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Assessing the Impact of Artificial Intelligence on the Role of the Teacher, Student Learning and the Transmission of Knowledge in Education

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Abstract: The integration of artificial intelligence (AI) in education is a promising transformation. Drawing on advanced technologies, AI enriches the learning experience through intelligent systems capable of analyzing, adapting and personalizing teaching. Despite a growing volume of scientific publications, there remains a lack of critical synthesis on the real impact of AI on the role of teachers, student learning and the transmission of knowledge. To fill this gap, this article proposes a systematic literature review, conducted using the PRISMA method, to identify the opportunities and limitations of AI in educational environments. From 1,248 publications extracted from the Scopus database between 2018 and 2024, 20 relevant studies were selected and analyzed after applying inclusion and exclusion criteria. The results show significant growth in research in this field, and demonstrate that AI enables teachers to automate certain tasks, personalize teaching and better meet learners' individual needs. However, significant obstacles remain, including lack of digital skills, resistance to change, and ethical concerns. The study also points out that AI enhances learners' skills, promoting the personalization of pathways, the identification of struggling students, the adaptation of materials, as well as real-time engagement and monitoring. It also makes it possible to model and transmit knowledge through the creation and adaptation of digital educational resources. However, AI also presents certain limitations in the educational context, such as excessive dependence on technology, inequalities of access, automatic generation of answers without real learning, as well as issues relating to the confidentiality of personal data. AI is a powerful but complex lever in the field of education. Its effective integration requires targeted training for teachers, critical reflection on its uses, and a rigorous ethical framework. This review thus provides a solid basis for guiding future research towards complementary empirical studies, while accompanying practitioners in a reasoned and beneficial adoption of AI in educational contexts.

Index Terms: Artificial Intelligence, Education, Teaching, Personalized Learning, Knowledge Transfer

1. Introduction

Digital technologies have become an essential part of our daily lives. They are changing the way we seek information, communicate and even behave. As a result, the educational landscape has also evolved. More and more educational programs are integrating digital culture into their curricula.

These changes are not limited to teaching programs. In recent years, interactive educational technologies have become widespread. Learners are using tablets instead of books, and teachers are adopting various learning platforms such as Google Classroom, Edmodo, PowerSchool and Moodle. The success of massive open online courses (MOOCs) demonstrates the growing appeal of e-learning and distance learning. In parallel, progress has been made in the application of virtual reality (VR), augmented reality (AR) and artificial intelligence (AI) to the educational process [1].

Baker and Smith [2] define AI not as a single technology, but as a set of systems capable of performing cognitive tasks typically associated with the human mind, including learning and problem solving. AI encompasses several analytical methods, including machine learning, neural networks and deep learning [3]. Machine learning is defined as the ability of a computer algorithm to learn from data to make decisions without being programmed, the most common machine learning models are supervised and unsupervised learning [4].

AI is already being used in education through several tools, such as Chatbots, Intelligent Tutoring Systems (ITS) and automated grading [5]. These technologies offer numerous possibilities for all stakeholders in the teaching and learning process [6]. They reduce teachers' workload in the collaborative construction of knowledge, enable student progress to be tracked [7] and facilitate summative assessment through automated grading [8]. Yet AI integration in education remains insufficient compared to other sectors such as finance and healthcare. For successful implementation, it is essential that teachers participate in the creation and development of AI systems [9].

Today, AI is increasingly used in educational environments, from kindergarten to university. This rapid evolution raises major issues in terms of pedagogy, teacher training and equity of access to digital tools. Scientific literature on the subject has intensified in recent years, but remains fragmented: many studies explore specific cases or are limited to descriptive approaches, without proposing a critical synthesis of the overall impact of AI on educational actors and processes.

In response to this gap, this article proposes a systematic review of the literature, conducted using the PRISMA method, in order to assess the contributions, limitations and perspectives raised by the integration of AI in education. From 1,248 documents extracted from the Scopus database between 2018 and 2024, 20 studies meeting rigorous methodological criteria were selected for in-depth analysis.

The aim of this study is to propose a framework for critical analysis that crosses three dimensions: the role of teachers, student learning and the transmission of knowledge. To structure our approach, we have formulated four research questions:

1. What is the temporal, thematic and geographical distribution of studies on AI in education?
2. What opportunities does AI offer teachers, what challenges does it raise, and what needs have been identified for effective pedagogical integration?
3. How does AI contribute to improving students' skills and learning processes?
4. What role does it play in knowledge modeling and transmission?

Through this approach, we hope to provide researchers, trainers and decision-makers with a solid basis for guiding the future uses of AI in education, while highlighting the ethical, pedagogical and technical challenges still to be overcome.

The rest of the paper is structured as follows: Section 2 details the methodology of our systematic search, using the PRISMA method. Section 3 presents the temporal, thematic and geographical distribution of studies on AI in education, as well as the analysis of the selected articles. Section 4 discusses the results obtained to answer the research questions. Finally, the conclusion and future perspectives are addressed in Section 5.

2. Methodology

Our study uses a systematic method based on the PRISMA approach to identify and select the most relevant publications in the Scopus bibliographic database. We performed the search using advanced queries, using the exact keywords “Artificial intelligence” and “Education” in the titles of the publications. To minimize the number of results, we added further search criteria in the publication abstracts, concerning the teacher, learner learning and knowledge transmission. Next, we applied a set of inclusion and exclusion criteria. The first inclusion criterion concerns the selection and analysis of articles published between 2018 and 2024, including journal articles, conference papers and review articles. The second inclusion criterion focuses on publications dealing with AI in education, in relation to teachers, learners and knowledge transmission. The third criterion is used to select high-impact publications, only those with a number of citations above 20 were retained.

With regard to exclusion criteria, publications that were irrelevant or did not meet the thematic and chronological criteria were eliminated. Table 1 details the inclusion and exclusion criteria applied in this systematic review. Three inclusion criteria were applied to select publications.

