Fostering Transversal Skills: A Pedagogical Experience in Higher Educational Programs of Technology

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2025 6th International Conference of the Portuguese Society for Engineering Education (CISPEE) | 979-8-3315-2189-9/25/$31.00 ©2025 IEEE | DOI: 10.1109/CISPEE64787.2025.11123980

***Abstract*—The short-cycle higher educational programs called CTeSP, with a strong practical and technological focus, designed to meet labour market demands, were introduced in Portugal by 2014. This paper explores the challenges faced both by the Smart Grids and Domotics CTeSP and by the Electric Vehicles CTeSP taught at Instituto Politécnico de Setúbal. The reorganization strategy applied, tailored to the characteristics of Generation Z, who prefer dynamic and engaging learning approaches, is presented. This strategy consisted of restructuring the organizational and pedagogical framework of the programs to motivate students and address the high dropout and failure rates of these CTeSP by incorporating active methodologies while fostering transversal skills like focus, adaptability, and critical thinking. These skills are essential for employability, contributing to improve the students' academic performance. The results achieved by the implementation of this pedagogical experience are also presented and analyzed.**

Keywords—learning strategies, soft skills development, Gen Z

I. Introduction

A new type of short-cycle higher educational program (2 years – 180 ECTS) was added in 2014 to the range of course offerings in polytechnics of Portugal, called professional higher technical courses (CTeSP) [1]. These programs have a significant practical and technological component and stronger links to the labour market needs, suitable for students from vocational education to whom higher education is usually not attractive. With a duration of two years, including a professional internship, these programs provide a balance between technical training and the development of soft skills such as teamwork, adaptability, and communication, which are crucial for employability. These courses are designed for a diverse student population, mainly composed of Generation Z (Gen Z) learners who bring unique perspectives and expectations to the classroom [2]. Moreover, many students come from non-traditional backgrounds, including vocational schools or varied professional experiences, which adds to the richness but also the complexity of managing their educational needs.

This paper aims to tackle the educational challenges that emerged from Gen Z students who currently attend CTeSP programs in technology, by implementing and evaluating organizational and pedagogical strategies that enhance the students' learning, foster transversal skills [3], and improve the overall success rates. The paper is structured as follows: section II presents an overview of Gen Z students and its challenges, section III explores the adaptation needs of educators to Gen Z, section IV outlines the organizational and pedagogical strategies implemented to develop the transversal skills needed and also presents the teaching techniques applied in some course units, section V addresses the overall outcomes of this educational strategy and section VI gives some relevant conclusions.

II. Gen Z

The current wave of students entering higher education institutions belongs to Gen Z, encompassing individuals born from the mid-1990s to the early 2010s [4]. This generation is deeply connected with digital technology from an early age, shaping their distinct learning behaviors and preferences [5].

A. Overall Characteristics

Gen Z students are experts in the intuitive use of digital tools and self-directed learning, often preferring resources such as video tutorials and online platforms. Their multitasking abilities suit dynamic environments but can lead to reduced focus and difficulties sustaining attention over long periods [6,7]. Moreover, they prefer interactive, personalized teaching methods and place high value on prompt feedback.

In terms of intellectual challenges, this generation faces issues such as information overload and rising rates of anxiety and depression, often linked to excessive social media use and performance pressures [4]. While critical thinking and problem-solving skills are increasingly vital in technology and engineering courses, they may not always be fully developed due to a reliance on fast, surface-level information.

B. Educational Challenges

Gen Z, like all previous generations, presents challenges for educators. These challenges, although not universal, often reflect socio-economic inequalities, inadequate academic preparation in physics and mathematics, and other contextual factors that shape their education. Some of Gen Z believe that an academic degree is irrelevant for the workplace and a waste of time [8]. Moreover, many students enter higher education without solid practices of academic organization and planning, often as result of gaps in secondary education, where autonomy may not have been adequately encouraged. Also,

some students struggle to understand and comply with the rules and don't have appropriate behaviors in formal settings, due to a lack of prior exposure to such environments. In fact, transitioning from adolescence to adulthood presents challenges for many Gen Z. For students from lower socio-economic backgrounds, this may be aggravated by limited family support or inconsistent behavioral models. Finally, the prevalence of digital distractions and difficulty in prioritizing tasks contribute to procrastination, especially when students receive little guidance on time management.

In the educational context, these challenges can be overcome with targeted interventions such as the development of soft skills and effective teaching strategies.

