Social Benefits	9
10. Suggestions for Improvement	6

Source. Own systematization

Table 2. Descriptive statistics of the Educational Game Prototype Evaluation

DIDACTIC ELEMENTS OF THE GAME	**M**	**Md**	**SD**
Learning objectives	4,44	4,0	0,50
Motivational elements	4,44	5,0	0,76
Relevance of the content of the game	4,56	5,0	0,60
Disclosure of learning objectives	3,78	4,0	0,92
Adequacy of guidance	4,22	4,0	0,79
Achieving Bloom's levels of knowledge	3,67	4,0	1,00
Feedback to the player	4,28	4,5	0,80
STRUCTURAL ELEMENTS OF THE GAME	**M**	**Md**	**SD**
Story	4,11	4,0	0,81
Clarity of rules	4,28	4,0	0,70
Design quality	4,56	5,0	0,68
Replay value	3,78	4,0	0,71
ORIGINALITY AND CREATIVITY	**M**	**Md**	**SD**
Creative Concept	4,06	4,0	0,70
Cultural integration	4,56	5,0	0,60
Inclusion	3,94	4,0	1,03

Source. Own systematization

Among the didactic elements, *Learning Objectives* (M = 4.44) and *Relevance of Content* (M = 4.56) received some of the highest ratings, suggesting that participants recognized the educational purpose of the game and found the content meaningful. *Motivational Elements* also scored highly (M = 4.44), confirming the game's ability to engage learners. *Disclosure of Learning Objectives* received a slightly lower mean (M = 3.78), possibly pointing to a need for more explicit communication of intended learning outcomes during gameplay. *Bloom's Levels of Knowledge* had the lowest mean in this group (M = 3.67), which may suggest that while participants found the content relevant, the game may not have fully addressed higher-order cognitive skills as outlined in Bloom's taxonomy.

The structural components of the game were also positively evaluated. *Design Quality* (M = 4.56) and *Clarity of Rules* (M = 4.28) received extreme scores, indicating that the game's mechanics and visuals were clear and appealing. *Replay Value* (M = 3.78) received a relatively lower score, suggesting that while the game was enjoyable, it might benefit from additional variability or complexity to encourage repeated playthroughs.

In the domain of creativity, *Cultural Integration* and *Design Quality* both scored exceptionally high (M = 4.56), demonstrating that the game not only featured a strong aesthetic but also embedded cultural content meaningfully. The *Creative Concept* was also positively rated (M = 4.06), indicating that participants appreciated the originality

behind the game. However, the category *Inclusion* (M = 3.94) showed the highest variability (SD = 1.03), suggesting mixed perceptions about how well the game addressed diversity and accessibility (Table 2).

A Friedman test was conducted across thirteen evaluation criteria to determine whether participants rated the different educational game elements significantly differently. These included items such as Learning Objectives, Motivational Elements, Relevance of Content, Design Quality, Replay Value, and Cultural Integration. The results of the Friedman test (χ^2: 32.90, p = 0.0010) indicate that there are significant differences in how participants perceived and rated the different evaluation aspects of the game.

Descriptive statistics of Student collaboration self-assessment (Table 3) indicate a generally high level of agreement across all items, with most mean scores above 4.5, and medians consistently at 5. The highest possible scores were recorded for "Learned from Team" and "Would Work with the Same Team Again", reflecting a strong sense of shared learning and positive team experience.

Table 3. Descriptive statistics of the student collaboration self-assessment

Variable	Mean	SD	Median
Open Communication	4.59	0.51	5.0
Idea Expression	4.53	0.51	5.0
Active Listening	4.71	0.47	5.0
Constructive Conflict Handling	4.41	0.51	4.0
Meaningful Contribution	4.71	0.47	5.0
Fair Distribution of Responsibility	4.65	0.49	5.0
Own Engagement	4.82	0.39	5.0
Feeling of Contribution Being Valued	4.76	0.44	5.0
Collaborative Decision-Making	4.71	0.47	5.0
Creative Problem Solving	4.76	0.44	5.0
Diverse Perspectives	4.71	0.47	5.0
Learned from Team	5.00	0.00	5.0
Improved Quality of the Game	4.94	0.24	5.0
Would Work with the Same Team Again	5.00	0.00	5.0

Source. Own systematization

The Spearman correlation (Table 4) analysis revealed several moderate to strong positive relationships, notably between own engagement and openness to diverse perspectives ($\rho = .72$), and between creative problem solving and feeling of contribution being valued ($\rho = .67$). Additionally, active listening strongly correlated with creative solutions ($\rho = .86$), suggesting a link between interpersonal communication and innovation in group work.

Table 4. Spearman's Rho Correlation Matrix

Variables	Correlation (ρ)
Own Engagement & Diverse Perspectives	0.72
Creative Solutions & Contribution Valued	0.67
Contribution Valued & Collaborative Decision-Making	0.55
Creative Solutions & Active Listening	0.86
Collaborative Decision-Making & Diverse Perspectives	0.72
Improved Game Quality & Creative Solutions	0.45

Source. Own systematization

3.5 Discussion

The findings address the three research questions concerning perceptions of heritage learning, game quality and relevance evaluation, and reflections on teamwork and learning during the collaborative game design process.

Students' reflections from the focus group reveal a generally positive perception of the board game's potential to enhance cultural heritage learning. Many participants noted that the game experience was enjoyable and engaging, contributing to greater involvement with the learning content. The use of play was perceived as an effective tool to promote curiosity, especially in non-traditional learning environments. A recurrent theme was the game's capacity to foster intercultural dialogue, with students sharing perspectives and insights linked to their cultural backgrounds.

Perceptions of how well cultural heritage was integrated into the game varied. Some students appreciated the embedded cultural narratives and themes, stating that they deepened their understanding of heritage issues. Others felt that certain games lacked sufficient contextual background or thematic depth. This feedback suggests that, while the format holds great promise, future iterations should more clearly and comprehensively embed heritage content in the gameplay to ensure meaningful learning.

Another significant insight was the perceived intergenerational potential of educational games. Several students highlighted how games could serve as bridges between different age groups, promoting inclusive and collaborative learning across generations. This supports the view of games not only as educational tools, but as platforms for broader social and cultural interaction.

Students rated the game prototypes highly across most evaluative dimensions, confirming their educational value and design quality. Among didactic elements, Relevance of Content ($M = 4.56$) and Learning Objectives ($M = 4.44$) received the highest ratings, suggesting that participants saw clear pedagogical intent and meaningful content in the games. Motivational Elements also scored highly ($M = 4.44$), reinforcing the capacity of games to sustain engagement. However, Disclosure of Learning Objectives ($M = 3.78$) and Bloom's Levels of Knowledge ($M = 3.67$) scored slightly lower, indicating the need for more explicit guidance during gameplay and deeper cognitive engagement.

In terms of structural quality, Design Quality (M = 4.56) and Clarity of Rules (M = 4.28) were positively evaluated, though Replay Value (M = 3.78) received a lower score, indicating room for improvement in game variability and complexity. These findings align with the students' qualitative feedback about the challenges they encountered, particularly related to the complexity of rules and the initial difficulty of understanding game mechanics, especially for those unfamiliar with board games.

Creativity-related components also received strong ratings. Cultural Integration and Design Quality were among the highest (M = 4.56), confirming the success of merging aesthetic appeal with meaningful heritage content. However, the Inclusion category showed higher variability (M = 3.94; SD = 1.03), suggesting diverse views regarding how well the games addressed diversity and accessibility.

Results of the Friedman test (χ^2: 32.90, $p < 0.05$) indicate that there are significant differences in how participants perceived and rated the different evaluation aspects of the game. Certain criteria were viewed more positively or negatively than others, suggesting varying levels of effectiveness or satisfaction across different dimensions of the game. This insight can be valuable for identifying which aspects of the game may need improvement and which are particularly successful from the users' perspective.

Students' self-assessment of teamwork and collaboration revealed strong positive experiences. All students rated items such as Learned from Team and Would Work with the Same Team Again with the highest possible scores (M = 5.00; SD = 0.00), demonstrating a highly effective and supportive team dynamic. These results suggest that the collaborative nature of the game design process promoted mutual learning, engagement, and social cohesion.

