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The daunting challenge of Artificial Intelligence in Education: a systematic literature review

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Abstract

This paper presents a Systematic Literature Review on the challenges that Artificial Intelligence (AI) poses in the field of education, specifically, on teaching and learning processes. Based on an exhaustive search in the Web of Science and Scopus databases, 1657 articles published between 2010 and 2024 were initially selected to be examined. The final sample consisted of 52 studies. To achieve this goal, the PRISMA 2020 protocol was employed. Identified challenges are grouped into several key categories. In pedagogical terms, the need to adapt teaching methods and curricula to leverage AI capabilities is highlighted, as well as the importance of maintaining a balance between AI-assisted teaching and human interaction. Additionally, training teachers to use these tools effectively is also considered as a significant obstacle to integrate the new ecology of learning. Finally, there are also ethical and social challenges that address concerns about the privacy of student data, equity in access to advanced technologies, and the potential of AI to perpetuate existing biases. Transparency in the operation of AI systems and the involvement of educational stakeholders are crucial to mitigating these risks. In conclusion, although AI has the potential to transform new ways of teaching and learning. These challenges encourage new paradigms where learning will be more flexible and closer to people's interests. Therefore, AI is not inherently good or bad; rather, it is the way we use it that will be the true key to promoting or not promoting changes in educational paradigms.

KEYWORDS: Artificial Intelligence; Teaching and Learning; Learning Ecology; Engagement; Systematic Literature Review.

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1. Introduction

There is no doubt that Artificial Intelligence (AI) and especially Generative artificial intelligence is going to change the way people teach and learn. Over the last few decades, we have witnessed changes in our daily practices where technology plays a more prominent social role. This trend is also evident in the educational context of teaching and learning. The concept of a learning ecology is considered as a set of technological contexts that evolve over time, providing new and compelling opportunities for learning (Kashiwa & Benson, 2018). The learning ecology involves a holistic approach to understanding the influence of technological processes on learning (Barron, 2006; Coll, 2013). An examination of learning ecologies associated with different subjects, such as the Holocaust, highlights the importance of social media and how educational interventions can be adapted to enhance effective strategies within these learning environments (Manca & Raffaghelli, 2023). Understanding learning ecologies involves recognizing the diverse contexts, both physical and virtual, that provide opportunities for learning (Danielsson et al., 2023).

From the ecological perspective, each learner constructs a unique learning pathway influenced by various factors such as goals, interests, and available resources within the STEM learning ecosystem (Shaby et al., 2021). In this sense, an approach to learning applied to clinical education provided a framework for better understanding the learning process and designing effective learning opportunities adapted to a real-world context (Brymer & Schweitzer, 2022). However, the application of AI in education represents a paradigm shift in the pre-existing learning ecology.

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AI technologies provide educators with tools to support active social learning, conduct interactive training courses in virtual environments, track student progress, and analyze data to determine effective teaching methods based on individual student needs (Hinojo-Lucena et al., 2019). Teaching AI in schools has been recognized as a strategic initiative to educate the next generation and prepare them for the evolving technological landscape (Chiu et al., 2022). Nothing will be the same. The nature and significance of knowledge will be profoundly restructured, resulting in a reevaluation of its role and relevance in contemporary society. Personalized learning, powered by AI, will be possible by adapting the learning experience to individual student needs, thus enhancing engagement and comprehension (Ahmad, 2024).

Furthermore, AI contributes to the development of educational content, tutoring methods, student evaluations, and improved teacher-student interactions. In the context of higher education, the integration of AI tools has rapidly increased, offering new opportunities for enhancing the learning process and supporting students in their academic journey (Demir & Güraksın, 2022; Crompton & Burke, 2023). AI technologies are also being leveraged to automate the mapping of course outcomes, to program learning objectives, and to streamline educational program evaluations (Zaki et al., 2023).