- The first criterion concerned the publication period : only studies published between 2018 and 2024 were selected, including scientific journal articles, conference papers and review journals.
- The second criterion concerned the theme : publications had to deal with AI in education, in direct relation to the role of teachers, learner learning and the transmission of knowledge.
- The third inclusion criterion concerned the academic impact of publications : only studies receiving more than 20 citations were retained. This threshold was set to ensure a certain scientific recognition of the selected works, and to focus on contributions that have significantly influenced AI research in education.

Table 1. Inclusion and exclusion criteria for the systematic review

Inclusion criteria	
Search criteria	Values
Year of publication	– 2018-2024
Artificial intelligence field	– Title contains: “Artificial intelligence” AND “education”.
Artificial intelligence in relation to the teacher, the student and knowledge.	– abstract contains words: “teacher OR Teaching”, “student” and “knowledge OR curriculum”.
Document type	– Journal, conference and review articles
Source type	– Journal, conference proceedings and book series.
Number of article citations	– More than 20 citations.
Exclusion criteria	
Search criteria	Values
Article language	– Not in English.
Type of article	– Book chapter, Conference proceedings, Editorials, Letter, Book and data document.
Subject	– Does not deal with the field of artificial intelligence in relation to the teacher, the learner and knowledge. – Deals with medicine or health. – Deals with a specific tool without discussing the field of AI. – Deals with AI in the field of higher education.

Figure 1 illustrates the systematic process of article selection in the form of a flow chart. We have detailed each step of this process, including identification of articles, application of inclusion and exclusion criteria, assessment of eligibility and relevance, and final selection of studies for analysis.

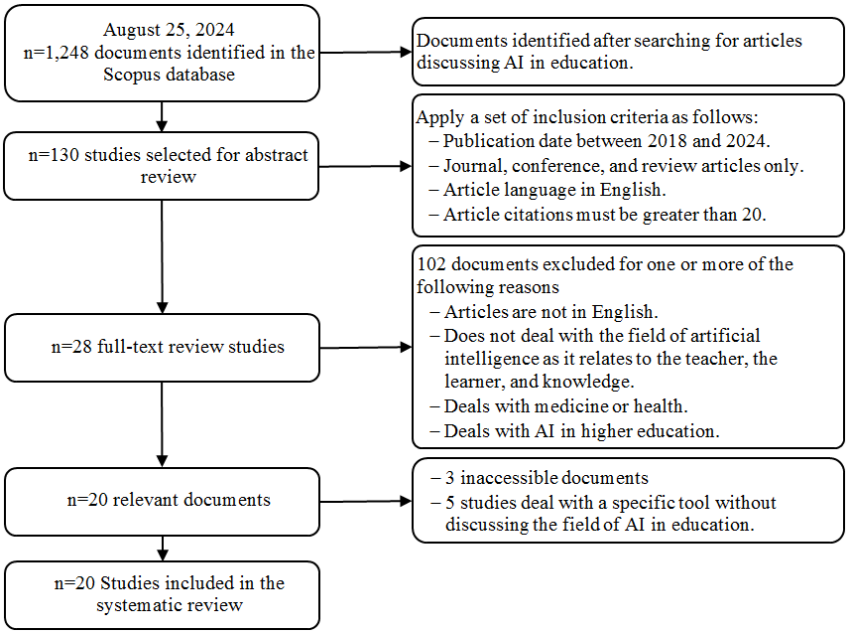

Fig. 1. Flowchart for selecting articles

To assess the methodological quality of the 20 selected studies, we used a set of specific criteria covering the main dimensions of the educational process likely to be influenced by artificial intelligence (AI): the role of the teacher, student learning and the transmission of knowledge.

Teacher dimension:

- Assesses the relevance of AI tools to support pedagogical practices.
- Discusses the opportunities and challenges of integrating AI into teaching.
- Analyzes the role of the teacher in an AI-enhanced environment and the associated needs.

Learner dimension:

- Measures the impact of AI on student engagement, motivation or autonomy.
- Studies the influence of AI on learning processes.
- Discusses the limits and risks associated with its use by learners.

Knowledge transmission dimension:

- Describes how AI can be used to adapt or personalize educational content.
- Analyzes the implementation of individualized learning paths according to students' needs.

3. Results

3.1 Temporal, thematic and geographical distribution of studies on AI in education

We have identified more than 1,248 documents in the Scopus database that deal with AI in education. These articles are classified by time distribution and grouped into three main categories: the teacher, the learner, and knowledge. Next, we classified the articles by country to identify the main contributors, as well as by research focus to assess the interest in integrating AI into different educational domains.

3.1.1 Temporal distribution of articles on AI in education

Figure 2 shows the evolution of the number of documents published between 2018 and 2024, broken down according to three dimensions of the educational process influenced by AI: teacher, learner and knowledge transmission. There is a steady increase in the volume of publications for all three dimensions.

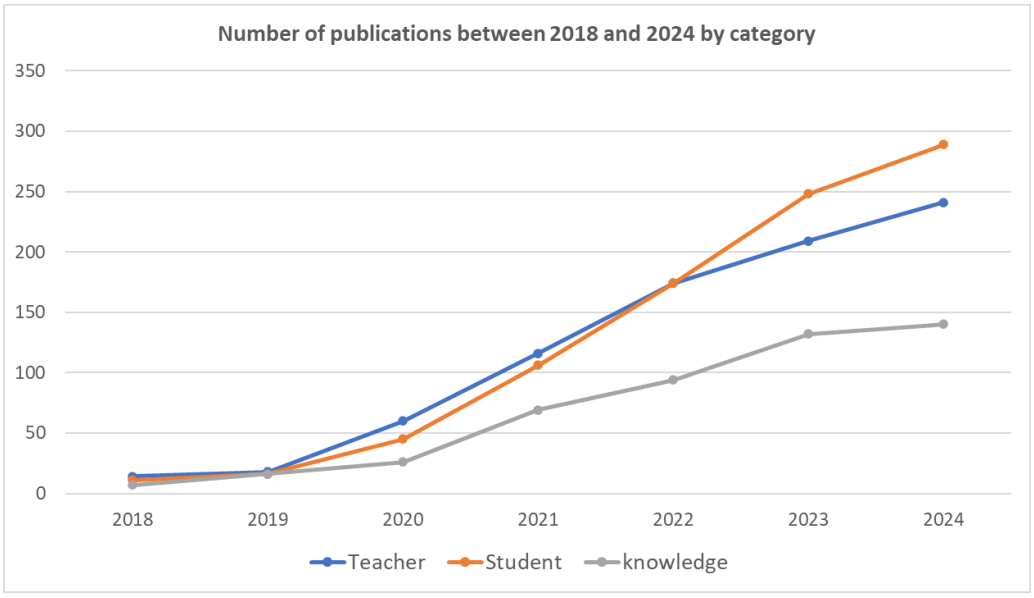

Fig. 2. Articles published in Scopus in the field of artificial intelligence in education in 2018 and 2024