Slightly lower scores were observed for Constructive Conflict Handling (M = 4.41), which implies that while teams functioned well overall, navigating disagreements could be further developed as a learning objective. Students also reflected positively on their sense of contribution, creativity, and openness to diverse perspectives.

Spearman's correlation analysis showed meaningful relationships between key interpersonal and cognitive dimensions. For example, Active Listening strongly correlated with Creative Solutions ($\rho = .86$), and Own Engagement correlated with Openness to Diverse Perspectives ($\rho = .72$), highlighting the role of communication and engagement in fostering innovation and inclusion. These findings reinforce the value of collaborative learning frameworks, where interpersonal dynamics significantly enhance individual learning outcomes.

4 Conclusion

This study underscores the potential of serious board games to enrich cultural heritage education through student-driven design and international collaboration. Beyond confirming their educational value, the project opened new pathways for integrating game-based learning into intercultural and intergenerational contexts. The active involvement of students in co-creation proved to be essential not only for the acquisition of knowledge, but also for the development of collaborative skills and cultural sensitivity—competences that are increasingly important in today's education.

Importantly, the findings highlight that engaging learners as designers can transform educational tools into participatory platforms that encourage deeper reflection, creativity,

and shared ownership of content. These outcomes support the idea that serious games are not merely instructional media but dynamic environments where social and cultural learning can converge meaningfully.

Future research should examine long-term impacts on learners' engagement with heritage and explore adaptations for wider demographic inclusivity, including older generations and diverse cultural backgrounds. Investigating how game-based strategies can be tailored to formal and informal educational settings may further expand their reach and effectiveness.

Ultimately, this study confirms the value of combining serious game design and cultural education and provides a blueprint for future interdisciplinary initiatives aimed at fostering both cognitive and emotional connections to cultural heritage through playful, collaborative, and context-sensitive learning experiences.

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Effective Protection or Just Formality: Critical Evaluation of Protection Measures in Violence Against Women: A Systematic Review

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Abstract. The objective of this research was to analyze the effectiveness of the protection measures implemented to confront gender violence and its impact on the safety of the victims. The methodology used was a systematic review, focusing on studies that address the implementation and compliance of protection measures in contexts of gender violence, through analysis of secondary sources in the following databases: Scopus, Scielo, and Redalyc. The Prisma protocol was used. In summary, the results indicated that, although protection measures are fundamental, their effectiveness is compromised by the lack of compliance and adequate monitoring. Consequently, regional disparities were observed in the implementation of these measures, as well as the need for an interdisciplinary approach that includes gender-sensitive education and technological tools to improve both prevention and monitoring of protection measures. Regarding the conclusions, the study highlighted the importance of guaranteeing the effective implementation of protection measures and the need for public policies that promote gender equality and the prevention of violence.

Keywords: Gender-based violence · protection measures · effectiveness · public policies

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 539–549, 2025.
https://doi.org/10.1007/978-3-032-09080-5_51

1 Introduction

Violence against women continues to represent a major issue worldwide, impacting both their physical integrity and emotional stability. In this regard, the United Nations (UN) (2020) warns that feminicide and gender-based violence continue to be alarming phenomena in various regions of the world, with repercussions affecting both individuals and communities. Therefore, protection measures have been designed as key instruments to safeguard women in situations of risk. However, several studies have shown that, in many cases, these tools do not fulfill their primary function, being reduced to mere legal procedures without concrete results (Domínguez and Zamora, 2023).

Globally, gender-based violence presents itself as a complex phenomenon with social, legal, and public health implications. In Europe, a study on gender violence indicates that between 20% and 30% of women have experienced physical or sexual violence, demonstrating how gender differences and cultural influences play a significant role in this issue. Consequently, there is a need to strengthen mechanisms such as protection orders and psychosocial support services. This scenario highlights the challenges faced in implementing effective measures, emphasizing the urgency of reviewing and optimizing current strategies to address this issue (Bermúdez and Meléndez-Domínguez, 2020).

In recent studies, Terrones et al. (2023) analyze from a legal perspective how deficiencies in the enforcement and monitoring of protection orders increase risks for abused women. On the other hand, Bermúdez and Meléndez (2021) emphasize the importance of implementing interdisciplinary approaches that facilitate the identification of social and cultural factors that limit the effectiveness of these measures.

In Latin America, there are laws and regulations to ensure that women who have been assaulted are safe and protected. In Peru, Law 30364 establishes rules to sanction and thus prevent or eliminate violence against women. In this context, the law requires actions to reduce violence, ensuring that victims can live a normal daily life and preserve their physical, psychological, and sexual integrity. According to Díaz (2019), these measures represent mechanisms designed by the state through various institutions to effectively protect victims, preventing them from experiencing new episodes of violence.

Similarly, recent studies by authors Gambetta et al. (2021) and Cuervo (2019) have documented how protection orders, although well-intentioned, face serious limitations due to inadequate follow-up and insufficient resources. In summary, the literature highlights recurring issues such as the lack of monitoring of protection orders, deficiencies in judicial systems to ensure compliance, and structural barriers, such as re-victimization and gender biases in the institutions responsible for applying them. Consequently, studies analyze the impact of these measures in specific environments, such as rural communities, vulnerable socioeconomic sectors, and indigenous populations, where structural inequalities exacerbate risks for women.

In this context, protection measures are a crucial tool to prevent violence and safeguard victims. Therefore, the importance of this study lies in ensuring that women are aware of their rights and demand access to these measures to guarantee their safety. The timely and effective application of these provisions is key to preventing future episodes of violence, as failure to comply with protection orders can lead to criminal sanctions, including imprisonment.

In light of this, the aim of this study is to critically analyze the effectiveness of protection measures from a multidimensional perspective, identifying best practices, as well as aspects to improve and legal and operational innovations. This analysis seeks to contribute both to academic discussion and to applied practices, with the goal of transforming these mechanisms into effective tools that ensure the comprehensive protection of women.

Furthermore, the justification is based on the fact that, based on the results obtained, it becomes evident that the protection measures implemented against violence against women must go beyond formality and become effective mechanisms that support the security and rights of victims. It is essential that public policies and regulatory frameworks guarantee real protection, allowing victims to report with reasonable grounds, thus exercising a legitimate right, without fear of reprisals or undue sanctions.

In the same line, the study emphasizes the importance of ensuring the effectiveness of protection measures as an extension to safeguard the victim. This right must support the safety and dignity of women victims of violence, ensuring that they can access justice mechanisms that not only protect their rights but also discourage acts of violence. In this way, it is emphasized that not all acquittals in a criminal process imply the non-existence of the reported crime, so it is necessary to approach complaints with a perspective that prioritizes the protection of victims without prejudice to the rights of the parties involved.

In this sense, education plays a critical role in fostering awareness and early prevention of gender-based violence. The integration of gender-sensitive content into school curricula, professional training for justice operators, and public educational campaigns are essential to achieving lasting cultural change. Likewise, technological innovations—such as mobile applications for emergency alerts, digital case tracking systems, and virtual support platforms—are increasingly important for improving the monitoring and enforcement of protection measures.