AI's impact on teaching and learning extends beyond traditional methods, with the potential to revolutionize education through the automation of tasks, the personalization of learning experiences, and the enhancement of decision-making processes. Specifically, "multimodal data can accurately classify tutors and have the potential to support the intuitive decision-making of expert tutors in the context of evaluating trainee applicants" (Cukurova et al., 2019, p. 3044). By utilizing AI in education, institutions can provide tailored support to students, improve learning outcomes, and foster critical thinking skills necessary for the digital age. AI also can assist in monitoring student progress, identifying learning challenges, and offering solutions to enhance the overall educational experience (Flores-Vivar & García Peñalvo, 2023, How & Hung, 2019).

The incorporation of AI in education is not only limited to theoretical aspects but also extends to practical applications such as interactive medical simulations, clinical documentation drafting, and literature reviews in the medical field (Scherr, 2023). AI technologies like ChatGPT are being utilized to enhance learning experiences, support clinical decision-making, and improve educational outcomes for medical students. It is also reshaping the field of radiology, attracting medical students to specialties that leverage AI for advanced medical inferences and diagnostic capabilities (Akiba & Fraboni, 2023; Harari, 2017; Liu et al., 2023; Ratten & Jones, 2023).

Considering the Copernicanesque turn to introduce AI in teaching and learning processes, the following article aims to carry out a Systematic Literature Review (SLR) of the research that has been carried out so far on this subject to gain a deeper understanding of the risks and benefits of using AI in education.

2. Method

The methodology employed to achieve the research goal was the SLR. This involved a documentary analysis strategy utilizing methods recommended by specialized literature (Gough, 2017; Petticrew, 2006; Kitchenham, 2004; Moher *et al*, 2009, Haddaway *et al*, 2022). The objective was to analyze the benefits and risks of AI for teaching and learning by exploring the research published to date. The study was conducted using the scientific databases Scopus and Web of Science (WoS) covering the period from January 1, 2010, to June 30, 2024.

2.1 Search strategy

The object of study focused on selecting research carried out in the educational context where the impact of AI on teaching-learning processes was investigated and where the main agents analyzed were educators and students. To conduct the SLR, the following research questions were addressed: 1) Which authors have carried out the most relevant research on the topic?; 2) What were the strengths and weaknesses of the use of AI for teachers and students?; 3) What are the main challenges of AI in terms of digital and curricular competencies?; 4) What are the most challenging points of AI according to research found so far?

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) 2020, the SLR applied the search strategy of the protocol (2020). This qualitative research technique is based on a search design for scientific articles using keywords defined by boolean operators. The strategies were defined by the search filters available in Scopus and WoS in the following fields: title (subject) + title-abs-key (subtopic) + subarea + tipdoc (ar) and the keywords combination implemented was: Artificial Intelligence (+education); Artificial Intelligence (+ competences); Artificial Intelligence (+ learning); Artificial Intelligence (+ skills); Artificial Intelligence + teaching); Artificial Intelligence (+ Learning design teacher); Artificial Intelligence (+ digital didactic skills).

2.2 Selection criteria

According to the PRISMA 2020 protocol, the selection of papers for conducting a SLR consists of three phases: Identification of articles in the databases, evaluation of eligibility, and finally, inclusion in the

final sample. The studies considered for review met the following selection criteria in the first stage:

1. Articles published in WoS and Scopus from January 1, 2010, to June 30, 2024.
2. Articles published in English and Spanish.
3. Articles published in the field of Social Sciences, especially in the educational domain.

In the second phase (screening), the title, abstract, keywords, and conclusions were reviewed, and three new criteria were set to assess their eligibility:

4. Studies that addressed empirical research on AI in the field of education.
5. Research that addressed the assessment of digital competencies using AI exclusively in teachers and/or students.
6. Studies published in open access in its various forms (green route / golden route).

As a result of this work, the detailed information from the database was made available in the freely accessible scientific repository Zenodo.

3. Results

3.1 The final sample and the relationship of authors

Considering the first research question, the application of search combinations in the databases provided us an initial sample of 1.657 eligible articles. At the end of the identification stage, duplicate papers were discarded (421) and records that did not meet any of the first three initial criteria were excluded. Specifically, 272 articles were not included because they were published in another language and an additional 168 articles were excluded for not belonging to the field of education. At the end of the first phase of the protocol, we shifted from 1.657 initial articles to 796.