We calculated the Compound Annual Growth Rate (CAGR) of scientific publications on AI in education for each dimension (teachers, learners and knowledge). The CAGR was calculated according to the following formula (equation 1):

$$CAGR = \left(\frac{V_{final}}{V_{initial}} \right)^{\frac{1}{n}} - 1 \quad (1)$$

Where:

- V_{final}: final value.
- $V_{initial}$: initial value.
- n: number of years.

The results show a rapid expansion of research in this area. Publications related to teachers grew on average by 60.69%, those related to learners by 72.42%, and those related to knowledge by 64.75%, reflecting significant increases. This strong growth underscores the growing interest in the integration of AI in education from both practitioners and researchers. This research momentum indicates not only increased academic interest, but also the immense potential for AI to shape the future of education by making education systems more efficient, inclusive, and adaptive.

3.1.2 Distribution of articles by research area

An analysis of scientific publications on AI in education between 2018 and 2024 shows a strong disciplinary diversity and a growing interest in integrating AI into different research fields. As shown in Figure 3, computer science accounts for around 31.5% of the total, highlighting the central role of computing technologies in the development and application of AI in education. Social sciences and engineering follow with 18% and 14.5% respectively, illustrating the importance of analyzing societal implications and technical innovations in this field.

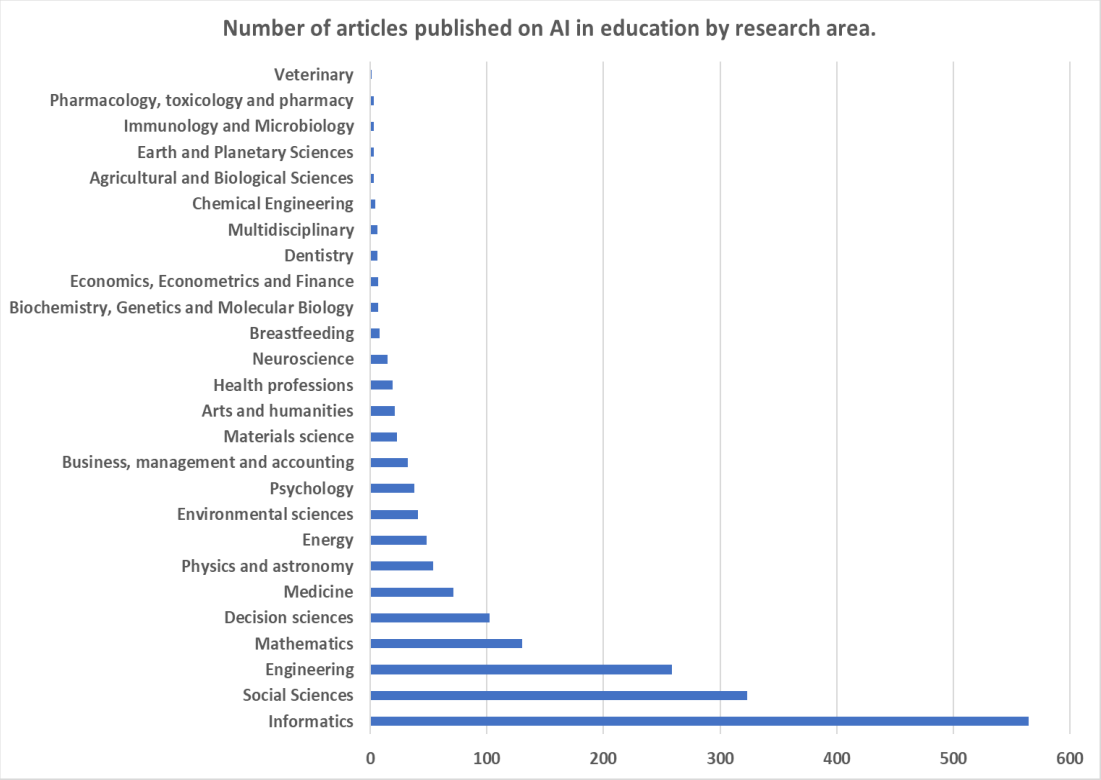

Fig. 3. Classification of published articles on AI in education by research field between 2018 and 2024

Mathematics and decision sciences are also well represented, with 7.3% and 5.7% of publications, showing an interest in algorithmic models and AI-based decision making in educational settings. Other fields, such as medicine, physics and astronomy, and environmental sciences, show interest in AI in specialized educational contexts. This analysis highlights the growing importance of AI as a multidisciplinary tool in education, with a transformative potential that extends far beyond traditional disciplines, touching both the exact sciences, the social sciences, and the health professions.

3.1.3 Geographical distribution of the top ten countries that have published articles on AI in education

Figure 4 shows the 10 countries with the highest number of published articles on AI in education. The analysis shows that China largely dominates AI in education research (52%), followed by the USA (15%) and India (10.5%). China's dominance reflects its strategic investments in AI and education. The US and other countries such as India, the UK, Spain and Germany also contribute, albeit more modestly. These results highlight geographic disparities in AI in education research, while also illustrating a growing global interest in using AI to improve education systems around the world.