2 Methodology

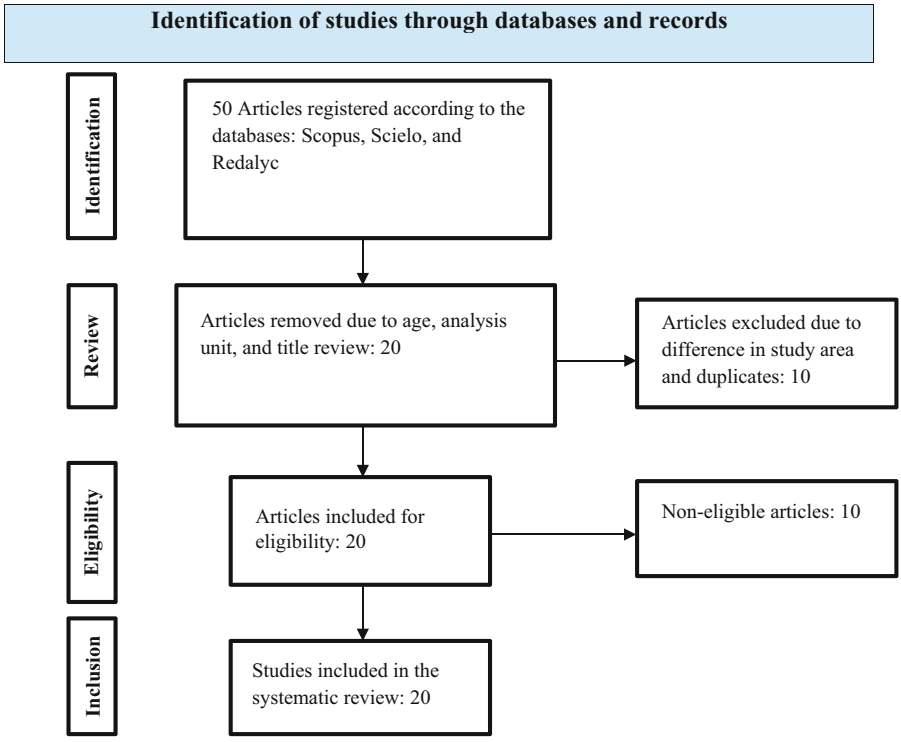
This research adopts a qualitative approach through a systematic review of scientific literature related to the effectiveness of protection measures against gender-based violence. The analysis focuses on studies conducted in Latin American and European contexts. To this end, high-impact academic databases such as Scielo, Scopus, and Redalyc were consulted during the period from September 2024 to January 2025.

Initially, 50 academic articles published between 2019 and 2024 were identified. The selection of these studies was based on eligibility criteria including thematic relevance (gender-based violence and protection measures), methodological rigor, peer review, and full-text availability. Studies that were not directly related to the research objective, those centered on legal contexts not applicable to Latin America or Europe, duplicate articles, those lacking a clear methodology, and works from non-academic sources were excluded.

Additionally, a manual search was conducted using the bibliographic references found in the primary and secondary studies. The analysis universe consisted of the categories previously described, as well as the results obtained from electronic searches conducted in the selected databases, recognized for their high quality and extensive coverage of academic legal literature. For the search and selection process, titles, abstracts,

and keywords in Spanish were considered, using terms such as: “violencia de género” (gender-based violence), “medidas de protección” (protection measures), “efectividad” (effectiveness), and “políticas públicas” (public policies).

In this context, the result of the process is illustrated in Fig. 1, which shows the PRISMA protocol. Initially, a set of articles was collected. Subsequently, after applying the inclusion and exclusion criteria, the most relevant articles were selected for detailed analysis, ensuring both transparency and reproducibility of the systematic review.



Source: Own creation

Fig. 1. PRISMA Flow Diagram

The 20 selected scientific articles were distributed according to the database as follows: Scielo predominating with 45% (9 articles), Redalyc with 35% (7 articles), and finally, Scopus with 20% (4 articles). Furthermore, regarding the geographic locations of the selected scientific articles, all 20 articles belong to Latin American and European countries (Fig. 2).

Moreover, while the PRISMA protocol and database triangulation increase the robustness of this review, some limitations must be acknowledged. Publication bias may affect the findings, as studies with null or contradictory results are less likely to be published. Additionally, unequal geographical representation—with limited studies

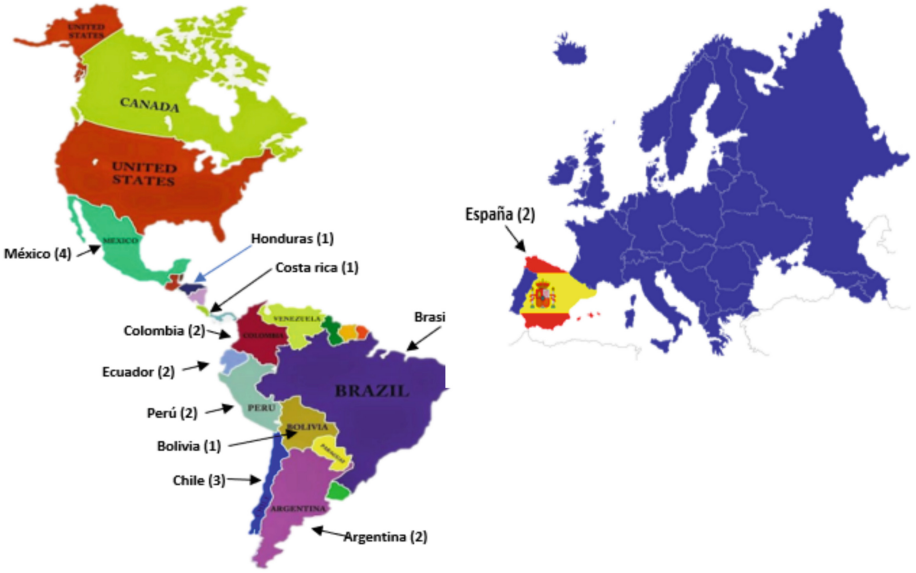


Fig. 2. Map showing the geographical distribution of the selected scientific articles

from Africa and Asia—may skew regional applicability. Furthermore, the lack of a quantitative meta-analysis limits the statistical strength of the conclusions. Future research should seek to address these constraints by including more diverse sources and combining qualitative and quantitative techniques.

3 Results and Discussion

Searches were conducted that yielded 50 initial references. After discarding 10 duplicate references, 5 eliminated due to age, and 15 that did not meet the inclusion criteria (evaluated by title and abstract), 20 articles were selected for full analysis, published between 2019 and 2024 (Table 1).

60% of these studies analyzed the achievements and limitations of government protection measures against gender-based violence. While progress in implementation was observed, obstacles in effective compliance and follow-up persisted. Below, the selected results are presented concisely and descriptively.

A systematic review of 20 studies published between 2019 and 2024 reveals that, while protection measures against gender-based violence are a fundamental legal instrument, their effectiveness is significantly constrained by structural, operational, and contextual factors. Approximately 60% of the studies analyzed report deficiencies in the implementation, monitoring, and follow-up of such measures. Terrones et al. (2023) highlight that in Peru, the ineffective enforcement of protection orders perpetuates cycles of violence, whereas Recalde and Vega (2021) point out that in Uruguay, weak inter-institutional coordination hinders the protection of victims.

Significant regional disparities are also evident. Bermúdez and Meléndez-Domínguez (2020) explain how geographical and socioeconomic differences directly

Table 1. Consolidation of Selected Articles (2019–2024)

N°	Author(s)	Year	Article Title	Study Type	Indexed Journal	Study Context
1	Terrones-Olórtiga	2023	Ineffectiveness of Protection Measures for Women	Original article	Scielo	Legal analysis of legal measures
2	Domínguez and Zamora	2023	Violation of the Right to Defense in the Imposition of Measures	Original article	Scielo	Right to defense vs. measures
3	UN Women	2020	Feminicidal Violence in Mexico: Approaches and Challenges	Original article	Scielo	Feminicide and protection
4	Bermúdez and Meléndez-Domínguez	2020	Epidemiological Analysis of Gender-Based Violence in the European Union	Scientific article	Scielo	Regional heterogeneity of gender-based violence
5	Recalde-Gracey and Vega	2021	Protection Orders as a Key Mechanism to Address Violence Against Women in Couple or Ex-Partner Relationships, Considering Their Legal Foundations and Implementation in Uruguay	Empirical research	Redalyc	Case analysis on non-compliance with measures
6	Martínez and Gómez	2022	Efficiency of Protection Measures in Rural Areas	Case study	Redalyc	Impact on rural communities

(*continued*)

Table 1. (*continued*)

N°	Author(s)	Year	Article Title	Study Type	Indexed Journal	Study Context
7	Torres and Cabrera	2020	Comparison Between Legal Frameworks in Europe and Latin America	Comparative analysis	Redalyc	International perspectives
8	García et al.	2023	The Importance of Follow-up in Protection Measures	Empirical research	Scielo	Evaluation of compliance with measures
9	Herrera and Pérez	2022	Judicial Training on Gender-Based Violence	Empirical research	Scopus	Training programs
10	López and Martínez	2021	Legal Obstacles in the Implementation of Measures	Legal analysis	Scielo	Legal and administrative barriers
11	Ramírez and Castellanos	2021	Social Impact of Protection Measures in Communities	Empirical research	Scielo	Study in rural communities
12	González et al.	2023	Victims' Perception Regarding Compliance	Case study	Redalyc	Evaluation of victims' perception
13	Cabrera and López	2020	Judicial Protocols in Cases of Violence	Legal analysis	Scopus	Evaluation of protocols
14	Pérez and Herrera	2021	Psychological Factors Associated with Gender-Based Violence	Empirical research	Scielo	Relationship between psychological factors and violence
15	Rojas and Calderón	2023	Protection Measures: Successes and Failures	Empirical research	Scopus	Statistical analysis on measures