In the second phase of the protocol, 796 papers were reviewed, and a total of 12 articles were excluded because they were classified as pending verification under suspicion of journal retraction. Finally, of the remaining 784 papers, criteria 4, 5, and 6 described above were applied. A total of 380 articles were excluded for not being considered as empirical studies applied to the educational field: 102 studies for not addressing the topic of digital competence, and 249 for not having any of the open access versions.

As shown in Figure 1, the final sample selected for this Systematic Literature Review consists of 52 scientific articles.

Upon detailing the sample selection, the subsequent focus is on analyzing the relationships between the authors. In this regard, we present a list of the most relevant authors in the field of Artificial Intelligence and educational competence. To do so, we analyzed the bibliography of the selected sample through a map of co-occurrences, and we observed what connection existed between the different authors and what was their degree of affinity in their research topic.

One of the major contributions that can be seen in this analysis is that there are two large blocks of authors connected to each other. In particular, the contribution of Lee (2021) is situated in a central axis that links with previous research by Knox (2020), Zaki (2021), Carin (2020) among others, and is an inspiration for research carried out subsequently, such as Civaner (2022), Guleria (2022) or Zaki (2022). Contrary to this research that is focused on teaching, Berendt 2020's research is more focused on student learning and gives continuity to research such as that of Han (2022) or Díaz-Tito (2021).

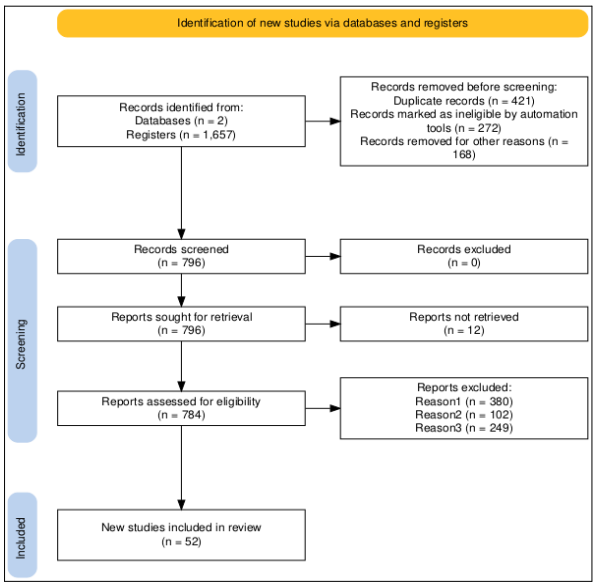

Figure 1 - Prisma Flow Diagram.

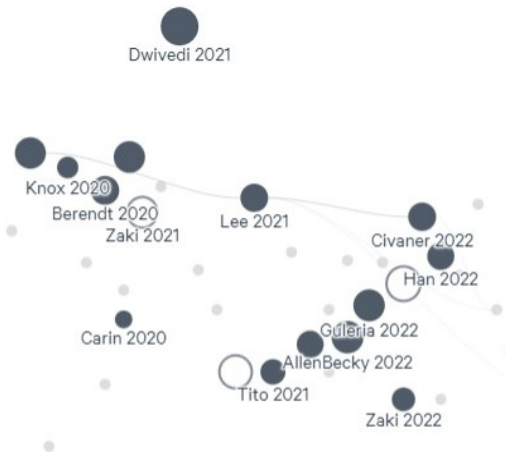

Figure 2 - Map of bibliographic co-occurrence (>2).

In short, the bibliography of all the articles in the selected sample shows, firstly, a very specific time sequence between 2020 and 2022 and, secondly, that

most of the articles have a stable analytical position, paying attention to a target group such as students, teachers or management groups.

3.2 The use and abuse of AI in learning

AI offers a wide array of benefits and opportunities for learners and educators alike. In the realm of educational technology, AI plays a pivotal role in monitoring and optimizing learning designs, offering insights into student progress and suggesting tailored solutions to address learning challenges. AI systems in education leverage data from past learners to enhance future learning experiences by providing intelligent tutoring and personalized learning pathways (Ahmad, 2023; 2024; Berendt et al., 2020; Cukurova et al.; Civaner et al., 2022; 2019; Dwivedi et al., 2021; Knopp, 2023; Popenici & Kerr, 2017; Zaleski, 2024).