C. Gen Z' Soft Skills Development

Soft skills directly influence students' academic performance and their future professional success. When these skills are underdeveloped, achieving hard skills becomes more difficult, often leading students to extend their studies to complete their courses. Throughout the academic journey, learning experiences can be designed to foster the development of transversal skills essential for academic success while integrating technical and scientific components. These skills enhance adaptability and performance in the workplace post-graduation.

In nowadays fast-paced business, technological and environmental changes, soft skills like adaptability, creativity, collaboration, critical thinking, problem-solving, resilience, autonomy, and time management are essential [9]. Institutionally, the challenge of implementing strategies to develop these skills in academia can include:

- Specific course units within the curriculum plan focused on transversal skills [10], such as time management, autonomy, problem-solving, oral and written communication. These course units, such as portfolio or project-based courses, are usually limited in number which is seldom sufficient for an effective development of soft skills.
- Extracurricular activities like sports, volunteering, academic associations, or internships [11].
- Formative assessment and constructive feedback throughout the learning process [12].
- Student-centered methodologies applied across multiple course units using active learning strategies and formative approaches [13].
- Mentorship programs offering opportunities for self-awareness, emotional management, and resilience development.

These combined strategies ensure a better Gen Z preparation for both academic and professional challenges. In addition, providing emotional support and structured guidance on organization and planning is essential to help these students adjust to the demands of higher education and prepare them for the job market.

III. Teaching Gen Z

Educators working with Gen Z students face the challenge of adapting their teaching practices to meet the educational needs of this dynamic generation [14], which is driven by a quest for practical relevance. According to Skiba and Burton [15], the traditional classroom teaching structure is no longer effective with these students. Trilling and Fadel [16], reinforce that for being an effective teacher in this new paradigm a shift from teacher-centered approach to student-centered approach is required. This involves moving away from traditional direct instruction towards fostering interactive exchanges among students, emphasizing the development of essential skills over simply teaching content knowledge and prioritizing problem-solving processes. Moreover, the modern teaching environment should integrate the advanced skills demanded by today's digital world [17,18].

Implementing student-centered approach effectively requires substantial resources, including additional time planning and customized educational tools. However, considering the institutional support given, educators often feel that such efforts—contrasting with traditional content-delivery approaches—are undervalued. This issue is aggravated by the fact that scientific and technological research activities tend to have a much greater impact on career progress and institutional reputation than pedagogical innovation. As a result, the additional workload involved in adopting innovative teaching strategies may be perceived as less rewarding, both professionally and institutionally, creating a misalignment between pedagogical innovation and career incentives.

IV. Educational Strategy

The aim of this paper is to present the innovative pedagogical strategy implemented during the academic year 2023/24 in Smart Grids and Domotics CTeSP (REID) and in Electric Vehicles CTeSP (VE) of Instituto Politécnico de Setúbal. The REID program covers a wide range of topics, from theoretical fundamentals of electrical engineering to practical applications in electrical networks and home automation systems. The VE program explores electric vehicle technology, propulsion systems, batteries, and charging infrastructures. The first semester of the first-year curricular plan of both these programs is composed of six course units: four course units with 6 ECTS and two course units with 3 ECTS.

The REID and VE programs face certain constraints compared to other CTeSP, since it is difficult to attract students to select REID and VE as their first-choice programs. In fact, students attending programs that were their top preference tend to be more motivated than those who select them as fallback options, which may contribute to high dropout and failure rates. This situation led to institutional support for implementing a range of actions to improve organizational practices and pedagogical activities in REID and VE programs over the academic year 2023/24 to reverse their declining trajectory. Structural and pedagogical changes were carried out within the student-centered approach, considering the characteristics of Gen Z students, as outlined in previous sections II and III, and encouraging teachers to implement effective teaching techniques that actively contribute to students' learning.

A. Organizational Strategy

The experimental restructuring of the programs organizational framework aimed to enhance the effective use of teaching time by ensuring that students only attended one course unit by weekday. Thus, the four 6 ECTS course units, which were previously split into twice 2-hours teaching blocks per week, were merged into a single 4-hours weekly block,

with 2 hours dedicated to theoretical-practical sessions and 2 hours to laboratory work. Also, the two 3 ECTS course units, which were previously taught simultaneously in a 2-hour teaching block per week during all semester, were organized into a 4-hour sequential teaching block over half semester.

