Teaching and learning with Artificial Intelligence

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Abstract

Artificial Intelligence (AI) has significant potential to revolutionize teaching and learning methods by providing innovative tools that personalize teaching and make the learning process more efficient. In this way, it is possible to create dynamic scenarios more easily, promoting the evolution of teaching towards a model based on the development of skills, which requires students to perform more actively. Considering that, between 2023 and 2024, Gartner places Generative AI at the peak of inflated expectations in its Hype Cycle, it becomes pertinent to analyze how learning and teaching with AI during this period. In this context, this work aims to conduct a scoping review using the Scopus database, covering the aforementioned period. The data obtained will be subjected to a content analysis, with the purpose of investigating the added value of AI in the way learning and teaching are carried out.

Keywords: Artificial Intelligence; Learning; Teaching.

1 Introduction

Artificial Intelligence (AI) is seen as an "omnipurpose technology" (Lee, 2023) that is transforming several sectors of society, including education. This is possible because, as we can see in Figure 1, AI integrates a growing set of modeling capabilities (U.S. Department of Education, 2023), whose major subfields of AI in construction are: (a) machine learning; (b) knowledge-based systems; (c) computer vision; (d) robotics; (e) natural language processing; (f) automated planning and scheduling, and (g) optimization (O'Brien, 2017).

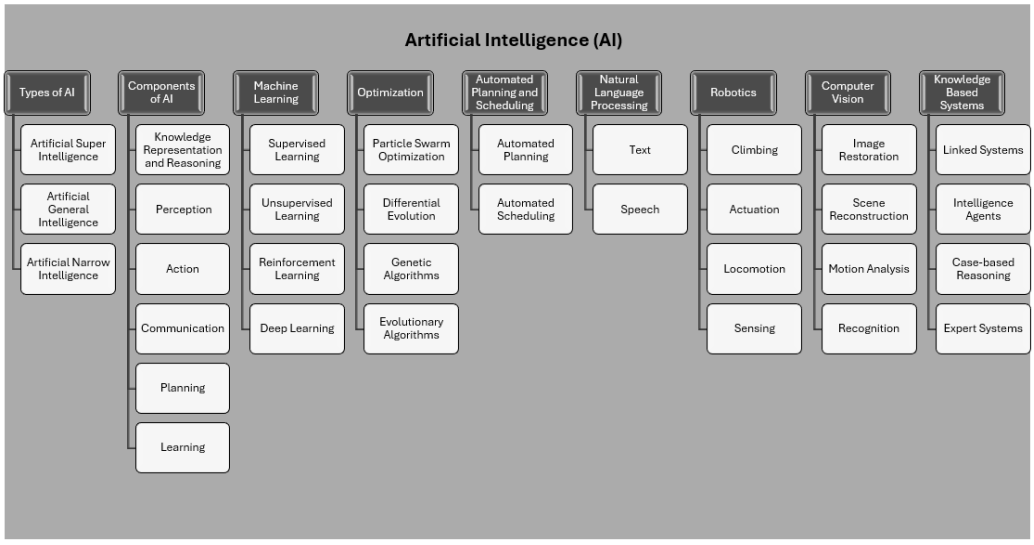

Figure 1 - Subfields and their components of AI based on Cardona et al (2023)

Thus, AI begins a revolution, unlike any other, because it is a tool with the capacity to create, sometimes without understanding how it reaches certain conclusions (some call it post-science), still with imperfections, in this initial phase, which can have negative impacts on teaching, as in all activities if, among other factors, there is a

cognitive transfer and not cooperation or critical reinforcement of our knowledge. However, the focus of this work is exclusively on knowing how to teach and how to learn with AI.

Thus, the potential of AI is systemic in education, for all levels of education, and encompasses scientific research, administrative and operational efficiency, AI teaching, teaching for a world with AI and teaching with AI, this being the central object of this study, since it is expected that, when integrated "into the educational system, it will significantly transform the learning environment and methodologies" (Summers, 2024).

Traditional teacher- and content-centered education faces profound challenges because, on the one hand, we have been facing the free globalization of knowledge sources for some years now and, on the other, in tha face of AI resources that change the role of the teacher and allow for more personalized, active and promising teaching in promoting problem-solving skills. All this in a scenario in which it is estimated that 65% of students entering school will have professions that do not yet exist today (World Economic Forum, 2025).