Chatbots for educational purposes are emerging as effective tools in distance education, providing personalized support to learners and facilitating the teaching and learning processes through interactive tutoring and guidance (Allen et al., 2021; Chocarro et al., 2021; Kahn & Winters, 2021). The utilization of AI technologies in college English translation teaching has shown promising results in developing key competencies among future translators, highlighting the potential of AI in enhancing language learning and translation skills (Baesler & Sasaki, 2020; Nikonova et al., 2023; Teng et al., 2022; Wang, 2023;). The application of AI in predicting learners' needs and analyzing student data at scale presents opportunities to enhance decision-making processes and to effectively inform educational strategies (Parapadakis, 2020).

The engagement of educators, students, policymakers, and researchers is vital in shaping the incorporation of AI technologies in education (Grunhut et al., 2022; Guleria & Sood, 2022; Puerto & Esteban, 2022). On one hand, these stakeholders are instrumental in recognizing the potential benefits of AI in education, such as adapted learning experiences, increased teaching practices, and improved student engagement. Educators are key in utilizing AI technologies to adjust teaching methods and curricula to meet students' evolving needs and educational objectives (Cukurova et al., 2019; Díaz-Tito et al., 2021; North et al., 2024; Knox, 2020).

On the other hand, the introduction of AI in education could lead to transformations in traditional professions, potentially jeopardizing certain jobs (Grabinska et al., 2021). The utilization of AI technologies requires adaptability and continuous evolution, underscoring the importance of addressing ethical and legal dimensions of AI (Barakina et al., 2021; Cornejo-Plaza & Cippiatani, 2023; Díaz-Tito et al., 2021). The use of AI in learning environments poses significant risks that need to be carefully addressed to safeguard educational integrity and student well-being. One of the primary concerns is the potential for AI tools to be exploited for academic cheating, undermining the fairness and credibility of educational assessments (Han et al., 2019; Hung & Chen, 2023). The rapid growth of AI technologies in academia has raised ethical concerns, particularly regarding the misuse of AI systems for unethical practices (Sun & Hoelscher, 2023; García-Peñalvo & Llorens-Largo, 2024). The widespread adoption of AI in educational settings can have detrimental effects on student learning outcomes and engagement. The reliance on AI-powered systems without proper oversight and regulation may result in a lack of critical thinking development among students, as they may become overly dependent on AI for problem-solving. Moreover, the use of AI in education raises concerns about the potential dehumanization of the learning process, as students may interact more with AI systems than with human educators, leading to a reduction in social and emotional learning experiences (Mangera et al., 2023; Murugesan, et al., 2023; Schiff, 2020).

Another significant risk associated with the appropriate use of AI in learning environments is the potential for biased decision-making and discriminatory outcomes. AI algorithms are susceptible to biases present in the data used to train them, which can perpetuate existing inequalities and prejudices in educational settings (Guleria & Sood, 2022). Furthermore, the ethical use of AI in education can infringe on students' privacy and data security. The collection and analysis of vast amounts of student data by AI systems raise concerns about data protection and the potential misuse of sensitive information (Weidener & Fischer, 2023).

In conclusion, the involvement of diverse educational stakeholders is essential to harness the powerful flexibility and alignment of AI with people's interests in education. By engaging educators, students, policymakers, and researchers in dialogues about the benefits, challenges, and ethical considerations of AI technologies, educational institutions can establish a supportive and inclusive environment that maximizes AI’s potential to enhance teaching and learning experiences. However, the inappropriate use of AI in learning environments can have far-reaching negative consequences related to ethical practices or dehumanization of the learning process. To mitigate these risks, it is essential for educators, policymakers, and stakeholders to establish clear guidelines and promote ethical AI practices.