This organization strategy, focused on one course unit by weekday, enabled the integration of supervised pedagogical activities in classroom, including the development of specific soft skills, while simultaneously allowing students to engage deeply with the technical-scientific content. Moreover, due to the sequential teaching of the 3 ECTS course units during half the semester, students only had to study regularly for five course units.

B. Pedagogical Strategy

Until the academic year 2023/24, the pedagogical methodology applied in the majority of the course units of these two CTeSP was the teacher-centered approach, with classes focused on its syllabus and on the development of technical skills. The assessment was essentially based on two traditional summative tests. Also, each course unit worked independently, without the discussion of teaching methodologies among teachers.

In 2023/24 a change of the pedagogical approach was proposed by the course coordinators, with the objective of adapting the contents and teaching strategies of the course units to meet the characteristics of Gen Z students. This involves implementing the student-centered approach in most of the classroom teaching time. It also requires defining and detailing the three key components of the pedagogical structure: learning objectives, learning activities and assessment, ensuring these elements are consistently aligned with one another. The support for educators teaching the first-year course units was structured around collaborative planning, including regular meetings during the preparation of the semester, which promoted and enabled understanding of the new pedagogical paradigm. It is a common misconception of teachers to think that the occasional use of active learning techniques in classroom is sufficient to implement the student-centered approach. In fact, this pedagogical approach, when lacking alignment between learning objectives and assessment, can be limited and inadequate to meet the students' learning needs and don't actively contribute for the development of soft skills.

Adapting to a 4-hours teaching block while applying active learning techniques can be a challenging task for educators. Sustaining students' attention and motivation over an extended period requires creativity and meticulous planning. This planning must incorporate a diverse range of activities, including group discussions, active learning exercises, presentations, case studies, problem-solving tasks and debates, all designed to encourage active student participation while developing its soft skills. These techniques must be supported by assertive time management to ensure that learning objectives are effectively achieved. Also, the inclusion of strategic breaks is essential to mitigate the students and teacher fatigue. Moreover, these breaks can be an opportunity for constructive feedback, which guides students in their learning journey while fostering reflection and critical thinking. Such feedback also strengthens communication between teacher and students, cultivating an environment of trust and mutual support. In fact, personalized and constructive feedback motivates students to engage more deeply with content and strive to achieve their academic goals. Finally, the continuous assessment of students' progress is vital to reinforce and adjust the learning process as needed, ensuring that the learning objectives are met effectively.

C. Course Units Application

All first-year teachers of REID and VE programs were tailored to the organizational strategy, with some teachers adopting active methodologies in their course units.

In both 6 ECTS mathematics course units that took place during the two semesters of the academic year, classes were planned for the teacher to give short presentations of content followed by the application of collaborative working group and gallery walk learning techniques, where students carried out a set of exercises that covered all the topics previously addressed. Under the supervision of the teacher, each group of students achieved the correct solution of the exercise given and then post it on the MS-Teams virtual room of the course unit by the end of each class. All the didactic resources of these course units were available in the Moodle platform and assessment was distributed into three or four individual summative tests aligned with the courses' learning objectives. Also, the students' final grade was gradually increased by each time a test was carried out, which contributed to the students' engagement and reduced dropout rate in the mathematics' course units.

In the 3 ECTS *Technical English* course unit, classes were supported by a diversity of teaching/learning strategies based essentially on interactive methodologies, which implied the active participation of the students in each activity, an aspect that strongly stimulated general class involvement. Some of the activities included visualization of videos followed by class discussion/debate; reading comprehension worksheets with the aim of consolidating skills such as writing, communication and critical analysis; gap-fill exercises to promote vocabulary acquisition and grammar consolidation worksheets in order to revise essential language structures and group work. It is important to highlight that the introduction of these diverse teaching strategies increased critical thinking among students. All the pedagogical materials were made available on Moodle platform so that students who missed classes could benefit from the same learning contents worked within the classroom. The Moodle platform was also used as a repository of complementary materials with the aim of helping students consolidate their learning process.

The 3 ECTS *Business Management and Organizational Behavior* course unit adopted two main methodologies: problem-based learning and collaborative work. Each 2-hour teaching block covered content through the presentation of a specific case study for each topic, which students solved in groups by the end of each class. The combination of these two methodologies allowed students to acquire essential knowledge and soft skills for their professional lives, such as collaboration, communication and problem-solving.

