Chapter 3
Intelligent Curricula: Personalizing Learning With Artificial Intelligence and Developing Transformative Skills

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ABSTRACT

This chapter explores how artificial intelligence can transform curriculum design by personalising learning and supporting the development of essential 21st-century skills. Integrating artificial intelligence into curricula enables adaptive learning environments that respond to individual student needs, promoting equity and improving educational outcomes. The chapter begins by contextualising the growing role of artificial intelligence in education and examining current opportunities and challenges for educators and institutions. It then discusses personalised learning mechanisms, offering examples of how generative artificial intelligence can enhance the student experience. The second section focuses on developing key skills such as critical thinking, collaboration, and digital literacy, showing how they can be integrated into the curriculum with the support of artificial intelligence. Ethical and inclusion issues are also considered to ensure fair and accessible implementation.

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1. INTRODUCTION

Digital transformation has decisively shaped all sectors of contemporary society, and education is no exception. Among emerging technologies, artificial intelligence (AI) stands out as one of the most promising and disruptive in the educational context. Its potential to analyze large volumes of data, identify patterns, and make automated or assisted decisions opens new possibilities for more effective, personalized, and equitable teaching and learning (Holmes et al., 2019).

Moreover, project-based pedagogical approaches have demonstrated proven effectiveness in the development of complex skills, with AI serving as a catalytic agent that enhances these practices by providing personalized and adaptive resources capable of meeting students' individual needs, promoting more meaningful and contextualized learning (Lourenço & Paiva, 2024).

In recent years, AI has been progressively integrated into educational systems on multiple fronts, including adaptive learning platforms, virtual assistants, intelligent tutoring systems, predictive analytics of student performance, and support for school management (Chen et al., 2020). This trend, also driven by advances in machine learning and natural language processing, is redefining how teachers teach, students learn, and educational institutions design their curricula.

However, the mere introduction of AI technologies into the school environment does not guarantee an automatic improvement in teaching and learning processes. On the contrary, without intentional, critical, and well-structured curriculum design, there is a risk of reinforcing inequalities, algorithmic biases, and outdated pedagogical practices (Williamson & Eynon, 2020). In this sense, it becomes urgent to rethink curricula in light of the potential and challenges brought by generative AI (GenAI), giving rise to the concept of "smart curricula."

1.1. Smart Curricula: Definition and Purpose

In the context of this chapter, "smart curricula" are understood as educational structures that incorporate AI technologies in a critical, ethical manner, oriented toward the holistic development of students. They are characterized by being dynamic, adaptive, and student-centered, promoting personalized learning based on data, without compromising fundamental pedagogical principles, social justice, and the active role of teachers (Holmes et al., 2019; Luckin et al., 2016).

Although the term *smart curricula* do not yet have a single, consolidated definition in the literature, its conception aligns with contemporary pedagogical approaches that value personalization, responsible technological mediation, and educational intentionality. Authors emphasize the importance of critically integrating GenAI in education, highlighting the need to maintain a focus on human development and

equity (e.g., Selwyn, 2019; Williamson & Eynon, 2020). These curricula, therefore, are not limited to automating processes but propose an intentional redesign of teaching, in which GenAI acts as an ally to the teacher, expanding the possibilities for student-centered learning.

Unlike traditional approaches, smart curricula do not follow a linear or uniform logic for all students. On the contrary, they aim to offer personalized pathways that take into account individual pace, interests, difficulties, and learning styles. In this process, Holmes and Tuomi (2022) address the concept of AI-mediated personalized learning and discuss the teacher's role in this context. The authors emphasize that although GenAI can offer personalized learning paths, it should be used as a tool to enhance learning, not to replace the teacher or homogenize instruction.

The discussion focuses more on the application of GenAI in the educational system and the associated pedagogical implications.

Beyond personalization, smart curricula assume as a central goal the development of transformative skills, those necessary not only for the constantly evolving job market but also for critical citizenship in a digitized, uncertain, and interdependent world. This includes skills such as critical thinking, creativity, collaboration, digital literacy, complex problem-solving, and ethical awareness (OECD, 2018).

1.2. Generative AI as a Vector of Transformation in Education

GenAI can serve as a catalyst for curriculum renewal through three main avenues (Zawacki-Richter et al., 2019): improving pedagogical efficiency by automating repetitive tasks and providing real-time feedback; personalizing instruction by adjusting content and strategies to student needs; and supporting the development of 21st-century skills by facilitating collaborative, exploratory, and data-driven learning environments.

However, this transformation does not occur without challenges. Issues such as unequal access to technology, lack of teacher training, risks of educational surveillance, and biases in AI algorithms raise legitimate concerns that must be addressed with seriousness and responsibility (Dignum, 2019; Selwyn, 2019).

1.3. Chapter Objectives

Based on this framework, the main objectives of this chapter are:

1. To analyze the opportunities and challenges of integrating generative AI into educational curricula;
2. To explore mechanisms for personalized learning supported by GenAI, with practical examples and empirical evidence;

3. To identify and discuss essential transformative skills in the digital age and strategies to integrate them into the curriculum;
4. To reflect on the ethical, social, and institutional dilemmas of using GenAI in education;
5. To propose future directions for the research and practice of smart curricula, with a focus on inclusion, equity, and pedagogical innovation.

Throughout the following sections, the chapter seeks to offer a comprehensive and critical perspective on the role of GenAI in building more responsive, personalized, and transformative learning environments, respecting the principles of humanistic and future-oriented education.

2. THE GENERATIVE AI REVOLUTION IN EDUCATION: OPPORTUNITIES AND CHALLENGES

GenAI has established itself as one of the driving forces of educational innovation in the 21st century. By offering tools that enable automation, personalization, and predictive analysis, GenAI is reshaping teaching practices, learning methods, and even the principles that govern curriculum design. This section of the chapter explores current applications of GenAI in teaching and learning, reviews the most recent literature on the subject, and discusses the main technical, pedagogical, and cultural challenges associated with its implementation.

2.1 Current Applications of Generative AI in Teaching and Learning

The applications of AI in the educational context are broad and diverse, ranging from institutional management to the classroom. Among the most recurring uses are:

Adaptive Learning Systems

GenAI has been widely applied in adaptive learning systems (Holmes & Tuomi, 2022). The authors explore how Intelligent Tutoring Systems use GenAI to provide automated, adaptive, and individualized instruction, adjusting content and teaching methods based on student performance. They highlight that many of these systems are based on cognitive architectures, reflecting a view of learning centered on information processing and problem-solving. Examples such as Knewton and

DreamBox have been utilized to implement adaptive learning practices, adjusting content according to students' progress.

The use of adaptive learning systems is not limited to content personalization but also extends to data analysis to predict which students may face difficulties in the future. These tools enable the creation of more dynamic and responsive curricula that not only react to student performance but also anticipate their needs, creating a more predictive and preventive approach (Chen et al., 2024).