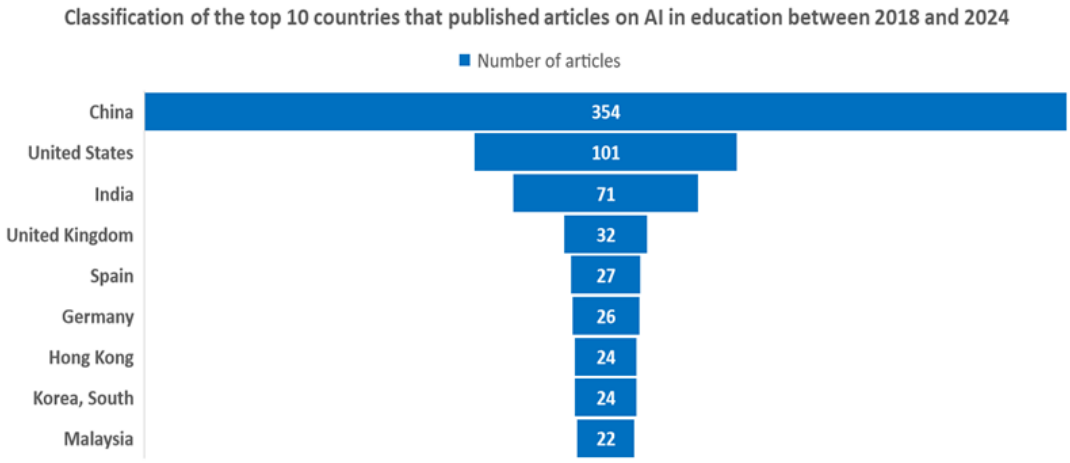

Fig. 4. Classification of the top 10 countries that published articles on AI in education between 2018 and 2024

3.2 Artificial Intelligence in Education

In order to adequately present the results of the literature on AI in education, we propose the model shown in Figure 5. This model allows us to examine three main dimensions of the educational process that are likely to be affected by AI: the role of the teacher, student learning, and knowledge transfer.

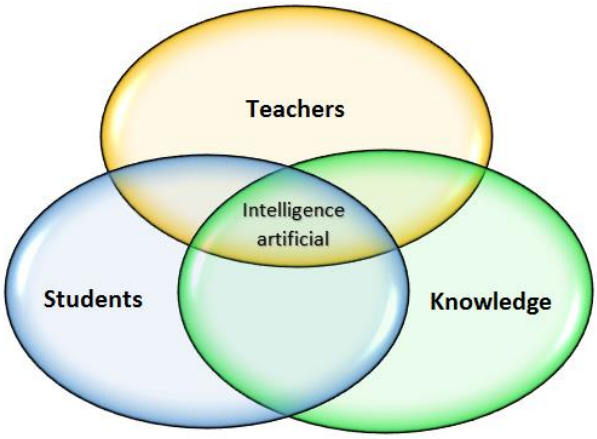

Fig. 5. Dimensions of the educational process likely to be impacted by AI

3.2.1 The impact of AI on the role of the teacher

In this section, we analyzed studies on the integration of AI in education and its impact on the role of the teacher. For this analysis, seven articles were selected from our systematic review, each contributing a specific perspective on the opportunities and challenges associated with teachers' use of AI. The aim is to highlight how AI supports teachers in their pedagogical practice and what specific needs teachers have to effectively integrate AI into their teaching.

Salas-Pilco's systematic review [10] provides an overview of research on artificial intelligence (AI) and learning analytics (LA) in teacher education. The study reviewed 2012 articles and selected 30 studies for in-depth analysis. The study's findings show that the integration of digital technologies into teacher education presents both opportunities and challenges. These include automated grading, predictive analytics to identify dropout risks, adaptive learning to personalize instruction, and the use of chatbots to support learning. However, the study also highlights ethical concerns, such as privacy and the data collected by AI. To reap the full benefits of these technologies, it is necessary to strengthen teachers' digital skills, both in initial and in-service training, and prepare them to integrate these tools into their teaching practice.

Chounta's study [11] explores teachers' perceptions of AI, focusing on fairness, accountability, transparency, and ethics (FATE). By interviewing 140 Estonian teachers, the researchers assessed their understanding and concerns about AI in education. The results show that teachers perceive AI as an opportunity for education, while acknowledging that they have limited knowledge about its use in practice. While they support the integration of AI, particularly for administrative tasks and managing instructional materials, they are concerned about the effort required to learn these technologies and the trust issues that may arise. Teachers identify a need for support to improve their effectiveness and efficiency in their professional practice, particularly in preparing educational materials, personalizing learning, and identifying misconceptions.

Lameras and Arnab's exploratory study [12] examines the impact of AI in education by analyzing 141 articles using the PRISMA framework. It proposes a classification of AI applications and a framework to help teachers develop the skills needed to use AI in education. The authors emphasize the importance of its ethical use and propose recommendations for its integration into teaching and learning. The results show that AI in education improves students' self-regulation skills, increases their cognitive engagement in problem solving, and enhances their motivation, both extrinsic and intrinsic. Furthermore, no significant differences were found between the learning outcomes of Intelligent Tutoring Systems (ITS) and human tutors.

Chiu's study [13] examines the impact of AI on pedagogical practices in the classroom and highlights the need for greater integration between AI and pedagogical perspectives, particularly in K-12 education. She shows that AI benefits motivated and advanced students in particular, but that its effectiveness depends on teacher support. Drawing on self-determination theory, the study analyzes how teacher support moderates the impact of students' expertise on their motivation to use AI. An experiment with 123 students using chatbots as AI technologies shows that students' intrinsic motivation and competence to learn with these tools depend on both student expertise and teacher support. The results underscore the importance of the teacher's role in optimizing the use of AI in the classroom, with a balanced approach that supports both student autonomy and relationships for effective use of AI technologies.

Polak's study [14] explores middle school teachers' perceptions of teaching AI-related skills and identifies needs for effectively integrating AI into pedagogical practices. Although teachers are motivated to integrate AI, their limited understanding of AI concepts and lack of digital literacy are significant barriers. The study highlights the importance of the relationship between motivation, skills, and available tools for adopting AI education. It recommends designing programs that address teachers' digital skills development needs while motivating them to engage in AI learning. These factors are essential for the successful and sustainable integration of AI in schools.