In this sense, as Summers (2024, p.149) states, this is an "immersive opportunity to improve educational outcomes and access", as its integration into education creates an opportunity for the use of innovative tools that allow greater ease in creating dynamic scenarios that promote the personalization of teaching and the transition to a more efficient educational model based on the development of skills, which requires students to play a more active role.

Its integration into education is of real importance, as the United States of America, in several recent documents, highlights the important role of AI in national development, emphasizing education as a central area for its application (Carter, Kinnucan, Elliot, Crumpler and Lloyd, 2018; National Science and Technology Council, 2019; Office of Science and Technology Policy, 2016). Furthermore, the United States of America also introduced funding mechanisms to help students, from primary to higher education, increase their knowledge of AI (Congress, 2020). Similarly, in the United Kingdom, the Office for Artificial Intelligence (2021) established a national AI strategy to design the integration of AI into a variety of educational scenarios. Given that the adoption of AI in teaching may still involve a large dispersion of tools or rely on its progressive integration into LMSs that already have advanced skills such as: structuring a subject, creating question banks, carrying out tests, assessment grids, but also including chatbots for Socratic dialogue and role play, providing feedback on work and open assessment questions, or managing groups of students involved in pedagogical case study processes.

Generative artificial intelligence (GenAI) refers to technology that uses machine learning techniques to generate new content, including text, images, and audio (Lim, 2023). The GenAI tools, launched in late 2022, have inspired rapid adoption among users worldwide (Lim et al., 2023), including teachers (Chiu, 2023). As GenAI continues to impact science jobs, it is essential to understand how AI can support the work of teachers and students. After all, with "rapid technological progress, the role of the teacher is not limited to imparting knowledge, but also to equipping students with the necessary skills" (Summers, 2024, p. 150).

Hope is reborn for better learning outcomes by solving Benjamin Bloom's 1984 The 2σ Learning Gap through AI-based active tutoring, in which the "student begins to experience new experiences and new challenges, which are capable of developing other skills, such as creativity and autonomy, far beyond those foreseen in content-based teaching" (Camargo in Debald, 2020, p.77). To help with active tutoring, there is a set of active learning methodologies available that can be seen as a continuum, varying according to the degree of student autonomy and the complexity involved in their application (Lima et al., 2024). Figure 2 presents the continuum

of methodologies developed by Lima et al. (2024) inspired by a lecture by Professor Michael Prince in 2011, at the American Society for Engineering Education conference.

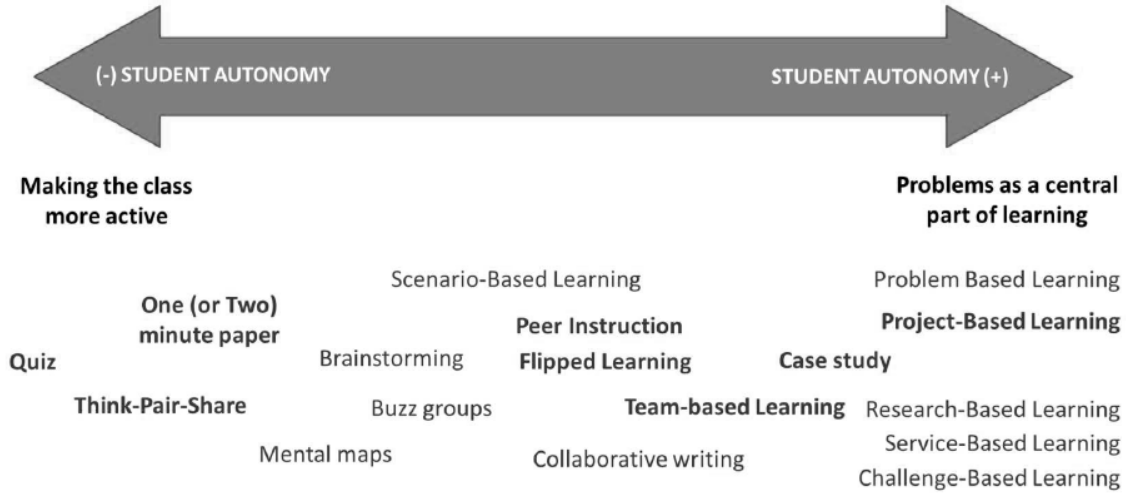

Figure 2 - Active Learning Continuum (Lima et al (2024) inspired by Prince (2011))

To take advantage of the use of Artificial Intelligence tools in the classroom, it is necessary that pedagogy, content and technology "coexist and influence each other" (Sampaio, 2013), a model called Technological Pedagogical Content Knowledge (TPACK), presented in figure 3.