Information and Communication Technologies

Information and Communication Technologies play a fundamental role in ensuring that AI-based solutions are effective in education. The digital infrastructure, including online learning platforms, communication networks, and mobile devices, enables AI to be used to personalize learning, optimize student interaction, and analyze data in real time. The interactivity and connectivity provided by Information and Communication Technologies are essential for collecting data on student performance and adapting teaching approaches (Luckin, 2016). Without a solid technological foundation, the effectiveness of AI tools in education would be significantly limited. As discussed by Lourenço and Paiva (2024), the globalization of education requires the integration of digital skills to ensure that both teachers and students can take advantage of emerging and adaptive technologies.

These systems, when supported by a robust technological infrastructure, provide teachers with the ability to monitor student progress, offer real-time feedback, and personalize instruction according to each student's specific needs, creating more inclusive and efficient learning environments.

Intelligent Tutoring

The use of GenAI in personalized teaching is transforming education. These systems employ AI to interact with students individually, effectively simulating the role of a human tutor. The technology can answer questions, provide real-time feedback, and help reinforce concepts taught in the classroom (Gomes et al., 2024). For example, Google's Socratic allows students to receive immediate support in math and science questions, while platforms like Carnegie Learning offer real-time tutoring across various subjects.

These systems not only help students understand content more deeply but also provide teachers with valuable insights into areas where students may be facing difficulties. Therefore, they do not replace the teacher but complement them, offering a more focused and effective approach to learning (Reyes & Torres, 2024).

Predictive Analytics

Another significant advancement of AI in the education sector is predictive analytics. Using behavioral data, such as frequency of access to learning platforms or assessment results, predictive analytics tools are able to identify students at risk of dropping out or experiencing learning difficulties (Bo, 2024). This allows teachers to intervene early, taking corrective measures to improve academic performance and reduce dropout rates. Organizations like Knewton have worked with platforms that help predict student performance in real time and suggest the best approaches for intervention (OECD, 2023).

Virtual Assistants and Educational Chatbots

Virtual assistants and educational chatbots have gained popularity in recent years. These systems are based on generative language models, such as OpenAI's GPT-4, and are used to answer questions, support text writing, and even foster critical thinking in educational contexts. Vast databases power these systems and are capable of providing contextually accurate responses to a wide range of academic questions. A practical example is the use of chatbots in universities, such as Georgia State University, which implemented a virtual assistant to help with enrollment and clarify students' administrative questions (Allman et al., 2023).

Automated Feedback Tools

Automation is also present in feedback tools, which can efficiently assess and comment on students' work. Platforms such as Turnitin and Grammarly utilize GenAI to detect plagiarism, suggest improvements in texts, and provide immediate feedback on students' writing (Mayo et al., 2024). Additionally, systems like Gradescope help teachers grade and evaluate exams quickly and accurately, using GenAI to identify patterns in students' errors and suggest areas for improvement.

These tools provide constant feedback, allowing students to adjust their study approaches and continuously improve their academic performance, while also relieving teachers' workload, enabling them more availability for pedagogical mediation and for developing their students' social and emotional skills (Narváez et al., 2025).

Detection of Emotions and Engagement

The detection of emotions and engagement is also being explored in education using GenAI. The analysis of digital behavior, including facial recognition, allows educational systems to adjust teaching in real time to better respond to students'

emotional and cognitive needs. Tools like EmoReact have been used to assess students' emotional engagement on learning platforms, adjusting the pace of the lesson or offering pedagogical interventions as needed (Ravenor, 2023). These tools help create more empathetic and receptive learning environments, making teaching more inclusive.

ChatGPT

ChatGPT has been used in both formal and informal contexts for the co-creation of texts, problem-solving, and support for metacognitive reflection (Ruiz-Rojas et al., 2024). The ability to produce complete and coherent responses to a wide range of questions makes ChatGPT a powerful tool to support the development of writing skills, critical reasoning, and creative problem-solving. In this sequence, students can utilize ChatGPT to explore different perspectives on a topic, generate ideas for projects, and even learn to structure arguments logically and convincingly (Suh et al., 2025). Tools like ChatGPT have been increasingly integrated into the teaching and learning process since 2022, providing teachers with new ways to facilitate active learning and the development of critical thinking (Ali et al., 2025).

2.2 Literature Review

In recent years, scientific literature has shown growing interest in the intersection between GenAI and education. The systematic review by Zawacki-Richter et al. (2019) identified significant gaps in teacher involvement in the development and implementation processes of AI technologies. This critique remains valid, but new studies show important advances.

Luckin et al. (2024) advocate a human-centered approach in which AI complements, rather than replaces, teachers' intelligence and roles. AI should enhance human capacities such as empathy and critical thinking. The authors emphasize the importance of integrating technology ethically and consciously. The focus is on empowering educational relationships and personalizing learning. Meanwhile, UNESCO (2023) warns about the ethical risks and global inequalities associated with the adoption of GenAI, reinforcing the need for public policies that ensure access, teacher training, and ethical development of these technologies. Additionally, the OECD (2023) published updated frameworks for integrating digital and GenAI skills into school curricula, underlining the importance of aligning technological innovation with clear pedagogical goals.

The study by Li et al. (2023) analyzes the use of devices with integrated AI to monitor students' behavior in real time in face-to-face classrooms, allowing teaching to be adapted according to their emotional responses. Although it does not directly

address virtual or hybrid environments, the principles presented can be adapted to these contexts, provided that pedagogical mediation accompanies them. Behavioral analysis with GenAI can support collaborative practices by improving student interaction and engagement, contributing to more effective learning.

Another emerging theme in the literature is the relationship between AI and equity. Studies highlight the need to develop inclusive technological solutions that consider the cultural, socioeconomic, and cognitive diversity of students (Holmes et al., 2019; Selwyn, 2019; Williamson & Eynon, 2020). The authors warn that without a robust ethical approach, GenAI may perpetuate or exacerbate existing inequalities, such as reproducing biases through biased algorithms or excluding students with limited access to technology. They argue that the development and implementation of AI in education must be guided by solid ethical principles, ensuring inclusion and equity for all students.

The literature has also emphasized the role of GenAI in promoting metacognition and self-regulation of learning, as well as valuing data-driven pedagogical practices, provided they are critically interpreted. The study by D'Mello & Graesser (2023) explores how intelligent tutoring systems can support students in developing metacognitive skills, such as monitoring and regulating their learning, through adaptive interactions and real-time feedback.

The authors discuss how these systems, by incorporating natural dialogue models and data analysis techniques, can provide personalized support that encourages students to reflect on their thinking processes and adjust their learning strategies as needed. Furthermore, they emphasize the importance of critically interpreting data collected by these systems to ensure that pedagogical interventions are effective and ethically sound.

2.3 Technical, Pedagogical, and Cultural Challenges

Despite the enthusiasm, the integration of AI in education presents substantial challenges. They can be grouped into three main categories:

1. *Technical:* The first set of challenges concerns technical issues. Infrastructure limitations, including a lack of connectivity and inadequate equipment, remain a significant obstacle, particularly in developing countries. The quality of data used by GenAI systems is also a concern, as the effectiveness of the tools depends on the accuracy and diversity of the data collected. Additionally, interoperability between educational platforms and GenAI systems is a constant challenge. Often, platforms fail to share data efficiently, which limits teachers' ability to make data-based interventions in real-time (UNESCO, 2023).