Celik's study [15] introduces Intelligent-TPACK, an extended framework of the TPACK model that incorporates an ethical dimension for the responsible use of AI-based tools in education. This framework combines technological, pedagogical, and content knowledge, adding an essential ethical dimension to address concerns about the use of AI in learning environments. It addresses the need for better AI integration and ethical reflection in the classroom. The findings highlight that ethical knowledge is essential for the fair and transparent use of AI tools, and that ongoing teacher training is crucial for successful integration.

Tedre's study [16] highlights the importance of integrating machine learning (ML) in the classroom to enable students to understand AI technology in a data-driven society. It highlights pedagogical and technical challenges, including the adaptation of traditional approaches to computer science education. The article emphasizes hands-on projects around data, the integration of STEM/STEAM approaches, and the inclusion of AI ethics. It concludes with a call for a balanced education that prepares students for the ethical and societal challenges of AI.

3.2.2 The impact of AI on learners' learning processes

In this section, we have selected nine articles for our systematic review of the impact of AI on learners' learning processes. The goal is to analyze the most relevant work to determine how AI can improve learners' skills and learning processes.

Huang's study [17] highlights the growing importance of AI education in China, showing its positive impact on key skills such as knowledge, teamwork, and learning. Although students are interested in learning AI skills, particularly in areas such as programming, image processing, and robotics, the study reveals challenges such as a lack of specialized teachers and regional disparities. The author recommends improving collaboration and cultural competence in AI courses, highlighting the need for reforms to prepare students for an intelligent society.

Bagunaid's study [18] presents AISAR, an AI-based assessment and recommendation system for e-learning. Using recurrent neural networks (RNNs), DBSCAN clustering, and reinforcement learning, AISAR overcomes the limitations of traditional systems by predicting student performance and providing personalized recommendations. Although effective, challenges remain in terms of accurate individual assessment. This system highlights the need for a more robust integration of AI into e-learning platforms to meet the diverse needs of students and optimize their educational journey in a big data context.

Khan's study [19] proposes a predictive model based on decision trees to identify students at risk of academic failure from the first weeks of classes. Using data such as cumulative grade point average and class attendance, the model provides accurate predictions that allow for targeted and personalised interventions. The results show an improvement in the performance of students who receive this support. The study highlights the effectiveness of decision trees in monitoring academic progress and facilitating tailored preventive interventions, thereby improving academic outcomes.

Ciolacu's study [20] explores Education 4.0, which integrates technologies such as AI, IoT, and augmented and virtual reality to create personalized learning environments. The author proposes an early detection system based on machine learning techniques, such as support vector machines (SVMs) and neural networks, to identify struggling students from the first few months of their course. The system aims to reduce exam failure rates and improve student engagement and the effectiveness of learning strategies. The study highlights the challenges of integrating smart sensors and managing the confidentiality of biometric data.

Chai's study [21] examines the factors that influence primary school students' intention to pursue AI learning, focusing on AI literacy, confidence in learning, and using AI for social good. The results show that all three factors are

positively associated with students' intention to pursue learning and use of AI technologies, with 'AI for social good' as the main predictor. The study highlights the importance of making AI concepts accessible in educational programmes, while building students' confidence through hands-on learning experiences. It also highlights the need to promote AI applications with a positive social impact to motivate young learners.

Ouyang's study [22] proposes the integration of AI models for performance prediction with learning analytics (LA) approaches to enhance collaborative online learning. The AI model accurately predicted student performance and provided personalized feedback. The results show improved engagement, collaborative performance and student satisfaction. The integration of AI and learning analytics provides data-driven adjustments that help improve the quality of teaching and learning.

Chiu's study [13] examines the impact of integrating AI chatbots into education, highlighting the role of teachers and student motivation according to self-determination theory. The results show that teacher support improves novice students' satisfaction of skill needs and motivation, while advanced students prefer self-learning with AI. The study highlights the importance of adapting teaching strategies to learners' skills in order to maximize the effectiveness of chatbots. It also highlights the crucial role of students' perceived digital skills in optimizing the use of chatbots in learning environments.

Yilmaz and Karaoglan's study [23] analyses the impact of ChatGPT on students' computational thinking skills, programming self-efficacy and motivation in university programming courses. The study, which involved 45 students divided into an experimental group (using ChatGPT) and a control group (no access), shows that the tool improves students' engagement by automating certain coding tasks, thereby reducing their frustration. The results show that using ChatGPT strengthens students' computational thinking skills and boosts their confidence, thereby increasing their motivation to learn. However, the study warns against over-reliance on these technologies and stresses the importance of developing problem-solving skills independently.

Chai's study [24] uses the Theory of Planned Behaviour (TPB) to examine the factors that influence primary school students' intention to learn AI. The results show that self-efficacy, readiness for AI and perceptions of its use for social good are key predictors of this intention, with self-efficacy being the most influential. This underlines the importance of students' confidence in their ability to learn. The study recommends including hands-on activities and solving real-world problems in curricula to motivate students and strengthen their intention to learn AI.

3.2.3 The impact of AI on knowledge transfer in education

In this section, we have selected five articles that explore how AI can personalize learning pathways according to the specific needs of learners.

Yang's study [25] explores the integration of AI into early childhood education, highlighting the importance of developing digital literacy from an early age to promote digital equity. It highlights the need to design curricula tailored to young children to raise awareness of basic AI concepts, using an embodied and culturally responsive pedagogical approach. This approach includes the use of hands-on activities, project-based learning, and interactive platforms such as "Quick, Draw!" and "Teachable Machine" to make learning about AI accessible and relevant. The AI for Kids program has proven effective in engaging young children in topics such as environmental protection. The article recommends developing teaching methods adapted to children's abilities and strengthening teacher training to improve digital literacy in a variety of educational contexts.

Cope's study [26] analyzes AI applications in education, focusing on the assessment of knowledge and learning. The authors highlight the potential of AI to transform education through personalized and adaptive approaches. They introduce personalized learning and AI-based assessment, which measure complex performance by detecting hidden patterns in data (text, images) using deep learning algorithms. AI can identify learners' individual needs, adjust learning paths according to results, and provide adaptive learning. AI acts as a "cognitive prosthesis" to augment the capabilities of teachers and students. However, they insist that AI must augment teachers, not replace them, to create richer, more human learning contexts.