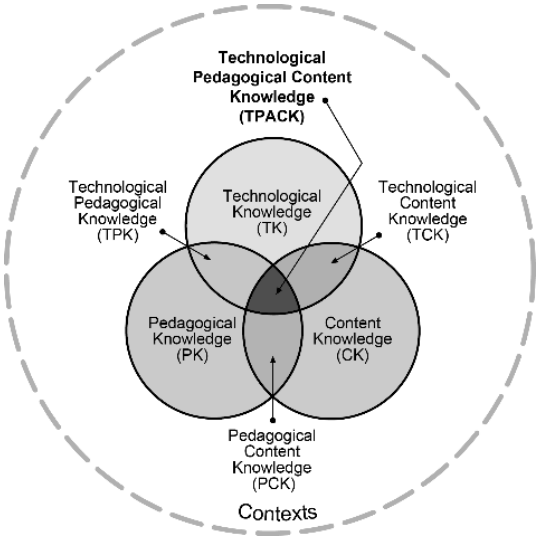

Figure 3 - Technological Pedagogical Content Knowledge (TPACK)

This model, according to (Cox, 2008), consists of "the appropriate use of technology, in a given curricular area, integrated into a specific pedagogical strategy, in a given educational context, to develop students' knowledge on a given topic or achieve a previously identified educational objective". In this way, the development of problem-solving skills in real and contextualized situations is encouraged, emphasizing active participation and shared responsibility for learning through group activities, debates and immediate feedback and reproducing and testing knowledge and skills through the creation of new scenarios or real life.

Like this, between 2023 and 2024, Gartner positions Generative AI at the peak of the inflated expectations of its Hype Cycle, resulting from the fact that "organizations across all industries have planned and implemented generative AI solutions at an unprecedented pace among emerging technologies" (Cribbs, 2024). Figure 4 illustrates the evolution of emerging technology trends and their impact on business strategies over time.

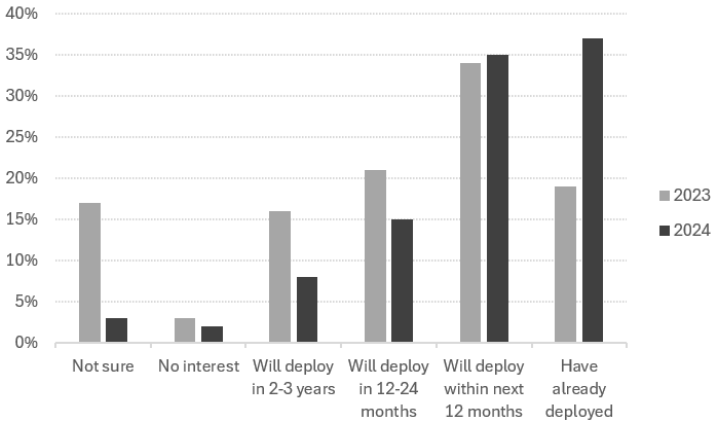

Figure 4 - Generative AI Solutions Are Deploying at an Unprecedented Pace based on Gartner by Cribbs (2024)

According to Gartner in Cribbs (2024), based on the content of the cases included in his survey, he presents a detailed analysis of emerging trends in technological education, highlighting "AI - content creation", "AI - content discovery", "AI - simulations" and "conversational AI". These are the result of the significant increase in the adoption of digital tools and online learning platforms, driven by the need for innovation and adaptation to new teaching methodologies, promoting more interactive and personalized learning.