2. *Pedagogical:* Pedagogical challenges are mainly related to inadequate teacher training, resistance to new methodologies, and the depersonalization of education. Many teachers still feel uncomfortable about adopting new technologies, especially when these tools are perceived as substitutes for traditional teaching methods. Furthermore, the lack of pedagogical training focused on the use of AI makes it challenging for teachers to effectively integrate these tools into their daily practices. Authors such as Williamson et al. (2023) advocate for strengthening teacher agency as a means to mitigate the risks associated with excessive automation in education. They argue that GenAI should be integrated in a way that complements and strengthens teachers' work without replacing their critical and human mediation. They criticize the growing dependence on automated solutions and the influence of large tech companies, which can reduce teacher autonomy and standardize pedagogical practices. They propose an ethical and critical approach to AI, aiming to strengthen the role of teachers and promote more personalized and inclusive teaching.
3. *Cultural and Ethical:* The cultural and ethical impact of GenAI in education is one of the most debated aspects in current literature. GenAI can perpetuate algorithmic biases, as shown by studies on the use of GenAI in admission and educational assessment systems, which often favor more privileged social groups and discriminate against marginalized groups. Facial recognition and surveillance in classrooms, for example, raise questions about student privacy and the act of observing or excessively controlling something in educational environments. Mohamed et al. (2020) warn of the risk of "digital colonialism," in which AI technologies developed from Eurocentric perspectives are indiscriminately applied in distinct cultural contexts, perpetuating inequalities and historical forms of domination. The authors advocate using a critical approach that challenges the legacies of colonialism, especially in forms of knowledge and power, as a tool for anticipating and critically analyzing sociotechnical futures, enabling the anticipation and mitigation of asymmetric impacts. They highlight, therefore, the importance of developing culturally sensitive, ethical, and politically aware GenAI systems, rejecting universal technological approaches that ignore local specificities.

Furthermore, the role of international guidelines in shaping educational policies related to AI is notable. A relevant example is the UNESCO report on AI and Education (2019), which presents recommendations for the design, development, and implementation of AI technologies in educational systems, emphasizing the inevitability of their presence in the sector. Although the document proposes a roadmap for the inclusive adoption of these technologies, it does not address the hidden costs of AI, which could be revealed by a critical approach to colonial legacies. From this

perspective, there is a need for deeper cultural and ethical reflection in the design and application of GenAI in education.

3. PERSONALIZATION OF LEARNING WITH AI

Personalization of learning has become one of the most central concepts in modern education, especially with the growing adoption of GenAI technologies. The use of these tools enables the development of adaptive curricula that can be shaped to the needs and learning pace of each student, resulting in a more effective and engaging educational experience. This chapter explores how GenAI enables personalization of learning, offers practical examples of implementation, and discusses the potentialities and limitations of this approach.

3.1 Personalization of Learning: The Role of AI

Personalization of learning, with the use of AI, allows educational processes to be adapted to the individual needs of students, optimizing their learning experiences. By analyzing student performance, GenAI can adjust the pace, content, and teaching methodologies, promoting a more student-centered approach (Santos & Franqueira, 2020). This has a positive impact on motivation, autonomy, and academic performance by demonstrating how adapting teaching favors learning more effectively (Campos et al., 2025).

Personalization also strengthens self-regulated learning, as it offers the student control over their learning process, allowing them to adjust their strategies as needed (Ferreira & Pedrosa, 2024). However, implementing this personalization requires accurate data and ethical care in the use of such information (Luckin et al., 2016). Furthermore, the role of the teacher remains essential, as technology should not replace human interaction but be used as a complementary tool in the teaching process (Williamson et al., 2023). Thus, personalization through GenAI offers great opportunities but also challenges that must be addressed with caution.

Intelligent tutoring systems are a classic example of how GenAI can personalize learning. These systems utilize AI algorithms to monitor student progress in real-time and provide adaptive feedback. According to Nascimento-Fragoso & Coutinho (2025), intelligent tutoring systems are designed to imitate the behavior of a human tutor, adjusting the difficulty level of questions and pedagogical approach based on student responses. The system analyzes student interactions, identifies areas of difficulty, and offers specific support to improve performance. Studies, such as those by VanLehn (2011), show that the use of these systems has produced positive results, with students demonstrating significant improvements in their learning.

The author discusses how intelligent tutoring systems can adapt question difficulty, adjust pedagogical approaches, and provide specific feedback based on student interactions. The author emphasizes that these systems are designed to diagnose student difficulties and provide personalized support, attempting to simulate the effectiveness of a human tutor in the teaching and learning process.

For example, the Cognitive Tutor Algebra I intelligent tutoring system, developed by Carnegie Learning, has been widely used for teaching mathematics. The platform adapts content according to student performance, providing specific materials and exercises for areas where students have more difficulty (Sales & Pane, 2021). The system's design assumes students follow a predefined order of material, moving from one section to the next only after mastering the skills of the previous section. However, the software offers teachers the flexibility to override this structure, allowing them to reassign students to different sections of the curriculum. These systems have proven effective in helping students overcome specific obstacles in the learning process and progress at their own pace, resulting in improved educational outcomes.

3.2 Adaptive and Student-Centered Curricula

With the incorporation of GenAI, school curricula can be continuously adjusted to the individual needs of students. Instead of adopting a uniform curricular model, GenAI allows dynamic adaptation of content and pedagogical methodologies as the profile and progress of students evolve. AI-based adaptive learning platforms represent a clear example of this transformative potential, promoting personalized learning pathways with a direct impact on student engagement and academic performance. Solutions like Carnegie Learning, DreamBox Learning, Smart Sparrow, and Knewton demonstrate how these technologies can shape curricula based on each student's preferences, pace, and difficulties, optimizing the educational experience (Dutta et al., 2024).

The Carnegie Learning Cognitive Tutor programs stand out for offering personalized learning adapted to the pace and needs of each student. Through the integration of educational technology, applied curriculum, and principles of cognitive science, these programs promote a more effective and student-centered teaching experience. According to Giraffa and Kohls-Santos (2023), one of the main differentiators is the use of intelligent software that continuously assesses the student's knowledge level and adjusts, in real time, the proposed content and exercises, ensuring an individualized learning path. The theoretical robustness and proven results in school environments position the Cognitive Tutor programs as an innovative and effective educational solution with great potential to improve academic performance and student autonomy.

DreamBox Learning, for example, offers a math teaching platform that adapts not only to the student's skill level but also to their learning style. The system continuously analyzes student responses and dynamically adjusts the learning pace. According to Dutta et al. (2024), students who used DreamBox Learning showed significant performance gains compared to those using traditional teaching methods.

Smart Sparrow is an adaptive learning platform designed to create personalized and interactive educational experiences centered on the student. This platform allows teachers to create dynamic digital content that adjusts to each student's performance (Sikora et al., 2021). Through intuitive authoring tools, teachers can develop personalized learning paths, offering immediate feedback and adapting content according to individual student responses and needs. One of its distinctive features is the ability to provide detailed analytical data on student progress and behavior, enabling more effective pedagogical interventions.