Kortemeyer's study [27] evaluates the performance of ChatGPT in an introductory physics course. Although able to handle some theoretical concepts and pass basic assessments, ChatGPT shows limitations in numerical computation, metacognition, and complex problem solving. The AI proves capable of supporting personalized learning, but shows significant shortcomings in self-correction and sophisticated problem solving. The study highlights the challenges of integrating AI into education, such as the risk of cheating, and proposes innovative solutions, such as the use of graphical questions and physical measurements based on practical tools, to strengthen students' analytical skills while reducing reliance on AI.

Williamson's study [28] examines the emergence of Artificial Intelligence Learning Science (AILSci) as a new mode of knowledge production in education, based on digital infrastructures and big data technologies. AILSci combines AI and learning sciences to analyze students' physical and neural processes through devices such as EEG sensors and biometric platforms. AILSci generates new expertise, such as educational precision and learning engineering, by merging human and machine cognition. This approach creates "cyborg assemblies" that provide innovative insights into educational processes.

The integration of an artificial intelligence chatbot into a smart campus, as proposed by Villegas-Ch [29], represents a significant step forward in improving personalized learning. The chatbot provides recommendations based on academic performance through natural language processing. The results of this study show a significant

improvement in engagement and academic performance, with a 59% increase in interest in academic activities over a 30-day period. By identifying students' strengths and weaknesses, AI enables personalized learning while providing real-time monitoring and feedback. The proposed architecture not only improves student engagement, but also enables dynamic adaptation of educational content according to critical variables such as participation, fatigue, or academic performance. This approach underscores the growing role of chatbots and AI in personalizing learning and disrupting traditional education models.

4. Discussion

To address this section, we will answer four key questions. The first explores the opportunities and challenges that AI can offer teachers. The second examines the specific needs of teachers to effectively integrate AI into their pedagogical practice. The third asks how AI can develop learners' skills and learning processes. Finally, the fourth looks at the role of AI in knowledge modeling and transfer.

4.1 The opportunities and challenges that AI can offer teachers

Artificial intelligence (AI) presents a multitude of avenues for enhancing educators' pedagogical methodologies. Such applications include the automation of administrative tasks, such as the automated grading of assignments, the prediction of student attrition, the management of teaching aids, and the use of chatbots to respond to student inquiries. This allows educators to allocate more time to lesson preparation and direct student assistance [10,11]. Learning analytics (LA) tools are capable of detecting students' needs and adapting content to suit their level [10,13]. This allows educators to more effectively identify students with particular difficulties and enhance their cognitive engagement.

Similarly, the study by Lameras and Arnab [12] underscores that AI does not supplant the role of teachers, but rather redefine it. Artificial intelligence (AI) provides educators with the ability to design and orchestrate more dynamic learning environments. However, it is incumbent upon teachers to become facilitators capable of integrating these tools in order to maximize student engagement.

The challenges to teachers' use of AI are numerous and have been the subject of several studies, which have provided key insights into these difficulties. The primary challenge is the lack of digital proficiency, which impedes the effective integration of AI technologies into pedagogical practices [10,14]. Furthermore, ethical concerns, such as those pertaining to privacy and bias in AI systems, present additional challenges to the adoption of these technologies, necessitating comprehensive ethical training [15]. Teachers have also indicated a need for assistance in light of the increased workload associated with learning these tools [11]. Additionally, there seems to be a certain reluctance to utilize them due to a perceived lack of trust and understanding. Finally, striking the optimal balance between student autonomy and teacher support in the use of AI is a significant challenge, particularly in the absence of adequate training [13].

Analysis of these studies shows that the integration of AI in education presents a wide range of opportunities and challenges for teachers. Table 2 presents these opportunities and challenges.

Table 2. opportunities and challenges that AI can offer teachers

Opportunities	Challenges
– Facilitate the management of learning materials. – Provide accurate information on learners. – Automate marking and grading of exams. – Monitor learner progress. – Improve pedagogical decision-making. – Model teachers' work. – Reinforce teachers' professional skills.	– Lack of digital skills to integrate AI in the classroom. – Ethical concerns and protection of sensitive data. – Limited understanding of AI technology. – Workload to master and integrate AI in the classroom. – Adaptation of traditional teaching approaches. – Unequal access to technology resources.

Analysis of the limitations encountered by teachers when integrating AI highlights a persistent tension between technological ambitions and educational realities. Although AI is perceived as a lever for individualization, efficiency and modernization of teaching, its practical implementation is hampered by several major obstacles: a lack of digital skills, ethical concerns, difficulties in adapting pedagogical practices and inequalities in access to resources.

4.2 The requirements of educators for the effective integration of AI into their pedagogical practice

In order to effectively integrate AI into their pedagogical practice, teachers require specific digital skills and institutional support. As evidenced by Polak's study [14], a significant challenge to AI integration is the dearth of digital proficiency among educators. Teachers require ongoing training that facilitates the development of not only technical competencies but also pedagogical expertise tailored to the integration of AI technologies. This encompasses the design of intelligent learning materials and the management of AI-assisted learning tools.

In addition to the requisite technical skills, educators must also possess a comprehensive understanding of the ethical implications associated with the use of AI. Celik's Intelligent-TPACK framework [15] proposes an approach that combines technological, pedagogical, and ethical knowledge, underscoring the significance of ethical reflection in the

utilization of AI in the classroom. It is thus imperative that teachers receive training in the transparent and responsible use of AI, with a view to guaranteeing fairness and data protection in the learning process.

Furthermore, Chounta [11] highlights the necessity for teachers to receive practical assistance in the utilization of AI tools, particularly in tasks such as the preparation of personalized educational content and the management of student data. This also encompasses the provision of adequate technological resources and a platform for the exchange of best practices, with a view to facilitating their ongoing learning in the use of AI technologies.

As shown in Figure 6, the results of these studies indicate that the effective integration of AI into teachers' pedagogical practices relies on training in the AI tools available, understanding the pedagogical and ethical impacts, as well as highlighting the benefits it can bring to student learning. At the same time, personalized support is needed to help teachers adopt these technologies effectively, as well as equitable access to AI-based educational resources.