3.3 The teaching paradigm shift

The integration of AI in education offers teachers a range of opportunities to improve their teaching practices and optimize student outcomes. Educators play a crucial role in adapting teaching methods to integrate AI technologies and facilitate meaningful

learning experiences for students (Tolentino et al., 2023). The use of AI in education empowers teachers to adopt innovative approaches that cater to diverse learning styles, customizing learning experiences, and simplifying evaluation processes (Han et al., 2019). AI-powered intelligent tutoring systems have transformed content delivery, student assessment, and feedback mechanisms, resulting in more engaging and effective learning experiences (Hung & Chen, 2023; Ni & Cheung, 2022; Teng et al., 2022; Wood et al., 2023).

The integration of AI in education curricula has also implications for teachers' professional development and pedagogical practices. Educators must acquire the necessary skills to effectively integrate AI tools into their teaching methodologies and utilize data-driven insights to enhance student outcomes (Cukurova et al., 2019; Grunhut et al., 2022; Schiff, 2020; Sun & Hoelscher, 2023). Training programs focusing on AI literacy and pedagogical best practices are crucial to support teachers in navigating the complexities of AI integration in educational settings (Boot et al, 2023; Celik, 2023).

The rapid progression of AI technologies in education requires continuous professional development for teachers to stay updated on the latest AI applications and pedagogical methods. Educators need to acquire the essential skills to effectively integrate AI tools into their teaching methodologies (Grunhut et al., 2022). One key challenge that educators must address to effectively utilize AI technologies in educational settings is its potential impact on students' critical thinking skills and cognitive development. Educators' overreliance on AI-powered systems for content delivery and assessment could impede students' ability to engage in deep critical thinking and problem-solving, potentially undermining effective AI use for learning (Sun & Hoelscher, 2023).

The integration of AI in education necessitates a shift in pedagogical approaches to accommodate diverse learning styles and to optimize student engagement (Lee et al., 2021). The implementation of AI in education underscores the importance of early and conscientious integration of AI content into curricula to prepare students for the digitalized healthcare systems and technological advancements in various fields facilitating accurate program evaluation and quality assurance processes (How & Hung, 2019; Weidener & Fischer, 2023; Xu et al., 2022; Zaki et al., 2023). By embracing AI techniques and educational methods, teachers can develop adaptive instructional systems that cater to diverse learning styles and engage students more effectively. Involving educators in the design and implementation of AI-powered educational programs is essential to ensure that AI tools align with pedagogical goals and enhance student learning experiences (Crompton & Burke, 2023; Han et al., 2019; Zhu et al., 2023).

In conclusion, the integration of AI in education provides teachers with opportunities to enhance teaching practices, personalize learning experiences, and optimize student outcomes. Adopting AI technologies allows educators to transform traditional teaching methods, promote student engagement and collaboration, and empower learners. Teaching through AI presents three significant challenges: 1) educators' familiarity with AI tools 2) the engagement of educational stakeholders and 3) adapting teaching methods and curricula. Only by fostering collaboration, communication, and involvement among stakeholders, educational institutions can effectively harness the power of AI tools to enhance teaching practices and prepare learners for the demands of a rapidly evolving digital world.

5. Conclusions

To best answer the research questions posed, the conclusions of this study indicate that the strengths of AI for learning are related to its effectiveness and suggestiveness for students and to a lesser extent for teachers. The integration of AI in education facilitates personalized learning experiences, exemplified by chatbots that assist learners in distance education (Allen et al., 2021; Chocarro et al., 2021). However, concerns regarding academic integrity have arisen, as AI tools may be exploited for cheating, undermining the credibility of assessments (Han et al., 2019; Hung & Chen, 2023). To mitigate these risks, it is essential to establish robust ethical frameworks that safeguard educational practices and promote equitable learning environments. Learning through AI can be positive to generate a more flexible form of learning that is closer to the interests of the student. The acquisition of new digital competencies will not only facilitate alternative modes of learning but also integrate AI as an additional tool to reach new objectives and horizons for humanity. It is equally true that this new paradigm involves a process of reflection for teachers, their collective collaboration, and specific curricular adaptations. While the major risks of AI are the dehumanization of the learning process and ethical issues related to its misuse, the foremost challenge of this paradigm shift are related to its curricular application. Only by setting very clear criteria and guidelines in the educational curriculum can a solid foundation be established for the teaching-learning process of the digital citizen.

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