Knewton, in turn, is an adaptive learning platform that uses student interaction data to adjust content in real time, aiming to maximize learning effectiveness (Navarro, 2024). When a student encounters difficulties with a specific concept, the system adjusts the content, providing support material to reinforce that concept before moving on to new concepts. This is possible because the system collects and analyzes a large amount of data on student performance, which allows curriculum personalization.

These examples are just a few of many that demonstrate how GenAI can be used to create a learning experience that is not only more personalized but also more efficient, as it allows each student to learn at their own pace without the pressure of keeping up with peers who progress at different rates.

3.3 Practical Cases and Empirical Evidence

Several empirical studies have investigated the impact of AI systems on the personalization of learning. The study by García et al. (2023) examines the application of artificial intelligence algorithms in virtual learning environments, aiming to adapt teaching to the needs of students in Digital Systems courses. The research proposes a hybrid learning model (b-learning) that integrates face-to-face classes and online activities, utilizing virtual, in-person, and remote laboratories equipped with reconfigurable technology, such as Field-Programmable Gate Arrays. Based on connectivism theory, the model applies AI algorithms to personalize learning, adjusting content and practices according to student performance data, aiming to optimize academic outcomes. Furthermore, the research suggests the use of libraries for developing data science and machine learning algorithms, emphasizing the

personalization of the educational experience to improve teaching effectiveness and respond to individual student needs.

Another empirical example comes from Luckin et al. (2016), which explores how AI-based intelligent tutoring systems can offer personalized learning experiences. These systems simulate individualized tutoring, adapting to students' cognitive needs and providing targeted and timely feedback without the need for a teacher to be present. Additionally, the study emphasizes that AI can enhance student engagement by allowing them to feel more involved in the learning process. The use of open learning models can also motivate students by enabling them to track their progress and reflect on their learning.

López's (2022) research analyzes how AI and computer vision techniques can be applied to the educational context to monitor, in real time, indicators such as facial expressions, body posture, and student attention levels. Based on this data, systems are capable of dynamically adapting content and pedagogical strategies, promoting a more student-centered experience. The author further highlights that this type of technology can be particularly useful in hybrid or remote environments, where direct teacher monitoring is more limited, reinforcing GenAI's capacity to offer personalized and responsive support tailored to each student's learning profile.

3.4 The Potential of Personalization: Advantages for Students and Teachers

The use of AI in learning personalization presents a series of advantages for both students and teachers. For students, personalization allows a learning experience more centered on their needs, helping them learn more effectively and with less frustration (Nascimento-Fragoso & Coutinho, 2025). The ability to learn at one's own pace can be especially beneficial for students with learning difficulties, as it allows them to receive the necessary support without the pressure of keeping up with their peers.

The Bo (2024) study, inspired by the OECD report (2023), examines how AI-based technologies can be integrated into digital educational ecosystems, placing special emphasis on learning personalization.

The research highlights the potential of AI as an ally to teachers, offering advanced tools to monitor student progress and early identify those who need additional support. Among these tools, educational information management systems and digital assessment platforms stand out, as they utilize predictive analysis algorithms to anticipate risk situations, such as learning difficulties or school dropout. By enabling more effective and targeted pedagogical interventions, these technologies contribute to a more personalized and proactive approach in teaching. The study also emphasizes the importance of establishing guidelines and safeguards that ensure

the ethical and equitable use of AI in education, promoting trust and transparency among all involved in the educational process.

3.5 Limitations and Challenges of Learning Personalization with AI

Despite the great potential of GenAI to personalize learning and improve educational outcomes, the UNESCO report (2023) warns of significant challenges, especially regarding unequal access to digital technologies. In many regions, particularly in developing countries, the lack of adequate technological infrastructure hinders the effective implementation of these solutions, widening the digital divide between students from more privileged backgrounds and those in vulnerable situations. The report reveals that only 40% of primary schools have internet access, and less than 10% of institutions have internal policies on AI use, highlighting the urgent need for investments in connectivity, infrastructure, and training to ensure equitable and sustainable adoption of GenAI in education.

Another challenge is the issue of privacy and ethics in data usage. The study by Williamson and Eynon (2020) critically examines the ethical and political challenges associated with the use of AI in education, including concerns over student data privacy. The authors warn about the growth of an increasingly data-driven educational ecosystem, in which algorithms are used to monitor, predict, and even shape student behavior. In this context, the massive collection of personal data raises serious concerns regarding transparency, consent, and information security. Williamson and Eynon (2020) argue that without robust governance and clear ethical principles, the use of AI can reinforce opaque surveillance and control practices, compromising the autonomy of teachers and students. Furthermore, they emphasize the need for public policies regulating the use of educational technologies based on GenAI, ensuring respect for fundamental rights in the school environment.

In this sense, Williamson et al. (2023) adopt a critical perspective on the use of GenAI in education, drawing attention to the risks associated with excessive automation, especially concerning the depersonalization of teaching and the reduction of meaningful human interactions. The authors argue that by prioritizing data- and algorithm-based solutions, there is a risk of neglecting fundamental aspects of the educational process, such as empathy, pedagogical supervision, and the bond between teachers and students. They also warn about the trend of commercialization in education, where technological platforms seek to replace or standardize educational practices based on logics of algorithmic efficiency. This can compromise the richness of learning experiences and deepen inequalities by imposing automated models that ignore students' cultural, social, and emotional contexts. The study reinforces that

GenAI should complement, not replace, the teacher's role, preserving the human and relational nature of teaching.

In summary, the discussion across the previous points highlights that AI-mediated learning personalization represents one of the most promising advances in the transformation of contemporary education. The ability these technologies offer to adapt curricula, content, and pedagogical strategies to the individual needs of students can result in more effective, engaging, and student-centered learning experiences (Holmes et al., 2019). According to Chen et al. (2020), AI systems applied to education have proven effective in personalized adaptation, providing real-time educational interventions that respect each student's learning pace and style. However, this innovative potential is not without significant challenges. Issues such as equity in access to technology, data privacy, and risks of depersonalizing education need to be carefully addressed. UNESCO (2023) warns of the growing digital inequality, highlighting that the implementation of AI may exacerbate disparities between students with and without access to adequate technological infrastructure. At the same time, Dignum (2019) emphasizes the importance of developing and applying AI systems responsibly, particularly in terms of algorithmic transparency and the protection of students' personal data.

Furthermore, there is a legitimate concern that the indiscriminate adoption of GenAI could lead to the undue replacement of the teacher's role by automated systems. In this sense, Giraffa and Kohls-Santos (2023) emphasize the importance of teacher mediation in the pedagogical application of AI, warning of the risks of excessive automation that compromise the essential human bond in the educational process. This concern is shared by Holmes et al. (2019), who emphasize that, although AI can support learning personalization, it should not replace teachers' pedagogical judgment but rather complement and expand their role.

The risk of depersonalizing teaching and the ethical use of technology are also emphasized by Williamson et al. (2023), who discuss the political, economic, and social impacts of GenAI in education. They highlight the dangers of excessive commercialization and algorithmic discrimination, evidencing the need for educational measures that ensure the fair and equitable use of these tools. Nascimento-Fragoso and Coutinho (2025), in turn, specifically analyze learning personalization with GenAI, highlighting both its potential and the technical, ethical, and pedagogical challenges involved in its implementation.