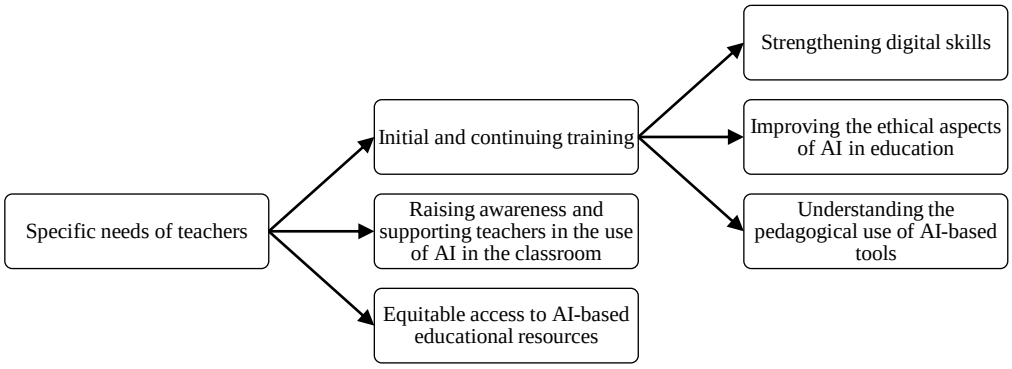

Fig. 6. Teachers' needs for integrating AI into their teaching practice

For AI to bring about a significant and lasting transformation in education, its integration must be part of a systemic and holistic approach. This implies several essential conditions:

- Teacher training that focuses on the pedagogical dimensions of AI, beyond mere technical mastery of the tools. The aim is to develop a critical and didactic understanding of AI, so that teachers can integrate it thoughtfully into their practices.
- Structured, long-term institutional support, including opportunities for consultation, experimentation and feedback. This support is necessary to gradually adapt the use of AI to the specific realities of each school.
- The provision of technical resources adapted to different contexts, taking into account inequalities in infrastructure, digital equipment and access to technology.
- The development of ethical, transparent teaching tools, co-constructed with educational players, to ensure that they are appropriated by teachers and used in a way that respects the principles of fairness, data protection and equity.

In this context, teachers cannot be reduced to passive users of technological solutions. They must be recognized as key players in the design, regulation and evaluation of AI-based devices. Thus, removing the obstacles to the adoption of AI in the classroom requires not only technical and logistical means, but above all a shared educational vision, built collectively and anchored in real teaching contexts.

4.3 The role of AI in improving learners' skills and learning processes

AI is playing an increasingly central role in improving learners' skills and learning processes, as highlighted by several studies. In China, Huang [17] highlights the importance of AI education in developing skills such as knowledge, teamwork, and autonomous learning. The results of this study also show a strong interest in learning AI skills. However, according to Huang [17], although AI helps improve students' skills, major shortcomings such as the lack of specialized teachers and the lack of comprehensive planning hinder the optimization of AI education. The author recommends reforming curricula to better integrate AI while promoting cooperation and cultural skills to prepare students for development in an intelligent society.

In the same context, the study by Yilmaz and Karaoglan [23] shows that AI tools such as ChatGPT enhance computational thinking skills and programming self-efficacy. By automating certain tasks, these tools reduce learner frustration and increase self-efficacy and engagement. However, the study cautions against over-reliance on AI and emphasizes the importance of maintaining autonomous problem-solving skills.

Analysis of these studies also shows that AI provides personalized learning and recommendations tailored to the individual needs of students. Bagunaid's study [18] proposes a new AI-based student recommendation and assessment system (AISAR) for e-learning, which is effective in predicting student performance and providing recommendations using machine learning algorithms. This system highlights the need for more robust integration of AI in e-learning

platforms to meet the diverse needs of students and optimize their educational journey in a big data context. Khan's study [19] also illustrates the effectiveness of AI in supporting learners by developing a predictive model based on decision trees. This model effectively identifies students at risk of academic failure within the first few weeks of a course. This approach illustrates how AI can play a preventive role in improving academic outcomes. The predictive role of AI is highlighted in the study by [20], which shows that AI can identify at-risk students early in their studies, facilitating preventive intervention and improving success rates.

The impact of AI tools on student engagement and performance is also evident in the results of Ouyang's study [22], which shows that integrating AI with learning analytics improves student engagement and collaborative performance, and increases student satisfaction with online learning. Students benefit from real-time feedback that promotes better understanding of assignments and improves group dynamics. Chai's studies [24,21] highlight the importance of making AI concepts accessible in educational programs while building student confidence through hands-on learning experiences. It also emphasizes the need to promote AI applications with a positive social impact, which seem to be particularly motivating for young learners.

Regarding the use of AI-based chatbots, Chiu [13] shows that teacher support is crucial for beginning students, increasing their motivation and satisfaction with AI-assisted learning. However, more advanced students seem to benefit more from self-learning with these tools. This study highlights the importance of adapting instructional strategies to different skill levels.

According to the studies analyzed, artificial intelligence plays an important role in improving learners' skills in a number of ways. These studies also show that the successful integration of AI often depends on the support of teachers and the adaptation of pedagogical tools to the specific needs of learners. In summary, we define AI's role with learners as follows:

- Personalize learning recommendations.
- Help identify learners at risk of academic failure.
- Detect students in difficulty and offer adapted learning resources.
- Increase learner motivation and engagement.
- Provide real-time feedback to students.
- Develop computational thinking skills.
- Improve learner self-efficacy through personalized support.

To complete the analysis of the impact of artificial intelligence on students' educational careers. Table 3 below presents a structured summary of the main risks identified in this systematic review. These risks are grouped into different categories (cognitive, ethical, social and technological) and are associated with their potential consequences on the development of learners' skills.