The 6 ECTS *Fundamentals of Power Electronics* course unit combined theoretical learning with practical applications through diverse teaching methodologies. Group-based and problem-solving encouraged research, collaboration and presentations to classmates, fostering active learning and critical thinking. Additionally, laboratory classes allowed students to design and test circuits, such as rectifiers and inverters, consolidating their understanding. This multifaceted approach develops technical expertise, teamwork and communication skills. Assessment included theoretical tests

and practical evaluations, ensuring a comprehensive and balanced learning experience.

In the 6 ECTS *Electrotechnics* course unit, collaborative learning activities were actively integrated to enhance students' engagement and skills' development. Group work was a central approach, where students collaborated on tasks and presented their results to the class, fostering teamwork, communication, and presentation skills. The Jigsaw technique was also applied, encouraging students to take responsibility for different parts of a topic and share their knowledge with peers, promoting leadership and mutual accountability. Problem-based learning activities were also applied, allowing students to consolidate their understanding through practical application, followed by debates to critically evaluate results and refine solutions. Personalized feedback was provided throughout the semester, offering guidance and helping students develop critical thinking, adaptability, and problem-solving skills. These activities not only reinforced technical knowledge but also fostered essential soft skills such as collaboration, time management and effective communication, preparing students for both academic and professional challenges.

In the 3 ECTS *Introduction to Smart Grids and Home Automation* course unit, collaborative learning activities played a key role in fostering student engagement and practical understanding. Two seminars led by professionals of smart grids and Domotics fields were given, providing students with insights into industry practices and hands-on exposure to typical high and low voltage circuit equipment. Students worked in small groups to complete laboratory tasks and develop detailed reports, enhancing their teamwork and technical writing skills. During classes, these activities encouraged critical thinking, problem-solving and effective communication, equipping students with both technical expertise and essential soft skills for their future careers.

V. Outcomes

At the beginning of the first semester of the academic year 2023/24, a survey was conducted among students from both REID and VE programs regarding their study habits, focusing on whether they studied in the run-up to the evaluations or studied on a daily basis, and whether they preferred to study in groups or individually. Their responses are shown in Fig. 1, where it can be noted that most students preferred to study alone and on the eve of evaluations.

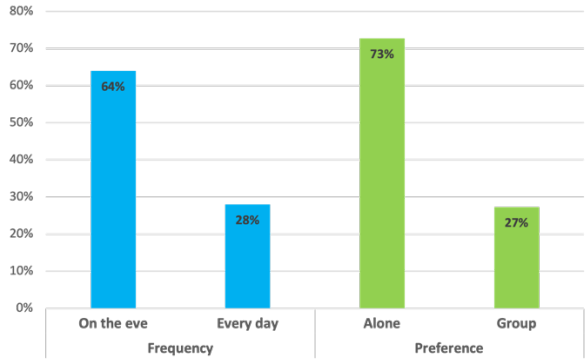

Fig. 1. Students' study habits.

Also, only one third of the students were used to actively participate in classroom activities, as shown in Fig. 2.

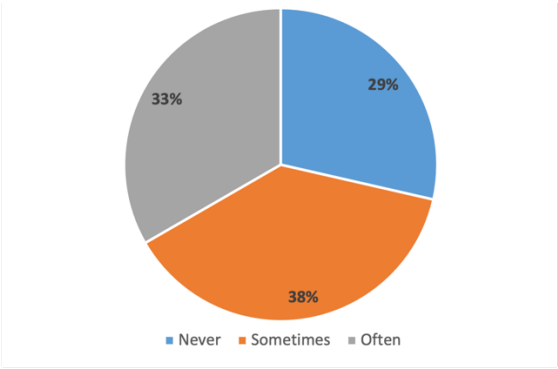

Fig. 2. Students' active participation in classroom.

Given these study habits, the application of active learning techniques in classroom would provide a positive contribution in improving the students' attitude and academic performance.

The overall academic performance of the students enrolled in the first-year course units of REID and VE educational programs over the academic years 2021/22, 2022/23 and 2023/24 are now presented.

A. Smart Grids and Domotics (REID)

In the academic year 2021/22 the REID program had 26 enrolled students, in 2022/23 there were 30 enrolled students and in the academic year 2023/24 the number of enrolled students increased up to 36, with an average percentage of 77% of freshman year students by course unit.

Regarding the 12 first-year course units of this educational program, Fig. 3 shows the total number of enrolled, evaluated and approved students by academic year.