Given this scenario, it is essential to analyze how AI is being integrated into teaching and learning processes during this period. In this sense, we intend to present a scoping review, using the Scopus database, to verify, through the works presented during this period, how AI is learned and taught, that is, how it is being integrated into teaching and learning processes, identifying the main trends and challenges associated with the implementation of AI in educational institutions, as well as the best practices to maximize the benefits of this technology.

2 Methodology

The research methodology describes the structure of a study by explaining the procedures, methods and techniques necessary for developing the research, with the aim of obtaining reliable knowledge and determining the veracity of the facts (Gil, 1989). In this sense, considering the type of data to be collected, it was identified that the most appropriate methodology for this study is qualitative, as these methods "emphasize the specificities of a phenomenon in terms of its origins and reason for being" (Haguette, 2005, p.63) and are "oriented towards the construction of comprehensive models of what is being studied" (González R., 2005).

Thus, this qualitative research was based on documentary analysis which, according to Quivy and Campenhoudt (2008), is especially appropriate when one intends to study social changes and historical development, as is the case of this work. The authors also add that this methodology has the benefit of taking advantage of the wealth of available documents, specifically in electronic databases.

This scoping review is structured based on the proposal by Kitchenham et al. (2009) and aims to analyze the use of AI to find out: how we learn with AI and how we teach with AI.

In this sense, this research began with the collection of scientific articles obtained from Scopus databases, between 2023 and 2024, the peak period of this technology, and using the search keywords "AI", "teaching", "learning", and "leadership".

As a result of the search, 47 articles appeared, but after applying the inclusion criteria and analysing the abstract, a sample of 21 articles were selected. The remaining articles were excluded because they did not meet the selection criteria.

3 Results

For each article in the sample collected, a content analysis was carried out, based on categories that answer the questions raised. Thus, Table 1 presents the categories and examples found through content analysis to answer the question: How do we learn with Artificial Intelligence?

Table 1 - Learning with Artificial Intelligence

Category	Examples
Assisted Environments	Useful tool for environments where learning resources are scarce. Valuable tool for filling gaps in learning opportunities. Facilitates the creation of digital content and promotes collaborative learning environments. Provides personalized assistance and explanations. Valuable resource for clarification on complex topics or assistance with assignments. Provides opportunities to enhance learning experiences through tutoring, immediate feedback, and access to extensive educational resources.
Productivity and Academic Performance	Plays a key role in transforming student productivity and increasing academic performance. Contributes to a significant improvement in student productivity and academic performance, laying the foundations for more effective and adaptable learning.
Efficiency and Collaboration	It can increase student efficiency by providing resources, improving language skills, and promoting collaboration. Increased collaboration among students, creating a more engaging learning environment. Support tool that can save time and effort.
Skills Development	Improves language skills. Increases learning efficiency. Increases motivation. Supports students' psychological needs for autonomy, competence and relationships, promising to improve self-determination, motivation and academic performance. Provides a personalized approach, improves understanding and engagement, and promotes a more conducive learning environment.
Content Creation	It helps students generate content based on their unique perspectives, assisting them with tasks such as editing or translation. It helps students design products and optimize business practices, offering potential benefits for economic development.
Interactive Support and Virtual Tutoring	They can provide multimedia learning resources, promoting active/self-regulated learning among students. They can provide personalized content and learning paths taking into account students' interest, aptitude and behavioral profile. They can support students' personalized learning, extending learning opportunities beyond classroom time and consolidating learning outcomes. Students can receive continuous interactive learning support at all times outside of regular class hours. It can act as a virtual tutor, answering students' questions and providing personalized learning experiences.

	It can provide personalized math tutoring to students, with improved learning outcomes through explanations tailored to students' misconceptions. It answers questions, summarizes information, facilitates collaboration, checks concepts, prepares for exams and provides feedback. It helps solve complex problems, develop reading and writing skills, create practice exercises and quizzes, and develop analytical and innovative thinking. It improves group dynamics by suggesting a discussion structure and providing real-time feedback. Identifies gaps in students' prior knowledge, indicating tools and learning materials to support student growth.

Table 2 presents the categories and examples found through content analysis of the sample of articles to answer the question: How do we teach with Artificial Intelligence?