(*continued*)

Table 1. (*continued*)

N°	Author(s)	Year	Article Title	Study Type	Indexed Journal	Study Context
16	Castañeda and Rivera	2023	Protection Policies in Urban Areas	Case study	Redalyc	Urban impact
17	Morales and Vega	2021	Legal Challenges in Gender-Based Violence	Legal analysis	Redalyc	Challenges in legislation
18	Guzmán and Torres	2020	Case Evaluation on Protection	Case study	Scielo	Practical evaluation
19	Vargas et al.	2023	Legal Perspectives on Protection	Empirical research	Scopus	Jurisprudence
20	Figueroa and Martínez	2022	Statistical Evaluation of Measures	Empirical research	Redalyc	Use of statistical data

Source: Own creation 2024

impact the effectiveness of protective measures in Latin America and Europe. In rural areas, access to protection mechanisms is limited (Martínez & Gómez, 2022), whereas urban areas demonstrate a better institutional response capacity (Vargas et al., 2023), although structural gaps persist.

The current legal framework presents ambiguities and lacks effective coercive mechanisms, which undermines public trust in the judicial system (Domínguez & Zamora, 2023). This is compounded by lengthy and bureaucratic judicial procedures that exacerbate inequalities in access to justice (Gambetta et al. 2021). The situation is further aggravated by institutional revictimization and inadequate treatment during judicial proceedings—issues that call for specialized training within the judicial system. In this regard, Herrera and Pérez (2022) propose training programs with empathetic and gender-sensitive approaches, while López and Martínez (2021) emphasize the importance of strong judicial education to improve the implementation of protective measures.

At the same time, some studies highlight good practices. In Brazil, Ramos and Silva (2022) show that awareness campaigns featuring real-life testimonies and concrete data increase public awareness. Fernández et al. (2021), in a comparative analysis of legislation in Spain and Argentina, conclude that continuous judicial training is positively correlated with the effectiveness of protection measures.

The need for interdisciplinary approaches is also underscored. Pérez and Herrera (2021) examine the relationship between psychological factors and violence, while Guzmán and Torres (2020) stress the importance of considering social, economic, and

cultural contexts in judicial decision-making. Rojas and Calderón (2023) argue that statistical analysis is essential for evaluating the success and shortcomings of implemented measures.

Regarding prevention, the role of gender equality education from early stages is recognized. Molina et al. (2020) demonstrate that incorporating equity-focused content into school curricula reduces sexist attitudes, while Araya et al. (2022) emphasize the role of community strategies in Costa Rica in strengthening preventive support networks.

In conclusion, the evidence suggests that the effectiveness of protection measures against gender-based violence depends on a comprehensive and structural transformation. This transformation must include legal reform, adequate institutional resources, specialized training, universal access to free legal assistance, and long-term preventive strategies. Coordination among the state, civil society, and international actors is essential to build fairer, more accessible, and more effective protection systems that genuinely ensure women a life free from violence.

4 Conclusions

After conducting a systematic review of the selected articles, key aspects addressing gender-based violence and the protective measures implemented to mitigate its effects can be identified. These aspects highlight the importance of ensuring a comprehensive approach that protects the rights of victims and promotes social justice.

Regarding protective measures in cases of gender-based violence, they are established as a fundamental tool to guarantee the safety of affected individuals. However, these measures face significant limitations in their implementation due to structural issues and a lack of institutional resources. Therefore, it is essential to optimize their application and monitoring to ensure their effectiveness.

Addressing the issue of gender-based violence, which is deeply tied to socioeconomic and regional disparities, the reviewed articles highlight that regions with higher levels of inequality have a higher incidence of femicides and other forms of violence. These inequalities require a response tailored to each context to ensure equity.

Concerning the impact of protection orders, although essential, their impact is limited due to insufficient monitoring and enforcement. This right, which constitutes a constitutional and human guarantee, should be strengthened through the allocation of adequate resources and the training of justice operators, as indicated by various studies included in this review.

Thus, the prevention of violence is recognized as a priority in the articles analyzed. Gender equality education from an early age and societal awareness-raising emerge as key strategies to reduce tolerance levels towards violence and foster a positive cultural change.

Additionally, interdisciplinary approaches are crucial for comprehensively understanding and addressing gender-based violence. Combining legal, social, psychological, and economic perspectives allows for the development of more effective solutions that address both the causes and consequences of this issue.

It is imperative to note that the findings underline the need to strengthen protection systems, promote inclusive public policies, and ensure the effective implementation

of existing legal frameworks. The collective efforts must actively involve governments, institutions, and civil society to ensure justice, equality, and the protection of fundamental rights.

Education emerges as a long-term solution to change social norms and reduce tolerance toward gender-based violence. Incorporating this theme across all levels of education—formal and informal—can help dismantle patriarchal structures and empower individuals. In parallel, adopting technological solutions such as digital monitoring systems and online reporting tools can enhance the responsiveness of protection systems and increase trust in institutions.

Funding. This work was supported by national funds through the Fundação para a Ciência e a Tecnologia, I.P. (Portuguese Foundation for Science and Technology) by the project UID/06173 – CARE - Research Center on Health and Social Sciences.

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Technology and Digital Dialogical Communication in Esports Organizations

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Abstract. Technology has brought about the advent of instantaneous and omnipresent means of communication, as well as revolutions in the way organizations communicate. This is evident in different organizations, particularly in the electronic sports (esports) sector, where video games have grown to become an industry with a solid organizational structure. This sector was born in a digital environment, with websites and social networks, particularly Twitter, now called X. In this context, two-way communication gains visibility and the dialogical principle of the dialogic loop is a path for providing to organizations the possibility of creating interaction with their audiences. Thus, the main objective of the research is to study the degree of adoption of the dialogic loop principle by the esports sector, namely on the websites and Twitter profiles. To carry out the study, a mixed quantitative and qualitative approach was chosen, with data being collected from the websites and Twitter profiles of ten Counter-Strike Global Offensive esports teams through an analysis grid. We conclude that, notwithstanding some indicators the dialogic loop principle are adopted, there is low implementation of the dialogical cycle principle, both on the website and on the Twitter profile page.

Keywords: Technology · digital dialogical communication · esports · social media · websites · Twitter

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 550–567, 2025.
https://doi.org/10.1007/978-3-032-09080-5_52

1 Introduction

In a world increasingly influenced by technology, communication and how to communicate have become an increasingly valuable asset in the organizational landscape. An organization that knows how to communicate can attract more attention and a larger audience. This is especially true for new industries that have been forming in the digital environment itself, such as the esports industry, which has been establishing itself over the last two decades as one of the biggest forms of entertainment.

One of the greatest examples is video games, mainly seen as a form of entertainment. There are now structures and organizations behind this entire industry. Since the genesis of this sector involves mainly digital media, the main way of experiencing all this action is, naturally, through digital media, namely websites and social networks, such as Twitter, now called X. Therefore, it is important to understand how organizations within this sector use new forms of digital communication to establish and maintain connection with their audiences.

The Dialogical Theory of Kent and Taylor (1998) was used as our theoretical basis, focusing on one of the five principles: the dialogic loop. This principle aims to know precisely how organizations can establish a dialogue with the public, and obtain responses from this dialogue, in order to nurture the relationship itself.