Given this scenario, it becomes evident that the success of AI-based learning personalization depends not only on technological advancement but also on commitment to ethics, equity, and active teacher supervision. As the analyzed authors suggest, these technologies must be implemented responsibly, always aiming to meet students' needs and to strengthen, not weaken, the human dimension of education.

4. TRANSFORMATIVE SKILLS AND CURRICULUM DESIGN

The emergence of AI as a structuring force in social, economic, and cultural dynamics in the 21st century demands a profound revision of the purposes of education. The growing presence of GenAI in productive processes, social interactions, and political decision-making mechanisms reconfigures the concept of competence, expanding it beyond technical and cognitive skills. Transformative skills, such as critical thinking, collaboration, creativity, empathy, and digital literacy, become essential for preparing students not only for the world of work but also for life in an increasingly complex and hyper-connected society. In this context, curriculum design must be rethought based on a broad, critical, and technology-sensitive formative perspective.

4.1 Essential Skills in the Generative AI Era

Critical Thinking and Algorithmic Ethics

The complexity of digital societies requires critical thinking to transcend logical analysis and involve an ethical and political dimension. It is not enough to identify fallacies or inconsistencies: it is necessary to understand how algorithmic systems shape reality, reproduce inequalities, and operate with biases (Eubanks, 2018).

According to Christen et al. (2020), information ethics and algorithmic ethics must be integrated into contemporary education as fundamental elements. For the authors, it is essential to prepare students to question automated decisions, understand the limits of GenAI, and act responsibly in technology-mediated environments. When addressing the moral dilemmas associated with automation and algorithmic decision-making, they highlight the need to develop, also in the school context, a critical awareness of the social impacts of these technologies. The construction of a technologically ethically oriented society, according to the authors, requires continuous and interdisciplinary training. Such a perspective underscores the importance of incorporating topics like algorithmic justice and digital ethics into school curricula, thereby fostering education that promotes critical and transformative citizenship.

Critical thinking, therefore, is not a neutral skill: it is deeply related to the construction of an active and vigilant digital citizenship. Students need to develop skills to identify informational manipulation, disinformation, and political uses of AI (Selwyn, 2019). This type of critical thinking is a practice of freedom, as it enables a critical reading of the world and engagement to transform it.

Collaboration, Empathy, and Emotional Intelligence

Although automation is transforming the labor market, human skills such as collaboration, empathy, and emotional intelligence remain irreplaceable. Schleicher (2018) highlights that, in the future of work, socioemotional skills such as collaboration, empathy, and emotional intelligence will be the most valued. In AI-mediated educational contexts, these skills become increasingly important because students must interact with peers, teachers, and virtual assistants, necessitating the development of communication, negotiation, leadership, and cooperation skills in hybrid environments.

The author argues that as automation replaces traditional cognitive skills like memorization and mechanical problem-solving, human skills become irreplaceable. Thus, education should emphasize the development of these socioemotional skills, preparing students for an unpredictable and interconnected future. He further stresses the need to rethink school curricula, incorporating these skills as central components of student training, creating environments that promote collaboration, empathy, and emotional intelligence, and preparing students to interact effectively with new technologies.

Lourenço et al. (2024) highlight the relevance of emotional intelligence in the organizational context, analyzing its impact on the culture and climate of Higher Education institutions. The authors consider emotional intelligence essential for promoting healthy interpersonal relationships and collaborative environments, which are fundamental aspects in the development of socioemotional skills, including those in technology-mediated educational contexts. The study suggests that this competency can be stimulated through pedagogical practices such as simulations and social interactions, making it particularly relevant when associated with technological tools like immersive environments, serious games, and emotional feedback platforms. Thus, it is argued that emotional intelligence can be cultivated in the educational context with the support of innovative digital resources.

Creativity, Problem Solving, and Computational Thinking

Creativity, often seen as an artistic skill, is increasingly valued as a transversal competency across all fields of knowledge. In times of AI, creativity means thinking outside the box, producing innovative solutions, exploring new languages, and combining interdisciplinary knowledge. Trevallion and Nischang (2021) argue that traditional school models inhibit creativity by punishing mistakes and valuing only correct answers. They advocate, in contrast, for a curriculum centered on transformative skills that promote experimentation and recognize error as part of the creative process. They emphasize creativity as an essential transversal competency in the

21st century and propose innovative pedagogical practices, such as project-based learning and interdisciplinary approaches, to prepare students for the challenges of a world marked by innovation and technology.

Problem solving, especially in digital environments, is closely linked to computational thinking, which involves understanding structured logic, breaking down complex problems, and modeling solutions. In this context, AI can play an important role, as argued by Luckin et al. (2016), by personalizing learning and promoting skills such as problem solving and critical thinking. AI enables content adaptation and real-time feedback, stimulating the development of these skills.

The application of explainable AI is particularly relevant, as it makes AI systems more transparent and understandable to users. In educational settings, explainable AI can strengthen the trust of students and teachers by clearly explaining how decisions are made by the systems. This aligns with Holzinger's (2021) discussion regarding the importance of explainable AI, which not only improves interaction but also enhances learning and the critical use of technologies.

Data and AI Digital Literacy

In an increasingly data-driven world, digital literacy must be understood broadly, including skills such as the critical and creative use of digital tools, understanding the influence of algorithms on information access, critical reading of data, and a basic understanding of how AI works (Long & Magerko, 2020).

The authors define AI literacy as the ability to critically evaluate these technologies, interact with them effectively, and utilize them in various contexts, ranging from virtual environments to everyday situations. They also emphasize that this literacy is interconnected with digital and data literacy, with the former being a prerequisite to understanding AI, and the latter especially relevant in areas like machine learning, where there is an overlap of skills.

When discussing AI literacy, Luckin et al. (2016) propose that educators and students develop a functional and ethical understanding of GenAI, including its potentials and limits. This is essential to ensure the digital agency of individuals, that is, their ability to act autonomously and critically in technological contexts.

4.2 Challenges and Possibilities in the Curricular Integration of these Skills

The curricular integration of transformative skills faces considerable challenges, ranging from structural to epistemological issues. Below are some of them, along with their potential solutions for overcoming.

Curricular rigidity and traditional assessment culture

Many school curricula are still organized into isolated subjects, focusing on compartmentalized content and standardized assessments. This structure hinders the transversal and interdisciplinary approach required by complex skills. Additionally, the emphasis on measurable results and school rankings can hinder pedagogical practices focused on the socio-emotional and critical development of students. (Wiliam et al., 2024).

To break this paradigm, it is necessary to adopt a competency-based integrated curriculum approach. In this perspective, content does not disappear but is mobilized as a means to solve significant problems linked to real contexts and mediated by digital technologies. As discussed by Third et al. (2025), these technologies play a fundamental role in promoting critical and digital skills in authentic contexts. This highlights the importance of digital education and the conscious use of technology in developing essential skills for contemporary life, such as digital citizenship, critical thinking, and problem-solving in digital environments.