Table 2 - Teaching with Artificial Intelligence

Category	Example
Collaborative and Personalized Learning	It helps in collaborative learning between teacher and student, intelligent tutoring systems, automated assessment and personalized learning. It can enhance active, collaborative and personalized learning experiences. It helps in generating materials and guiding students. It can meet individual support needs and contribute to personalized learning.
Integration in Education	Creating quiz questions and feedback on student writing. With the potential to reshape traditional tasks and assessments in education.
Automation and Efficiency	It empowers teachers to make data-driven decisions as they review and improve teaching and learning practices, which helps them predict student outcomes. It helps teachers understand the student learning process by identifying critical factors that can impact student learning outcomes. It helps them make informed decisions, provide responsive pedagogy, offer differentiated learning, and provide timely feedback.
Transformation and Innovation in Education	It marks a fundamental transformation in the way knowledge is acquired, disseminated and applied. Teachers analyze student learning data to gain a better understanding of their learning situation, enabling more personalized teaching guidance and scenario design.
Personalized Instructions and Adapted Testing	It fosters a supportive learning environment, helps implement innovative teaching practices, and ensures equity in education. It provides teachers with tools to increase efficiency and effectiveness in individualized learning. It alleviates teachers' administrative workload and supports personalized learning. It provides extra time that can be used for targeted feedback, personalized learning plans, and professional development activities. AI-powered grading also eliminates bias, ensuring fair and objective assessments of student work. It can free up teacher time by helping with repetitive and bureaucratic tasks. It frees up time for more human tasks, such as building relationships with students and collaborating with colleagues. It helps design resources and create tools that uniquely meet the needs of each student, and it is the basis for algorithmic scoring systems that provide feedback on students' writing, assignments, and exams and allow teachers to focus on more creative or relational efforts. It helps predict student performance and prompt organizational interventions to help prevent non-completion or course failure.

4 Discussion

The results obtained show that Artificial Intelligence (AI) in education is transforming both teaching and learning, providing new opportunities and approaches for students and teachers.

Thus, AI can fill gaps, provide essential educational support and facilitate the creation of digital content (Aanders, 2023). Furthermore, it promotes collaborative learning environments and adapts to individual

students' needs, offering personalized assistance and explanations (Shabbir, 2024). It also plays a key role in transforming student productivity and increasing academic performance, laying the foundation for more effective and adaptive learning (Shabbir, 2024).

In this way, AI can increase student efficiency by providing resources, improving language skills and promoting collaboration (Kasneci, 2023) and assist students by offering multimedia learning resources that promote active and self-regulated learning (Rahayu, 2022). Ultimately, it can act as a virtual tutor, answering students' questions and providing personalized learning experiences (Han, 2023).

In education, AI promotes a supportive learning environment, helping to implement innovative teaching practices and ensure equity in education (Luo, 2024) that facilitates collaborative learning between teacher and student, through intelligent tutoring systems, automated assessment and personalized learning (Shabbir et al., 2024). It has the potential to reshape traditional tasks and assessments in education, providing a more efficient approach tailored to the needs of students (Rice, 2023). Because it is data-driven, it helps teachers predict student outcomes and improve teaching and learning practices (Cheng & Wang, 2023), in order to prevent non-completion or failure of the course (Akgun & Greenhow, 2022).

Therefore, AI is redefining the educational landscape, providing teachers with tools to increase efficiency and effectiveness in individualized learning, alleviating the workload in administrative areas and supporting personalized learning (Fullan, 2023).

5 Conclusion

Artificial intelligence (AI) has the potential to transform teaching and learning methods by offering new opportunities to personalize and optimize the educational process.

Thus, it turns out that AI can be used to teach, because it allows teachers to personalize instruction according to the individual needs of students. AI tools can analyze student performance and provide immediate feedback, helping teachers identify areas that need more attention. In addition, AI can automate administrative tasks, allowing teachers to focus more on pedagogical development and direct interaction with students.

AI enables learning because students benefit from more adaptive and interactive learning. AI-based learning platforms can adjust content and pace based on individual students' progress and preferences. AI also facilitates access to diverse educational resources and immersive learning experiences, such as simulations and augmented reality, which make the learning process more engaging and effective.

In short, we can harness the power of AI to create enriching and inclusive learning experiences that prepare students for the challenges of the future. Its harmonious integration into the education system has the power to transform education, making it more accessible, personalized and effective.

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