In this context, we formulate the following research question: How well do websites and Twitter accounts in the esports sector adopt the dialogue cycle principle? To answer this question, the following main objective was defined: to study the degree of adoption of the dialogic loop principle by the esports sector, namely on websites and Twitter profiles of the organizations. The specific objectives are: 1) to identify the organization's website with the highest and lowest degree of adoption of the dialogic loop; 2) to identify the organization's Twitter profile with the highest and lowest degree of adoption of the dialogic loop; 3) to identify the indicator of the dialogic loop most and least adopted by the organization's website; 4) to identify the indicator of the dialogic loop most and least adopted by the organization's Twitter profile; 5) to carry out a comparative analysis of the adoption of the dialogic indicators of the dialogic loop most and least adopted between the organization's website and Twitter; 6) to carry out a comparative analysis of the adoption of the dialogic loop between the organization's website and Twitter; 7) to identify the degree of adoption of the indicators present in the publication tool on the social network Twitter.

The methodology used is mixed quantitative and qualitative. Data were collected through a grid based on the literature review. The sample is composed of ten organizations that have teams that compete in the esport Counter-Strike Global Offensive. The paper, in the first part, presents a brief review on technology, digital communication and the esports sector. In the second part, it presents the empirical study and ends with the conclusions.

2 Background

2.1 Technology and Digital Communication

In the current context of organizations, technology and digitalization have taken on a preponderant role, namely by forcing organizations to look differently at the way they communicate with their audiences. In this context, communication focused on dialogue and interaction between organizations and audiences has proven to be very relevant in the search for capturing and retaining audiences (Kent & Taylor, 2002; Botan & Taylor, 2004). In other words, interaction with the audience leads to an increase in metrics that are key in the world currently dominated by statistics, such as website views, viewing time, likes, comments, reactions, among others (Wang & Yang, 2020). Bearing in mind that establishing strategic two-way communication can be contradictory, given that factors such as strategy, marketing and others were the focus of unilaterally governed communication (Botan & Taylor, 2004), dialogic theory is the basis that can establish relationships with the public, with dialogue assuming itself as a fundamental variable in organization-public relations (Kent & Taylor, 2002). In a scenario where organizations have started to have an online presence, communication has become something valuable for organizations to obtain (Taylor et al., 2001; Kent et al., 2003). In this context, dialogic communication involves a relationship of cooperation and communication, which leads to more interaction, which will result in dynamic and rigorous connections between organizations and their audience (Kent & Taylor, 1998).

To achieve this, it is necessary to establish mechanisms so that these dialogues and dialogic relationships can be created, developed and nurtured frequently. Kent and Taylor establish five principles for this purpose: 1) Conservation Rule; 2) Production of Repeat Visits (Generation of Revisits [RV]); 3) Relevance of Information; 4) Intuitive - Ease of interface; 5) Dialogic loop - focus of this research.

The dialogic loop allows the public to interact with the organization, which in turn gives the organization the opportunity to respond to questions, concerns, and problems (Kent & Taylor, 1998). One way for this cycle to be successful is to have professionals dedicated to creating and maintaining this communication, so that comments have a reply and are updated as quickly as possible. This contact information must be up to date so that it can be properly responded to, and thus the person's message reaches the intended contact (Kent & Taylor, 1998). These ideas are materialized in website features such as links and contacts to directly contact employees or request information. However, it is important not only to appear that one wants to build a dialogic relationship, it is important to give the public reasons to invest in this dialogic relationship (Taylor et al., 2001). Over the years, several studies have analyzed the dialogic capacity of different types of websites (Taylor et al., 2001; Kent et al., 2003; McAllister-Spooner & Kent, 2009; see also Sheila McAllister-Spooner's contributions to dialogic theory studies (McAllister-Spooner, 2008; McAllister-Spooner, 2010). These and other works on dialogic theory use identical tools to verify whether the analyzed websites contain functionalities that allow us to attest whether a website is dialogic or not. This versatility of analysis is also demonstrated by the types of organizational scopes and the websites in

question: for example, activist in nature (Taylor et al., 2001; Kent et al., 2003) or university websites, respectively (McAllister-Spooner, 2010; McAllister-Spooner, 2008; McAllister-Spooner & Kent, 2009).

The main methodology used is to analyze the content of websites, checking whether they have the functionalities (indicators) that allow a dialogic relationship to be established with the public, and include all of them in a matrix (Kent and Taylor, 2002; Kent et al. 2003; McAllister-Spooner and Kent, 2009). Within the dialogic loop, several indicators have been used in different studies over the years. This is because technology has also evolved and it was necessary to adapt dialogic theory to new realities. An example of this is the indicator called Chat (Jambeiro et al., 2012; Karkin & Janssen, 2014; Hinson et al., 2020). Chat in these studies was used by the authors to assess the presence of this dialogic tool on the websites of Brazilian capitals, Turkish local governments and African destinations, respectively. Another indicator that has become more relevant is related to the presence of links that provide access to social networks, as observed by Fietkiewicz et al. (2017), who despite not applying dialogic theory to their work, make a pertinent analysis regarding the use of connections within social networks.

In addition to these, other indicators have been mentioned regarding the theme of dialogic principles, namely the dialogic loop in different studies, such as: space for comments (Jambeiro et al., 2012; Karkin & Janssen, 2014; Kent et al., 2003; Kent & Taylor, 1998; Taylor et al., 2001); forum (Taylor et al., 2001); sharing of experiences lived by fans in the form of text (Augusto, 2014); sharing of experiences lived by fans in the form of photographs (Augusto, 2014); possibility of sending messages/comments (McAllister-Spooner, 2010); links and contacts to directly contact the entity's employees/departments (Reber & Kim, 2006; Ingenhoff & Koelling, 2009; McAllister-Spooner & Kent, 2009); possibility of subscribing to newsletters/news (Karkin & Janssen, 2014); possibility of transactions/service requests (Karkin & Janssen, 2014; Feeney & Brown, 2017); texts responding to audiences (Taylor et al., 2001; Kent et al., 2003; Reber & Kim, 2006; Seltzer & Mitrook, 2007); possibility of requesting information (Taylor et al., 2001; Kent et al., 2003; Reber & Kim, 2006; Ingenhoff & Koelling, 2009); possibility for users to ask questions (McAllister-Spooner, 2010); Questionnaire (to give opinions on issues) (Taylor et al., 2001; Kent et al., 2003; Kang & Norton, 2004, 2006; Reber & Kim, 2006; McAllister-Spooner & Kent, 2009; Ingenhoff & Koelling, 2009; McAllister-Spooner, 2010); engaging and interactive online environment (Hinson et al., 2020); and finally possibilities for community interaction (Hinson et al., 2020) – these indicators are used in the empirical study.

Interestingly, Kent et al. (2003), McAllister-Spooner (2008) and McAllister-Spooner and Kent (2009) reached the same conclusion as Taylor et al. (2001), that the Dialogic loop is the one with the lowest scores across the various sites analyzed. In other words, this means that organizations have already mastered the ability to build a site that complies with various dialogic principles at a technical level; however, there is still much room for improvement in the part that really matters, which is actually establishing a dialogic relationship with their audiences: "Given the Web's increasing role in mediating commerce and as a tool for building organization-audience relationships, it is advisable for organizations to increase their commitment if they want to achieve the Web's full potential" (Kent, Taylor and White, 2003, 74).

With this in mind, the main focus of this paper will be the analysis of the principle related to the Dialogical Cycle, being "an appropriate starting point for dialogic communications between an organization and its publics" (Kent and Taylor, 1998, 326). Furthermore, as mentioned in Taylor et al. (2001) and also previously observed, the dialogic cluster is one that presents less positive results. However, it will always be the basic principle of dialogic theory because "It is in dialogic communication that trust and commitment emerge" (Taylor et al., 2001, 279). Kent and Taylor theorize that there are at least three ways of incorporating dialogue into everyday public relations: interpersonal, mediated and procedural (Kent & Taylor, 2002).

2.2 Technology, Communication and the Esports Sector

Technology has shaped the video game sector, which has been experiencing gradual growth over the last few years. The technology that the digital world has brought with it has helped to disseminate this market, particularly by focusing on competitive players who participate in organized tournaments and competitions known as "esports" (Hamari & Sjöblom, 2017). This practice is not new, dating back to the 1940s. However, the practice as it is currently known began in the late 1990s, with the acquisition of computers providing greater openness, ease of access and greater growth of video games (Scholz, 2019, 2020). In the current esports market, there are structures entirely dedicated to esports, namely: players who participate competitively within teams and who belong to organizations; tournament organizers in which these teams play and compete against each other, and other stakeholders in the ecosystem (Scholz, 2019; Hamari and Sjöblom, 2017). There are several reasons to justify the existence of an audience increasingly interested and willing to consume this type of content: the dissemination of the specificity of the content, the existence of tools for communities and betting services related to esports (e.g. Hamari & Sjöblom, 2017).