Role of AI as pedagogical support

AI can be a powerful ally in building personalized learning pathways that respect each student's pace and learning styles. Holmes et al. (2019) highlight that the use of GenAI-based technologies in the educational context, such as intelligent tutors, writing assistants, sentiment analysis systems, and adaptive feedback mechanisms, has great potential to enrich teaching and learning processes. Such tools allow the personalization of learning trajectories, respecting each student's pace and learning styles by providing real-time feedback and adaptive support.

According to Sajja et al. (2023), intelligent tutors, for example, monitor the individual student's progress and adjust content based on their performance. Writing assistants contribute to the development of written expression by offering contextually relevant suggestions. Sentiment analysis enables the inference of a student's emotional state from their interactions with the platform, allowing for more sensitive pedagogical responses. Meanwhile, adaptive feedback dynamically adjusts to the needs manifested throughout the learning experience.

However, the use of these technologies must be subordinated to clearly defined pedagogical purposes and grounded in ethical principles, such as ensuring privacy, promoting equity, and ensuring algorithmic transparency. Even in the face of GenAI's growing presence in education, the central role of the teacher and respect for students' differences must remain essential foundations of the educational process.

Some authors warn that uncritical use of AI can reduce education to technical training, deepen inequalities, introduce algorithmic biases, and weaken the relational

and humanizing dimension of teaching (Selwyn, 2019; Williamson et al., 2023). Thus, they emphasize the need for an interdisciplinary approach involving social sciences, philosophy, and critical theory to evaluate its implications. They further argue that curriculum design should go beyond the use of AI as a pedagogical tool, promoting its critical analysis as an object of study, in line with ethical values and well-defined educational objectives.

Continuous and critical teacher training

The teacher is a central agent in mediating between curriculum, technologies, and students. Without critical training, the AI use tends to be instrumental, superficial, or even harmful. Therefore, teacher preparation must go beyond technical mastery, incorporating pedagogical, epistemological, and ethical foundations. Zawacki-Richter et al. (2019) highlight the scarcity of critical reflections and the weak connection with pedagogical perspectives in AI studies, warning that this gap compromises the relational dimension of teaching. Thus, they advocate for the critical and ethical integration of GenAI into the curriculum, reinforcing the need for broader teacher training.

Similarly, Giraffa et al. (2023) and UNESCO (2019) emphasize the importance of an interdisciplinary approach to empower teachers to understand the ethical and educational implications of GenAI, ensuring its meaningful use aligned with educational objectives.

Furthermore, it is essential to foster communities of practice among teachers to share experiences, collaboratively develop projects, and jointly design innovative curricula. Continuing education programs focused on digital and pedagogical skills are indispensable for the successful integration of GenAI in school environments.

4.3 Pedagogical Strategies for the Skill Curriculum Supported by AI

Next, a set of pedagogical strategies is proposed to guide the effective integration of transformative skills with the use of AI, assisting in learning personalization, critical thinking development, promotion of collaboration, and ethical training of students, aligning with contemporary educational goals.

Project-Based Learning

Project-Based Learning is configured as an effective pedagogical approach for the development of multidimensional skills, as it promotes the investigation of real problems, stimulates the proposal of creative solutions, and favors collaborative

work among students. The integration of GenAI in this context enhances these processes by offering advanced tools for research, data analysis, scenario simulation, and creativity support. For example, generative models like ChatGPT can be used to explore different writing styles, conduct discourse analysis, simulate historical dialogues, or create digital prototypes, expanding the possibilities for student engagement and deepening (Holmes et al.,2019). Furthermore, project-centered pedagogical approaches show proven effectiveness in developing complex skills, with AI acting as a catalyst that enhances these practices by offering personalized and adaptive resources capable of meeting individual student needs, promoting more meaningful and contextualized learning. The incorporation of AI in Project-Based Learning also contributes to the development of critical digital skills, considered essential in the contemporary educational context. Thus, Project-Based Learning stands as a robust methodology for competency development, while AI represents a valuable tool to enrich these educational processes. However, studies address AI from a broader perspective, highlighting its transformative potential in teaching and learning in general, encompassing strategies such as Project-Based Learning (Dutta et al., 2024; Ruiz-Rojas et al., 2024). In this sense, Gomes et al. (2024) emphasize that Project-Based Learning favors the integration of cognitive, social, and ethical skills, aligning with the principles of transformative education.

Data and Digital Ethics Labs

Another relevant strategy is the creation of pedagogical labs focused on data and digital ethics. These spaces can be interdisciplinary and involve activities such as analysis of recommendation algorithms, construction of simple GenAI systems (using tools like Scratch or Teachable Machine), and discussion of cases about algorithmic decisions in areas such as justice, health, and security (Long & Magerko, 2020; Nemorin, 2024; Williamson et al., 2023).

These labs help develop data literacy, computational thinking, and civic responsibility. These skills should be cultivated from early education to prepare students for an increasingly automated society.

Zhou (2025) proposes the creation of pedagogical labs that promote children's practical and critical interaction with data, algorithms, and ethical issues related to GenAI. These educational spaces are conceived as interdisciplinary environments where students participate in activities such as analysis of recommendation algorithms, construction of simple AI systems using accessible tools like Scratch and Teachable Machine, as well as discussions of real cases involving algorithmic decisions in social contexts, including justice, health, and security.

The central goal of these labs is to develop data literacy, computational thinking, and civic responsibility from the earliest school years, preparing students to

act consciously and critically in an increasingly automated society mediated by intelligent technologies.

Multimodal Assessment and Digital Portfolios

When guided by humanistic values, AI can become a strategic ally in building more just, participatory, and empowering educational practices. For this, its implementation must align not only with technical skills but also with the development of emotional intelligence, a fundamental basis for promoting school environments that are more humane, critical, and aware of their social role. The school of the future will not only be digital but also a space where empathy, collaboration, and ethics walk together with critical thinking and digital literacy. Thus, skills such as critical thinking, collaboration, digital literacy, ethics, and emotional intelligence cease to be merely instruments of adaptation and become fundamental tools of emancipation, capable of forming citizens prepared to understand, question, and transform the world they live in (Lourenço et al., 2024).

Andrade and Brookhart (2020) conceive classroom assessment, especially multimodal assessment, as a co-regulation process of learning, in which teachers and students share responsibility for goal-setting, use of formative rubrics, and metacognitive reflection on their progress. As Shepard (2000) suggests, assessing complex skills such as critical thinking and self-regulation requires strategies beyond traditional tests, including portfolios and self-assessments. Digital portfolios, which aggregate multiple forms of learning evidence, become powerful tools when combined with AI, which can analyze and offer personalized feedback. Additionally, authors like Luckin et al. (2016) and Holmes et al. (2019) highlight AI's potential to support these practices by organizing evidence, analyzing patterns, and offering personalized recommendations, always subordinate to the teacher's pedagogical judgment. Thus, AI acts as diagnostic support, expanding formative feedback and strengthening student engagement in the assessment process. By providing real-time data on performance, it contributes to more effective pedagogical decisions, promoting personalized and reflective learning, in line with the principles of co-regulation.

The construction of a curriculum oriented by transformative skills with the support of GenAI should be seen not only as a technical initiative but as a political and pedagogical decision deeply linked to promoting critical, ethical, and inclusive education. The use of GenAI in this context demands a commitment to the holistic education of students, making it essential that its application be guided by humanistic and democratic principles, ensuring that technology strengthens equity and social justice in the school environment (Dignum, 2019; Williamson et al., 2023).