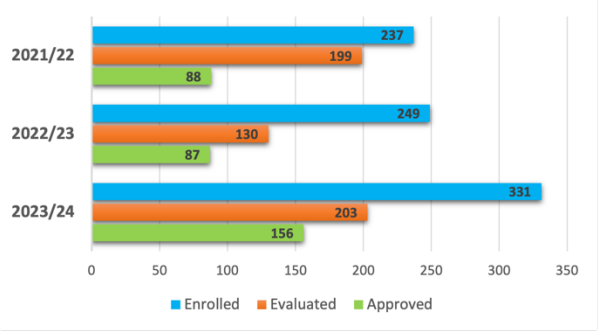

Fig. 3. Total number of enrolled, evaluated and approved students in the 12 first-year course units of REID.

Looking at these numbers, in 2021/21 there was a success rate of 37% passed students by enrolled ones; in 2022/23 this rate was 35% and in 2023/24 the success rate increased up to 47%, being the highest rate ever accomplished.

B. Electric Vehicles (VE)

In the academic year 2021/22 the VE program had 32 enrolled students, in 2022/23 there were 30 enrolled students and in the academic year 2023/24 the number of enrolled students was 31, with an average percentage of 71% of freshman year students by course unit.

Regarding the 11 first-year course units of this educational program, Fig. 4 shows the total number of enrolled, evaluated and approved students by academic year.

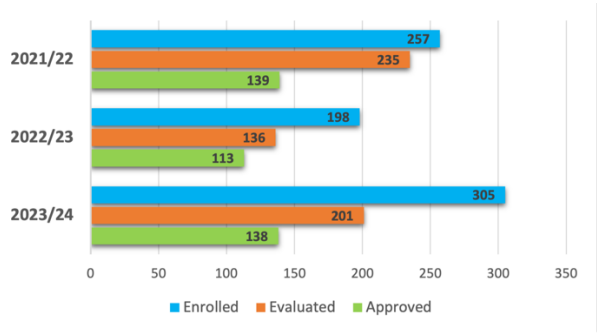

Fig. 4. Total number of enrolled, evaluated and approved students in the 11 first-year course units of VE.

Looking at these numbers, in 2021/21 there was a success rate of 54% passed students by enrolled ones; in 2022/23 this rate was 57% and in 2023/24 the success rate was of 45%.

Although the academic performance rates were promising in REID program, the results in VE program after the implementation of the educational strategy presented in this paper were far more modest, which can be explain by the fact that the students' academic background was weaker and that not all first-year teachers of VE were able to apply the student-centered approach in their course units.

VI. Conclusions

The initial challenge of this pedagogical experience was understanding the traits and needs of Gen Z to adapt the educational structure to quickly address knowledge gaps and some soft skills, reducing dropout rates of REID and VE programs and better preparing students for either entering the job market or continuing their studies. The student-centered approach, using active learning techniques to develop transversal skills, was proposed to the teaching group. The suggested active learning techniques included collaborative group work to enhance interaction, create bonds and foster knowledge sharing, problem-solving, autonomy, critical thinking, empathy, and group communication skills. Although some teachers were prepared to apply these techniques, their effectiveness may be hindered by students' lack of motivation, inadequate alignment with the course's technical-scientific context, insufficient implementation training, and passive student resistance. These barriers may lead teachers to revert to traditional classroom methods. While some educators embraced this challenge, others predominantly maintained traditional teaching methods. Among those who adopted the new pedagogical approach, some encountered difficulties due to the need for a mindset shift, as traditional teaching tends to focus primarily on content rather than learning outcomes. The effort to adapt teaching methods for Gen Z may have doubly impacted some teachers. They received little recognition for implementing the new educational strategy and reduced research output due to the time spent on this pedagogical innovation, leading to lower career evaluations and frustration.

From the students' perspective, it was perceived that the learning activities facilitated a quick integration among students and into the academic environment, contributing to their self-motivation, work dynamics, and critical thinking. In addition, the soft skills developed by students in the course units that applied active learning techniques must have contributed to improve the students' academic performance in the others course units that applied teacher-centered approach.

Having finished this first phase, it is necessary to continue this pedagogical work to consolidate results and improve the development of Gen Z students' competencies, enriching their academic experience.

Acknowledgment

This paper is financed by the Research Center in Mathematics and Applications (CIMA).

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