Considering the focus of the research, it is pertinent to understand the role of organizations and audiences in the context described. Organizations are business structures that hire workers and players for their teams or games in which they want to compete (Scholz, 2019). An organization may have different teams for different video games, since esports can appear in different video game genres; that is, just as with so-called "traditional" sports, there are also many subcultures within esports in the context of video games, such as "multiplayer online battle arenas" (for example: League of Legends, Dota 2), "first-person shooters" (for example: Counter-Strike: Global Offensive), "real time strategy" (for example: Starcraft 2), "collectible card games (for example: Hearthstone) or sports games (for example: the FIFA series)" (Hamari & Sjöblom, 2017, 212). Regarding the audience, they mostly use the live broadcast chat or social networks to access the world of video games. One of the most widely used social networks is Twitter (Sjöblom et al., 2018). The social network allows users to have very close contact with their interests, namely by sharing very short posts (140 characters, which have since been increased to 280), the like functionality, republishing other people's content (through a retweet) and the possibility, like many other networks, of sharing instant messages and following pages (Rybalko & Seltzer, 2010; Kim et al., 2014; Wang & Yang, 2020). For these reasons, Twitter emerges as one of the most relevant social networks to use and interact with in the world of esports. In other words, the content is all broadcast online, through

streaming platforms, with Twitch being the most common (Hamari & Sjöblom, 2017; Scholz, 2019). The audiences that watch this type of content interact mainly through the broadcast "chat" or, mostly, though social networks.

3 Empirical Research

3.1 Problem and Objectives

The literature review showed that in a scenario where technology, digitalization and two-way communication have played a central role in the organizational context, metrics, whether on websites or social networks, play a preponderant role (Wang & Yang, 2020). The interaction can be achieved through the use of digital dialogisms, mainly from the dialogic loop, as they allow organizations to create relationships with audiences and have an omnipresent presence (Kent & Taylor, 1998; Taylor et al., 2001). Organizations in the esports sector, which operates mainly online, whether on websites or on social networks such as Twitter, have not been indifferent to the need to establish communication marked by dialogue and interaction with their audiences. In this context, it was understood that there was room to formulate the following research question: How well do websites and Twitter accounts in the esports sector adopt the dialogue cycle principle? To answer this question, the following main objective was defined: to study the degree of adoption of the dialogic loop principle by the esports sector, namely on the websites and Twitter profiles of organizations. The specific objectives are: 1) to identify the organization's website with the highest and lowest degree of adoption of the dialogic loop; 2) to identify the organization's Twitter profile with the highest and lowest degree of adoption of the dialogic loop; 3) to identify the indicator of the dialogic loop most and least adopted by the organization's website; 4) to identify the indicator of the dialogic loop most and least adopted by the organization's Twitter profile; 5) to carry out a comparative analysis of the adoption of the dialogic indicators, of the dialogic loop, most and least adopted between the organization's website and Twitter; 6) to carry out a comparative analysis of the adoption of the dialogic loop between the organization's website and Twitter; 7) to identify the degree of adoption of the indicators present in the publication tool on the social network Twitter.

3.2 Research Design

To answer the research question, a mixed quantitative and quantitative approach was chosen. Data collection was carried out using a grid drawn up from an analysis matrix based on the literature review (e.g. Taylor et al., 2001; Kent et al., 2003; S. M. McAllister-Spooner, 2008; S. M. McAllister-Spooner & Kent, 2009; S. McAllister-Spooner, 2010). A matrix was constructed to analyse the data on the websites and another for the data on the Twitter profiles: one analyses the data relating to the page as a whole and the other only relating to the social network's publication box. Given the characteristics of the websites and Twitter profiles, the indicators underwent the necessary adjustments. In order to analyse the organisations' Twitter profile, only the "Forum" indicator will not be checked, since the social network itself constitutes what would normally be observed

by "Forum" on organisational websites. Other indicators were adapted, namely: "Chat" was adapted in order to analyse whether or not there is a message box available to the public; the "possibility of subscribing to newsletters/news" by analysing the possibility of receiving notifications of publications from that organisation, which acts similarly to a newsletter; "links to social networks", where only whether or not this functionality is used is analysed, since the Twitter profile only allows adding one link to the account. Thus, the analysis matrix for the websites contains 16 indicators, and 15 on Twitter—see Table 1.

Regarding the matrix referring to the publication tool, six indicators will not be verified, an analysis matrix of 10 indicators was constructed—see Table 2.

Data collection was carried out using a grid based on the analysis matrix. Data were collected by analyzing the content published on the website and Twitter of the organizations under study. Whenever the content analysis revealed the existence of an indicator of the dialogic loop, the number one (1) was marked on the grid; when there was none, it was marked with a zero (0). Once the data had been collected, it was analyzed using frequency and descriptive statistics, using Excel.

3.3 Sample

To select the sample, the HLTV.org website was accessed, which is the most respected website when it comes to news and rankings for the Counter-Strike: Global Offensive esports. The 10 best teams in the ranking of August 28, 2023, representing 10 different organizations, were chosen: Vitality; Heroic; G2 Esport; ENCE; FaZe Clan; Astralis; GamerLegion; Cloud9; Natus Vincere e Virtus.pro—see Table 3.

Each team is made up of five players. Six organisations (Vitality, G2, ENCE, FaZe Clan, GamerLegion and Natus Vincere) have teams with players from different countries, mainly European. Two organisations (Heroic and Astralis) have Danish players. Two other teams (Cloud9 and Virtus.pro) have mainly Russian players (out of ten players, only one is the exception, coming from Kazakhstan). This description is particularly pertinent if we take into account the fact that the organisation they represent may or may not correspond to the nationality of the team. In the case of Astralis and Heroic, the organisations are Danish and teams are made up of Danish players, but in the vast majority of cases, there is no direct correlation between the location of the organisation and the players' nationality. A more extreme case is the organisation Cloud9, which despite being based in the United States, has a predominantly Russian team. This means that fans of teams, and therefore of organizations, are as diverse or even more diverse than the organizations they follow.

Table 1. Dialogic loop Analysis Matrix—Organizations' Websites and Twitter

	Indicators	Authors	Observation
Dialogic loop	Chat	Jambeiro et al. (2012); Karkin & Janssen (2014); Hinson et al. (2020)	
	Space for comments	Jambeiro et al. (2012); Karkin & Janssen (2014); Kent & Taylor (1998); Kent et al. (2003; 2001)	
	Forum	Kent e Taylor (2001)	Only analysed on websites
	Sharing fan experiences (texts)	Augusto (2014)	
	Sharing of fan experiences (photos)	Augusto (2014)	
	Possibility of sending messages/comments	McAllister-Spooner (2010)	
	Links and contacts to contact the organisation's employees/departments directly	McAllister-Spooner & Kent (2009); Ingenhoff & Koelling (2009); Reber & Kim (2006)	
	Possibility of subscribing to newsletter, news	Karkin & Janssen (2014)	
	Possibility of transactions/requesting services	Karkin & Janssen (2014); Feeney & Brown (2017)	
	Links to social networks	Fietkiewicz et al. (2017)	
	Texts to respond to the public	Taylor et al. (2001; 2003); Seltzer & Mitrook (2007); Reber & Kim (2006)	
	Possibility of requesting information	Taylor et al. (2001; 2003); Ingenhoff & Koelling (2009); Reber & Kim (2006)	
	Possibility for users to ask questions	McAllister-Spooner (2010)	

(*continued*)

Table 1. (*continued*)

	Indicators	Authors	Observation
	Questionnaire (to give your opinion on issues)	Taylor et al. (2001; 2003); McAllister-Spooner (2010) Kang & Norton (2004); Kang & Norton (2006); McAllister-Spooner & Kent (2009); Ingenhoff & Koelling (2009); Reber & Kim (2006)	
	Engaging and interactive online environment	Hinson et al. (2020)	
	Possibilities for community interaction	Hinson et al. (2020)	