5. ETHICS, INCLUSION, AND THE ROLE OF TEACHERS

The increasing incorporation of GenAI technologies in education necessitates a thorough examination of their ethical, social, and institutional implications. Although AI represents enormous potential for personalizing learning, educational management, and supporting skills development, its use also raises concerns about equity, privacy, teacher autonomy, and social justice. This topic discusses three fundamental dimensions of this process: the ethical and social implications of GenAI in education, ensuring equity and access, and teacher training and the institutional changes necessary for responsible integration of GenAI.

5.1. Ethical and Social Implications of Generative AI in Education

Ethics in the use of GenAI in education goes beyond technical issues. It involves understanding the consequences of algorithmic decisions on the lives of students, teachers, and institutions. The Williamson et al. (2023) study indicates that, algorithmic systems in education are not merely technical tools but sociotechnical products that incorporate normative values and reproduce dominant conceptions of learning and performance. Ignoring these aspects can lead to subtle forms of discrimination, exclusion, and loss of pedagogical autonomy.

As Eubanks (2018) highlights, algorithmic systems used in social contexts often operate as surveillance and punishment mechanisms targeted at the most vulnerable populations and reinforcing stigmas and historical inequalities. Transposed to the educational field, these systems can manifest as recommendations or automated feedback forms that limit learning trajectories based on past data. Selwyn (2019) reinforces this concern by emphasizing that the adoption of intelligent technologies in education often operates opaquely and technocratic, legitimizing pedagogical decisions based on logics of efficiency and performance, to the detriment of social justice principles.

A central aspect of the ethical debate on AI in education is the need for transparency and interpretability of systems. Explainable AI aims to address this challenge by making algorithmic processes more transparent and understandable to teachers and students. As Holzinger (2021) and Christen et al. (2020) state, the lack of explainability compromises institutional accountability and hinders transparency in pedagogical decisions. Explainable AI contributes to strengthening trust and facilitating scrutiny by justifying recommendations and predictions in a manner accessible to users.

Educational AI ethics also involve considerations of power and coloniality, raising questions about the dominance of Eurocentric perspectives and values in algorithmic

models. Building fairer systems requires questioning this hegemony and including multiple voices, cultural contexts, and forms of knowledge, especially those from historically marginalized regions (Mohamed et al., 2020; Nemorin, 2024). Decolonizing AI thus means recognizing and integrating diverse epistemologies in the design and application of these technologies.

5.2. Guarantee of Equity and Access

One of the greatest risks of widespread AI adoption in education is the deepening of existing structural inequalities. Unequal access to devices, connectivity, and digital literacy can exclude certain groups from fully benefiting from AI-based solutions. UNESCO (2019; 2023) and OECD (2023) emphasize the importance of public policies and institutional strategies that ensure equity in access to and use of these technologies.

Equity, in this context, should be understood not only as the fair distribution of technological resources but also as the active inclusion of diverse student profiles in decision-making processes and solution building. As Third et al. (2025) argue, it is essential to recognize students' rights, especially younger ones, in the digital environment, ensuring their active participation, protection, and ability to make informed decisions, act autonomously, and influence processes that affect their online experience. Digital policies and practices must be grounded in evidence that reflects the experiences and perspectives of students themselves, thereby promoting their effective inclusion in decision-making and solution-building processes. In this sense, equity extends beyond the simple distribution of technological resources, encompassing the inclusion of diverse student profiles as active agents, rather than mere passive recipients, of educational technologies.

In this regard, GenAI can be both part of the problem and the solution. Studies such as those by Nascimento-Fragoso and Coutinho (2025) show that GenAI-mediated personalized teaching can benefit students with specific difficulties by promoting real-time adaptations. However, this personalization is only effective if based on representative data and inclusive mechanisms.

Inclusion also involves accessibility. AI technologies can support students with visual, auditory, or cognitive disabilities by offering multimodal interfaces and adaptive resources (Dutta et al., 2024; Suh et al., 2025). However, this requires user-centered design that considers diverse ways of interacting with learning systems.

Another fundamental aspect is data privacy. The intensive collection of information about students, their interactions, and outcomes raises concerns about the protection of personal data and the ethical use of such information. According to García et al. (2023), clear standards for consent, anonymization, and the purpose of educational data use must be established.

Finally, ensuring equity also involves empowering all educational stakeholders to understand and critique how AI works. So-called "AI literacy" (Long & Magerko, 2020; Zhou, 2025) should be a cross-cutting competency, not only for programmers but for everyone involved in education.

5.3. Teacher Training and Institutional Changes

The role of teachers is central in the ethical and inclusive mediation of AI in education. However, many teachers still feel disoriented or even threatened by these technologies, revealing a gap between technological advances and daily pedagogical practice. As noted by Zawacki-Richter et al. (2019) and Giraffa and Kohls-Santos (2023), a significant disconnect exists between technological developments and everyday teaching practices. This gap demands a profound reconfiguration of initial and ongoing teacher training. The integration of AI into training curricula must go beyond technical mastery. It is necessary to develop critical, ethical, and pedagogical skills so that teachers can use AI reflectively, adapted to their contexts and educational objectives.

Authors such as Holmes and Tuomi (2022) and Luckin et al. (2016; 2024) argue that AI can act as an ally of teachers, automating repetitive tasks and providing data for more precise diagnostics. However, this potential is only realized if teachers have the autonomy and knowledge to interpret and act upon this information.

Teacher training should include: understanding the fundamentals of AI and its algorithmic models; the ability to critically evaluate educational tools based on GenAI; knowledge about data protection, privacy, and digital ethics; skills to adapt pedagogical practices with AI support without dehumanizing teaching; and training to promote a culture of responsible innovation in schools and universities.

Furthermore, higher education institutions must promote structural changes to support this transformation. So, assessment and curriculum need to be rethought in light of the new possibilities and challenges of AI (Andrade & Brookhart, 2020; Sales & Pane, 2021). This includes redesigning assessment strategies focused on self-regulation of learning (Ferreira & Pedrosa, 2024) and valuing socio-emotional skills (Lourenço et al., 2024).

From an institutional standpoint, it is essential to promote collaborative experimental environments where teachers, students, technicians, and researchers can jointly develop AI-based solutions. As Williamson et al. (2023) emphasize, teacher involvement in the development and regulation of AI is a necessary condition for its ethical and effective adoption.

Ultimately, it is essential to develop and implement public policies and institutional guidelines that promote the responsible use of GenAI. Teacher training cannot be

dissociated from clear legal and regulatory frameworks that ensure ethical standards, effective control mechanisms, and the protection of the rights of all parties involved.

Thus, the integration of GenAI in teacher training is a transformative opportunity, but one that requires prudence, critical thinking, and ethical action. The risk of reproducing and amplifying inequalities, compromising rights, and emptying the role of teachers is real if measures are not implemented to guarantee equity, transparency, and critical training of teachers.

In this scenario, teachers cease to be mere users of technologies to become active agents in their ethical and pedagogical configuration. They must be empowered to play their role as mediators of knowledge, promoters of inclusion, and defenders of genuinely human-centered education.