Table 3. Main risks associated with the use of AI by learners

Risk category	Description	Possible consequences	References
Cognitive / technological dependency	Excessive use of AI to accomplish tasks without personal effort.	Reduced capacity for critical analysis, autonomous reasoning, deep learning and creativity.	[17,18,19,20,21,22,23]
Plagiarism / Academic cheating.	Use of AI generators to produce homework and assignments.	Violation of academic integrity, loss of skills, superficial learning	[17,21,22,23]
Reduced creativity.	Automation of the production of ideas or solutions with AI.	Reduced personal initiative, innovation and original thinking.	[17,22,23]
Algorithmic bias / misinformation.	AI models can reflect or amplify cultural, social or linguistic biases.	Erroneous learning, reinforcement of stereotypes and unintentional ideological orientation.	[18,19,20,22,23]
Invasion of privacy.	Inadvertent collection or sharing of personal data.	Risks of data surveillance, leakage or misuse.	[17,18,19,20,21,24]
Inequalities of access.	Unequal access to AI technology and tools.	Reinforcement of educational and social disparities.	[18,19,20,21,22, 24]
Decrease in human interaction.	AI systems replace the pedagogical relationship.	Isolation, loss of emotional or social support.	[18,19,20,21]
Errors in interpretation or prediction.	AI providing incorrect or unsuitable analyses.	Poor teaching decisions, ineffective learning.	[18,20]
Standardization of learning.	AI favoring standard paths to the detriment of pedagogical diversity.	Reduced personalization and richness of learning.	[19,22]

A systematic examination of the risks involved in integrating AI into the educational pathway highlights a plurality of potential challenges. Despite AI's promising contributions in terms of personalization, automation and learning support, its unsupervised use can compromise the development of key skills such as critical thinking, creativity or autonomy. It therefore seems essential that educational players adopt a cautious and critical approach, articulating technological innovation and pedagogical requirements, to ensure a balanced integration of AI into learning environments.

4.4 The Role of AI in Knowledge Modeling and Transfer

AI makes it possible to personalize learning paths according to the specific needs of learners. Yang's article [25] highlights the importance of adapting instruction to young children's abilities through interactive tools such as "Quick, Draw!" and "Teachable Machine." Similarly, Cope [26] shows that AI provides personalized, adaptive learning by adjusting courses in real time. This idea is reinforced by Villegas-Ch's study [29], which highlights improved student engagement thanks to chatbots that use IoT-derived data to provide personalized recommendations.

AI is often associated with performance assessment and analytics systems. Cope [26] highlights how AI can provide continuous and adaptive assessment. In addition, AI enables personalized learning through precise analysis, as illustrated by the work of Villegas-Ch [29], where AI analyzes students' academic performance in real time to adjust recommendations.

AI is also integrated into the production and organization of knowledge. Williamson [28] explores how AILSci (Artificial Intelligence Learning Science) uses AI devices to produce new forms of knowledge about educational processes, combining human and machine cognition. This approach is also present in studies by Cope [26], who discusses the use of ontologies and data models to organize and structure educational information.

AI is also directly involved in knowledge transfer. AI systems can select and adapt the educational content to be delivered, ensuring that it meets the specific needs of learners. As reported by Villegas-Ch [29], the use of chatbots integrated into personalized learning environments enables dynamic adaptation of resources, increasing student engagement and effectiveness. These AI-enhanced systems also enable the production and enrichment of educational resources, such as course materials, tailored to the individual characteristics of learners [25].

These studies show that AI plays a crucial role in the modeling and transmission of knowledge, enabling learning paths to be more personalized. Knowledge can be modeled by creating semantic networks to link concepts together, or by extrapolating or inferring relationships from a knowledge base. It is on the basis of this modeling that intelligent tutoring systems can make pedagogical decisions without them having been explicitly programmed. This modeling of knowledge made or supported by AI then enables the transmission of knowledge to learners. More specifically, the AI's role may be to select the knowledge to be transmitted. AI systems can also be used to produce or enrich learning resources. This may involve producing material to suit a student's particular characteristics, translating material, automatically generating subtitles or summarizing content. In short, what artificial intelligence can do for modeling and transmitting knowledge:

- Select and adapt learning activities.
- Select the most relevant content and activities for learners.
- Transmit knowledge in a targeted way.
- Personalize learning paths in real time.
- Improve the effectiveness of collaborative online learning.
- Produce or enrich digital educational resources.

However, this technical efficiency should not obscure certain potential pitfalls. AI systems often rely on homogeneous databases, which can lead to an impoverishment of cognitive and cultural diversity. What's more, the opacity of algorithms makes it difficult to justify the pedagogical content proposed, limiting the transparency of teaching choices. Finally, the growing reliance on these technologies for the transmission of knowledge raises concerns about the autonomy of teachers and the sustainability of critical, contextualized teaching.

5. Conclusion

AI represents a major transformation in education, having a significant impact on the role of teachers, the learning of learners, and the transmission of knowledge. This systematic review, based on a rigorous analysis of 20 studies, identified the impact of AI on three dimensions of the educational process: the role of the teacher, student learning and the transmission of knowledge.

On the teachers' side, AI offers powerful levers for automating administrative tasks, personalizing educational pathways and improving decision-making. However, these opportunities are often hampered by a digital skills deficit, a lack of suitable teaching resources, and ethical concerns linked to data protection. These findings underline the need for ongoing training that integrates technological, pedagogical and ethical dimensions, as well as structured institutional support.

For learners, AI-based technologies enable more personalized, adaptive and engaging learning, notably through targeted recommendations and real-time feedback. However, it's important to note that these benefits are unevenly distributed depending on the student's level of digital literacy, socio-economic background or degree of autonomy. Risks of cognitive dependency, superficial learning or loss of critical skills have also been identified, highlighting the need for solid pedagogical support.

In terms of knowledge transfer, AI facilitates dynamic modeling of knowledge, real-time adaptation of content, and automated assessment of prior learning. However, this technical power is accompanied by major risks, notably the

standardization of content, the opacity of algorithms, and the weakening of pedagogical and cultural diversity. Without vigilance, AI could contribute to a form of educational standardization that runs counter to the principles of equity and inclusion.

The future of AI-assisted education lies in the collective ability of educational players to combine technological innovation with pedagogical requirements, from an ethical, critical and inclusive perspective. To achieve this, in-depth empirical research is essential if we are to go beyond mere observation, and contribute to the enlightened and sustainable integration of artificial intelligence into education systems.

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