Table 2. Dialogic loop Analysis Matrix—Twitter post

	Indicators	Authors
Dialogic loop	Space for comments	Jambeiro et al. (2012); Karkin & Janssen (2014); Kent & Taylor (1998); Kent et al. (2003; 2001)
	Sharing of fan experiences (texts)	Augusto (2014)
	Sharing of fan experiences (photos)	Augusto (2014)
	Possibility of sending messages, comments	McAllister-Spooner (2010)
	Text responses to audiences	Taylor et al. (2001; 2003); Seltzer & Mitrook (2007); Reber & Kim (2006)
	Possibility of requesting information	Taylor et al. (2001; 2003); Ingenhoff & Koelling (2009); Reber & Kim (2006)
	Possibility for users to ask questions	McAllister-Spooner (2010)
	Questionnaire (to give your opinion on issues)	Taylor et al. (2001; 2003); McAllister-Spooner (2010) Kang & Norton (2004); Kang & Norton (2006); McAllister-Spooner & Kent (2009); Ingenhoff & Koelling (2009); Reber & Kim (2006)
	Engaging and interactive online environment	Hinson et al. (2020)
	Possibilities for community interaction	Hinson et al. (2020)

Table 3. Organizations analyzed and their websites and Twitter pages

Organizations	Website	Twitter Pages
Vitality	https://vitality.gg	https://twitter.com/TeamVitality
Heroic	https://heroic.gg	https://twitter.com/heroicgg
G2 Esports	https://g2esports.com	https://twitter.com/G2esports
ENCE	https://www.ence.gg	https://twitter.com/ENCE
FaZe Clan	https://fazeclan.com	https://twitter.com/FaZeClan
Astralis	https://astralis.gg	https://twitter.com/AstralisCS
GamerLegion	https://gamerlegion.gg	https://twitter.com/GamerLegion
Cloud9	https://cloud9.gg	https://twitter.com/Cloud9
Natus Vincere	https://navi.gg/en	https://twitter.com/natusvincere
Virtus.pro	https://virtus.pro/en	https://twitter.com/virtuspro

4 Results

4.1 Dialogic Loop on Websites and Twitter

Of the sixteen indicators analyzed, only four are relatively adopted: links to social networks; possibility of transactions/requesting services; links and contacts to directly contact the organization's employees/departments; and possibility of subscribing to newsletters/news. However, only two of them have an adoption rate of 100%. It is also worth mentioning that, in addition to the other indicators that are not adopted by the organizations' websites, only the forum indicator is observed once, on the website of the organization Natus Vincere. Even so, this adoption was a particular case, considering that this forum is specially designed for a Russian-speaking population. In general, organizations have very low adoption rates of the dialogic loop indicators, since the vast majority of indicators are not adopted (according to table 21, 80% of the indicators that could be observed were not), and even within the 20% of all possible indicators that were found, they do not present a great diversity between them—see Table 4.

Table 4. Dialogic loop on organizations' websites

	Exist		Not exist	
	Frequency	Percentage	Frequency	Percentage
Chat	0	0%	10	100%
Space for comments	0	0%	10	100%
Forum	1	10%	9	90%

(*continued*)

Table 4. (*continued*)

	Exist		Not exist	
	Frequency	Percentage	Frequency	Percentage
Sharing fan experiences (texts)	0	0%	10	100%
Sharing of fan experiences (photos)	0	0%	10	100%
Possibility of sending messages/comments	0	0%	10	100%
Links and contacts to contact the organisation's employees/departments directly	8	80%	2	20%
Possibility of subscribing to newsletter, news	3	30%	7	70%
Possibility of transactions/requesting services	10	100%	0	0%
Links to social networks	10	100%	0	0%
Texts to respond to the public	0	0%	10	100%
Possibility of requesting information	0	0%	10	100%
Possibility for users to ask questions	0	0%	10	100%
Questionnaire (to give your opinion on issues)	0	0%	10	100%
Engaging and interactive online environment	0	0%	10	100%
Possibilities for community interaction	0	0%	10	100%

In the case of the organizations' profiles on the social network Twitter, the data are very similar. However, it is important to highlight the indicator regarding the possibility of subscribing to newsletters/news in this environment. As mentioned, the inclusion of this indicator in the analysis matrix for the organizations' profiles on Twitter had to undergo a slight modification to adapt to the needs of the page in question. The data show that this indicator was present on all the organizations' profile pages, as long as the user followed the page. In other words, this means that all the organizations' pages on the social network automatically saw this indicator adopted on their respective pages. Regarding the degree of adoption of the different indicators of the dialogic loop for the organizations' Twitter profiles, the data also show a low adoption of the indicators (only 20% of the total indicators were observed), and there is little variety between the indicators that were observed, that is, the low number of indicators observed were observed in the different organizations—see Table 5.

Table 5. Dialogic loop for organizations' Twitter profiles

	Exist		Not exist	
	Frequency	Percentage	Frequency	Percentage
Chat	6	60%	4	40%
Space for comments	0	0%	10	100%
Sharing fan experiences (texts)	0	0%	10	100%
Sharing of fan experiences (photos)	0	0%	10	100%
Possibility of sending messages, comments	0	0%	10	100%
Links and contacts to contact the organisation's employees/departments directly	0	0%	10	100%
Possibility of subscribing to newsletters	10	100%	0	0%
Possibility of transactions/requesting services	4	40%	6	60%
Links to the site/other social networks	10	100%	0	0%
Text responses to the public	0	0%	10	100%
Possibility of requesting information	0	0%	10	100%
Possibility for users to ask questions	0	0%	10	100%
Questionnaire (to give your opinion on issues)	0	0%	10	100%
Engaging and interactive online environment	0	0%	10	100%
Possibilities for community interaction	0	0%	10	100%

Regarding the Twitter publishing tool, the data show that there is some adoption of the observed dialogic indicators (40%). Since the Twitter publishing tool is the same for all organizations, given that the social network provides the same publishing tool for all users, when an indicator was observed, that indicator was observed for all organizations under analysis—see Table 6.

4.2 Dialogical Cycle by Organizations

In general, all organizations present a low rate of adoption of the dialogic loop indicators (with no values higher than 25% for the website and 26.67% for the Twitter social network profile). This means that the minimum observed number of indicators adopted by an organization is two and the maximum is four—see Table 7.

In a detailed comparison, organizations such as G2 Esports and Astralis are homogeneous in the way they work on the issue of the dialogic loop, both on the website and on Twitter. It is also possible to see that the organization Vitality focuses more on the issue of the dialogic loop on the website than on Twitter. However, there is in fact a

Table 6. Dialogic loop in the Twitter publishing area

	Exist		Not exist	
	Frequency	Percentage	Frequency	Percentage
Space for comments	10	100%	0	0%
Sharing fan experiences (texts)	0	0%	10	100%
Sharing of fan experiences (photos)	0	0%	10	100%
Possibility of sending messages, comments	10	100%	0	0%
Text responses to audiences	0	0%	10	100%
Possibility of requesting information	0	0%	10	100%
Possibility for users to ask questions	0	0%	10	100%
Questionnaire (to give your opinion on issues)	10	100%	0	0%
Engaging and interactive online environment	0	0%	10	100%
Possibilities for community interaction	10	100%	0	0%

Table 7. Dialogic loop by organizations

	Website				Twitter (Profile)			
	Exist		Not exist		Exist		Not exist	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Vitality	4	25,00%	12	75%	2	13,33%	13	86,67%
Heroic	2	12,50%	14	88%	3	20,00%	12	80,00%
G2 Esports	4	25,00%	12	75%	4	26,67%	11	73,33%
ENCE	3	18,75%	13	81%	3	20,00%	12	80,00%
FaZe Clan	3	18,75%	13	81%	2	13,33%	13	86,67%
Astralis	4	25,00%	12	75%	4	26,67%	11	73,33%
GamerLegion	3	18,75%	13	81%	4	26,67%	11	73,33%
Cloud9	3	18,75%	13	81%	3	20,00%	12	80,00%
Natus Vincere	3	18,75%	13	81%	3	20,00%	12	80,00%
Virtus.pro	3	18,75%	13	81%	2	13,33%	13	86,67%

balance in the way organizations manage communication issues between websites and Twitter—see Fig. 1.