6. CONCLUSION

The GenAI incorporation in education represents an emerging paradigm with transformative potential, but also with complex and multifaceted challenges. Throughout this chapter, it has been highlighted how GenAI can act both as a powerful tool to personalize teaching and promote inclusion, as well as a vector that can perpetuate inequalities and vulnerabilities if not implemented with an ethical and critical vision. A deep understanding of the technical, social, cultural, and ethical aspects is essential to ensure that smart curricula evolve toward a truly human-centered education.

Main insights from the chapter

First, it was shown that AI-mediated educational personalization has the potential to meet the specific needs of students with diverse difficulties, adapting content in real time and favoring more effective learning (Nascimento-Fragoso & Coutinho, 2025). However, this efficacy depends on the quality and representativeness of the data used, as well as the inclusion of mechanisms that guarantee equity and justice in access and outcomes. The active inclusion of multiple student profiles, especially those facing barriers, must be a priority, aligning with proposals for technological accessibility and digital equity (Dutta et al., 2024; Suh et al., 2025).

Another fundamental insight is the ethical dimension of GenAI serving education, which transcends technical issues to encompass debates about power, coloniality, and values implicit in algorithms (Mohamed et al., 2020; Nemorin, 2024). The hegemony of Eurocentric data and epistemologies can marginalize knowledge from the Global South, making the "decolonization" of GenAI models essential—that is, the inclusion of multiple voices and cultural contexts in the development of

these technologies. Ethics in digital education therefore requires a commitment to epistemological diversity and social justice.

Additionally, transparency and explainability of AI systems are central issues for institutional accountability and for building trust between teachers and students. The absence of clear explanations about algorithmic decision-making processes can generate opacity and technological dependence, harming pedagogical autonomy (Holzinger, 2021; Christen et al., 2020). In this sense, the development of Explainable AI emerges as a promising path to ensure that automated decisions are understandable and contestable, reinforcing transparency and ethics in educational environments.

Finally, the empowerment of educational agents—teachers, students, and technicians—is a crucial pillar for the ethical and effective use of GenAI in education. GenAI literacy, understood as a transversal competence, allows all involved to understand and critique the functioning of these technologies, promoting more active and conscious participation in educational processes (Long & Magerko, 2020; Zhou, 2025). The role of teachers, in particular, is crucial in mediating the impacts of AI; yet many still feel disoriented before rapid technological innovations, revealing a gap between technical development and daily pedagogical practice (Giraffa & Kohls-Santos, 2023; Zawacki-Richter et al., 2019).

Practical recommendations

Based on these insights, some practical recommendations can guide the responsible and inclusive implementation of smart curricula:

- Ensure representativeness and diversity in educational data and algorithms: it is fundamental to collect and use data that reflect the diversity of students, avoiding biases that may reinforce inequalities. Development teams should include specialists in cultural diversity and ethics to continuously review the models and data used.
- Develop and implement explainable AI systems: GenAI educational platforms should provide clear and accessible mechanisms that explain their decisions and recommendations to teachers and students. This strengthens transparency, trust, and the possibility of contestation, all of which are essential to democratic pedagogical practice.
- Promote AI literacy as a transversal competence: continuous training for teachers and students should include content addressing the functioning, limitations, and ethical impacts of GenAI. This empowers users to be critical and informed mediators, avoiding uncritical acceptance of automated results.
- Foster collaborative environments for the development of GenAI solutions in education: Educational institutions should encourage joint participation of

teachers, students, technicians, and researchers in the creation and evaluation of GenAI-based tools. This collaborative process ensures that solutions reflect real needs and shared values.

- Respect and protect students' digital rights, with special attention to children: clear policies should ensure privacy protection, informed consent, and students' agency in the use of educational technologies. Active participation of students in the design and implementation of systems should be prioritized to avoid their mere submission to technologies.

Critical and open vision for the evolution of smart curricula

When designing the future of smart curricula, it is essential to maintain a critical and open vision, recognizing that AI is a constantly evolving tool embedded in dynamic and challenging social contexts. Although technological advances offer unprecedented opportunities for personalization and democratization of learning, they also increase risks related to inequalities, excessive surveillance, and pedagogical alienation (Eubanks, 2018; Williamson et al., 2023).

Study's emphasize that smart curricula must avoid reproducing colonialist and exclusionary patterns, adopting a pluriversal perspective that values diverse epistemologies and the active participation of involved subjects (e.g., Mohamed et al. 2020; Third et al. 2025). This plurality necessitates curricular flexibility, allowing for multiple learning pathways and accommodating varied cultural contexts.

On the other hand, increasing dependence on automated systems can generate opacity and reduce the autonomy of teachers and students, as pointed out by Holzinger (2021) and Christen et al. (2020). Investment in explainable AI is a necessary response but insufficient without continuous ethical reflection and participatory management that includes all educational agents.

Moreover, technological and critical empowerment of educational agents is a challenge that requires ongoing investments and integrated public policies. The gap between technical innovation and daily teaching practice, observed by Giraffa & Kohls-Santos (2023) and Zawacki-Richter et al. (2019), shows the need to bring these two worlds closer so that technology truly enhances the educational process.

Therefore, the smart curricula of the future must be built based on human values, social justice, and transparency, incorporating diverse knowledge and promoting real inclusion. Technology, in this context, is a means, not an end in itself, for an education that respects the dignity, autonomy, and rights of all its participants.

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KEY TERMS AND DEFINITIONS

Algorithmic Ethics: field dedicated to the critical analysis of automated decisions made by algorithms, addressing issues such as transparency, fairness, inclusion, and the social and political impacts of these decisions in education.

Artificial Intelligence Literacy: The ability of students and teachers to understand, use, and critically assess AI-based systems, promoting ethical, informed, and conscious use of these technologies.

Competency-Based Curriculum: An educational model organized around the development of relevant and applicable skills, rather than solely on content, favoring meaningful and contextualized learning.

Digital Equity: A principle that ensures fair and inclusive access to digital technologies in education, guaranteeing that all students, regardless of background or condition, can benefit from AI-driven learning opportunities.

Generative Artificial Intelligence: A branch of artificial intelligence capable of creating new content: such as texts, images, or code, based on large volumes of data, and which can be used in education to personalize instruction and support skill development.

Intelligent Tutoring Systems: Educational technologies that simulate the actions of a human tutor, offering adaptive feedback and personalized support based on student performance.

Multimodal Assessment: An evaluation approach that uses multiple forms of learning evidence (such a digital portfolio, self-assessments, and automated feedback), promoting a more comprehensive and personalized view of student progress.

Personalized Learning: An educational process that adapts content, pace, and teaching methods to students' individual needs, supported by technology and the pedagogical mediation of the teacher.

Smart Curriculum: A curricular structure that integrates artificial intelligence technologies in a critical and ethical way, promoting personalized, adaptive, and student-centered learning, while respecting pedagogical principles and social justice.

Transformative Skills: A set of essential 21st-century abilities such as critical thinking, creativity, collaboration, digital literacy, and ethics that empower students to act consciously and responsibly in a complex, digitalized world.