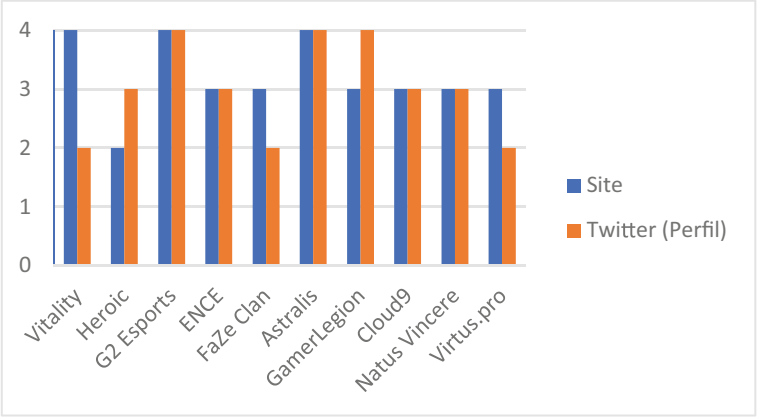

Fig. 1. Comparison of the dialogic loop between websites and Twitter profiles by organizations

5 Discussion

Regarding the dialogic loop through the adoption of its indicators related to the organizations' websites, of the sixteen indicators, eleven were not flagged on any of the organizations' websites. On the websites of Vitality, G2 Esports and Astralis, the presence of indicators referring to the possibility of subscribing to newsletters/news and links and contacts to directly contact the organization's employees/departments have a higher degree of adoption. Within these links and contacts, there are different degrees of use in the organizations: Virtus.pro; ENCE; FaZe Clan and Cloud9 provide diverse contacts for different departments, while the organizations GamerLegion, Astralis and G2 Esports offer a single, more generalized contact. In the case of Vitality, they provide a possible contact, however it is not easily accessible. It is worth highlighting the particularity of the website of the organization Natus Vincere, which has a Forum space – although only for Russian-speaking users – showing itself to be the only website of the ten in which it is possible to observe this indicator.

The indicators that mark the presence of the possibility of transactions/requesting services and links to social networks are observed in all the websites, making them the indicators of the dialogic loop with the greatest adoption on the organizations' websites. However, there is a low adoption of the dialogic loop, in line with what was mentioned in the literature review (Taylor et al., 2001; Kent et al., 2003; McAllister-Spooner, 2008; McAllister-Spooner and Kent, 2009). The website of Heroic is the one that contains the fewest indicators, with only two, and the three organizations that achieve a higher frequency of indicators are limited to only four observed indicators, which makes up a percentage of 12.5% of the total indicators on the website with the fewest indicators, and a maximum of 25% of the total indicators used on the websites with four observed indicators. The organizations that make up this triad are Vitality, G2 Esports and Astralis, proving that they are the ones that most adopt the dialogical cycle, adopting the same indicators, evidencing results found in other studies (e.g. Reber and Kim, 2006; Fietkiewicz et al., 2017; Karkin and Janssen, 2014). In this line of thought, it is

understood that the adoption is not very comprehensive, which is in line with what has already been described in the literature (e.g. Kent et al., 2003; Taylor et al., 2001).

Regarding the profile of organizations within the social network Twitter, links to establish a connection to other networks, a store, or to the website or the possibility of subscribing to newsletters/news are the indicators most adopted by the organizations under study. However, in general, there is a low adoption of the dialogic loop, compromising the quality of communication and integration between organizations and their audiences (e.g. Wang & Yang, 2020). The organizations that adopt the most indicators regarding their Twitter profile are the G2 Esports, Astralis and GamerLegion, while those that adopt the least were, for example, Vitality, FaZe Clan and Virtus.pro. The Twitter publishing area has a 40% degree of adoption of the dialogic indicators described. In particular, the indicator possibilities for community interaction, by achieving a wide adoption, ends up contributing to the construction of a good image of the organization (Hinson et al., 2020). It should also be noted that, although the questionnaire indicator is not frequently observed, as evidenced in studies such as those by Kim (2006) or Ingenhoff and Koelling (2009), the Twitter publishing tool has this functionality, available to all users of the social network, which in the context of Twitter is defined as the indicator that allows the user to create a survey. Thus, although it is not possible to ask the user directly and obtain a response, it allows for a survey and thus obtain information regarding what the public thinks about a given subject. The Twitter social network only allows direct interaction with other profiles through the comments box. However, if a user wants to directly approach the organization, they will never be able to do so on the Twitter profile page. They will have to resort to other features, namely the organization's website.

When comparing the adoption of the dialogic loop between the website and the Twitter profile of organizations, one of the most used indicators is the links to social networks/to the website, data that are in line with the result found, for example, in the study by Fietkiewicz et al. (2017). It is worth noting that the analysis of the data allows us to state that the organizations G2 Esports and Cloud9 used their space to place the link to redirect directly to the area where the website could be used to transact services, while in the case of GamerLegion and Astralis they used the page description to place a link to that area. The principle, in essence, is the same: redirect the user to the area of the organization's website where that transaction can be carried out. Another contrasting point is the indicator regarding the possibility of subscribing to the newsletter/news, where only three organization websites have it (Vitality; G2 Esports and Astralis) and on Twitter it is a function that the platform itself facilitates, as long as the user is following the organization's page and activates this functionality.

It is also worth noting that in the case of websites, the indicator regarding links and contacts to directly contact the organization's employees/departments is the most adopted, while on the Twitter profile there is the indicator for the availability of receiving instant messages, or chat. The scenario tends to show that the social network is mainly used as a form of direct contact with the user, and the website as a tool for less direct, more asynchronous and formal contact. It is also worth highlighting the fact that Twitter also has a publishing tool, which in turn contains dialogic indicators that were not observed either on the website or on the organization's profile, an example being the possibility of

conducting surveys. Comparing the organization's website and Twitter profile in relation to the degree of adoption of the dialogic loop principle as a whole, there is a tendency for the adoption of the dialogic loop to have the same degree, emphasizing that it is low.

6 Conclusion

This paper sought to answer the following research question: How well do websites and Twitter accounts in the esports sector adopt the dialogue cycle principle? To answer this question, the following main objective was defined: to study the degree of adoption of the dialogic loop principle by the esports sector, namely on the websites and Twitter profiles of organizations. The specific objectives are: 1) to identify the organization's website with the highest and lowest degree of adoption of the dialogic loop; 2) to identify the organization's Twitter profile with the highest and lowest degree of adoption of the dialogic loop; 3) to identify the indicator of the dialogic loop most and least adopted by the organization's website; 4) to identify the indicator of the dialogic loop most and least adopted by the organization's Twitter profile; 5) to carry out a comparative analysis of the adoption of the dialogic indicators, of the dialogic loop, most and least adopted between the organization's website and Twitter; 6) to carry out a comparative analysis of the adoption of the dialogic loop between the organization's website and Twitter; 7) to identify the degree of adoption of the indicators present in the publication tool on the social network Twitter.

Results showed that the possibility of subscribing to newsletters/news and links and contacts to directly contact the entity's employees/departments have a higher degree of adoption. Regarding the profile of organizations within the social network Twitter, links to establish a connection to other networks, stores, or websites or the possibility of subscribing to newsletters/news are the indicators most adopted by the organizations under study. Regarding the comparative analysis of the indicators adopted by organizations in the two media analyzed, both the website and the organization's Twitter profile page adopt the same indicators, both on the website and on the Twitter profile page.

We conclude that, despite the different degrees of adoption, organizations use the website and social networks to communicate with the public. Going back to the research question - How well do websites and Twitter accounts in the esports sector adopt the dialogue cycle principle? - we conclude that, notwithstanding indicators are adopted, there is low implementation of the dialogical cycle principle, both on the website and on the Twitter profile page.

One of the limitations of this study is that it is a small and restricted sample. Future studies should carry out analyses with larger samples and content analysis of publications made by esports organizations on Twitter, in order to observe the use of the dialogic potential of Twitter by organizations.

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J. V. Carvalho et al. (Eds.): ICITED 2025, LNNS 1694, pp. 569–571, 2025.
https://doi.org/10.1007/978-3-032-09080-5

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