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PERCEPTIONS, STRATEGIES, AND CHALLENGES OF TEACHERS IN THE INTEGRATION OF ARTIFICIAL INTELLIGENCE IN PRIMARY EDUCATION: A SYSTEMATIC REVIEW

Olga Arranz-García *	Faculty of Education, Pontifical University of Salamanca (UPSA), Spain	oarranzga@upsa.es
María del Carmen Romero García	Faculty of Education, International University of La Rioja (UNIR), Madrid, Spain	mariadelcarmen.romero@unir.net
Vidal Alonso-Secades	Faculty of Computer Science, Pontifical University of Salamanca (UPSA), Spain	valonsose@upsa.es

* Corresponding author

ABSTRACT

Aim/Purpose	Evaluate teachers' perceptions, strategies, and challenges in integrating artificial intelligence (AI) into K-12 education and identify patterns and trends in the data from the reviewed studies.
Background	This systematic review examines a decade of innovation to explore the transformative impact of AI on education (2014–2024). Adhering to PRISMA 2020 guidelines, the study uncovers key trends, challenges, and breakthroughs in AI-driven teaching and learning, offering a comprehensive perspective on how AI reshapes educational practices and methodologies.
Methodology	The study employs a systematic review to analyze the implementation of AI techniques and tools in primary education, following the PRISMA 2020 guidelines to ensure the reliability and effectiveness of the findings. To achieve this, an extensive search was conducted in academic databases such as Web of Science, Scopus, and ERIC, focusing on empirical studies and peer-reviewed articles published between 2014 and 2024. Only accessible, peer-reviewed articles

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	classified under Education and Educational Research and published in English or Spanish were selected. The search strategy was structured into five categories aligned with the research questions to identify relevant studies accurately. The selection process was carried out in three phases – Identification, Screening, and Inclusion – applying predefined criteria to guarantee the quality and relevance of the selected studies. Of an initial total of 514,919 articles, 488,940 were excluded for not meeting the inclusion criteria. After removing duplicates and evaluating titles, abstracts, and full texts, a final set of 28 studies was included.
Contribution	The study explores the integration of AI in primary education, revealing both teachers' enthusiasm and the challenges they face. While AI is perceived as a tool to enhance critical thinking, problem-solving, and student engagement, its implementation is limited by insufficient training, resources, and institutional support. Despite these obstacles, teachers show confidence in designing AI-integrated curricula, though this is weakened by inadequate infrastructure and technical support, highlighting the need for continuous professional development. The study also stresses the importance of establishing a competency framework for AI literacy and adopting a systemic approach to AI education. Additionally, ensuring safe learning environments by addressing data privacy and AI biases remains a key challenge. Overcoming these issues is essential for the ethical and effective integration of AI, maximizing its benefits while safeguarding student equity and security.
Findings	- Educators see the potential of AI to personalize learning. - Barriers are lack of training and resources for teachers. - Importance of continuous training in digital skills. - Need for policies that promote AI literacy. - Collaboration with experts to optimize AI in the classroom.
Recommendations for Practitioners	Teachers are encouraged to collaborate in using AI tools to enhance educational outcomes, supported by continuous professional development programs, clear policies that safeguard privacy and promote equality, and a framework that preserves human autonomy in integrating AI technologies.
Recommendations for Researchers	The lack of empirical research on AI interventions in education limits understanding of its true impact, highlighting the need for future studies to fill this gap and optimize its application for greater educational benefits.
Impact on Society	The integration of AI in K-12 education is not just an opportunity; it is a necessity to prepare future generations for an increasingly digital world. While AI has the potential to revolutionize learning by fostering critical thinking, personalization, and engagement, its impact depends on how effectively it is implemented. To ensure its benefits, it is essential to empower educators and students with AI literacy, address issues like bias and data privacy, and establish robust legal frameworks for fair and transparent use. Without proactive policies, AI could widen educational inequalities instead of reducing them. A responsible, human-centered approach is needed to create an inclusive, ethical, and effective AI-powered education system.

Future Research	The article highlights the urgency of future empirical research to better understand the real impact of AI in education, as the lack of intervention studies limits its optimal application. Analyzing how AI influences learning outcomes, teaching dynamics, equity, and accessibility is essential, along with investigating the pedagogical competencies and technological conditions that affect its adoption. To this end, expanding the scope of studies is recommended by incorporating multicultural and multilingual perspectives, exploring AI applications across various disciplines and educational levels, and promoting interdisciplinary approaches that address ethical, social, and pedagogical dimensions.
Keywords	artificial intelligence (AI), elementary education, teaching, professional development and ethics, privacy

INTRODUCTION

The role of education is critical in preparing people for the changes driven by Industrial Revolution 4.0. This process requires a focus on developing 21st-century skills and incorporating digital technologies (Elayyan, 2021). Education has evolved to meet diverse learning needs by integrating advanced technologies (X. Chen et al., 2022). The adoption of artificial intelligence (AI) technologies in education has accelerated due to the COVID-19 pandemic, which has revealed both its transformative potential and its limitations and challenges (Grassini, 2023; Mallik & Gangopadhyay, 2023). AI is rapidly transforming various aspects of society, including education. This transformation necessitates a more cosmopolitan approach to education while addressing the challenges teachers face in the era of the Industrial Revolution 4.0 (Elayyan, 2021).

In the context of primary education, the integration of AI presents both opportunities and challenges for teachers. AI assists teachers in planning by facilitating content preparation, designing activities and assessments, and adapting them to the diverse abilities of learners. AI has significant potential to optimize teaching and learning processes through personalization of learning, automated assessment, and intelligent tutoring (Mallik & Gangopadhyay, 2023). From this perspective, AI optimizes various tasks that support the implementation of active and interactive learning models, enriching student learning by making it more meaningful and profound. Rather than restricting its expansion, integrating AI tools into educational settings proves to be a more effective approach (Grassini, 2023). AI has the potential to enhance education across all levels, from preschool to high school, with a particularly positive impact on disadvantaged communities (Pelaez et al., 2022). For instance, Zhang (2024) examined the application of AI in technology education, where an AI system provided continuous feedback to students during the development of a web page. This approach not only improved learning efficiency but also fostered students' autonomous learning skills.

While teachers are generally open to using AI, they face significant challenges that must be addressed to ensure their effective integration into the educational landscape. One of the first challenges is the digital divide and limited access to technology (Sharifuddin & Hashim, 2024). This challenge highlights the importance of inclusive policies that ensure that all schools, regardless of location, have access to technology. Furthermore, the successful integration of AI in the classroom heavily relies on teachers' preparedness and willingness to adapt to these new technologies (K. Kim & Kwon, 2023). Teachers need to be trained in using AI tools to support their teaching tasks. Only through proper training can AI be implemented effectively in classrooms, ensuring that students develop critical and ethical approaches to its use (Y. Chen & Zou, 2024).

On the other hand, AI tools could perform student tasks efficiently and accurately. This highlights a new challenge: redefining the role of learners in this evolving environment, where they must develop new competencies such as critical thinking, creativity, and complex problem-solving skills. Students' use of AI must be balanced carefully to prevent it from diminishing their critical and analytical skills,

which are crucial for making informed and ethical decisions about AI (García-Peñalvo et al., 2024). Lee et al. (2023) examined the implementation of an AI translator to support primary school students struggling with English learning. The findings highlighted its positive impact, reducing anxiety and boosting confidence. However, initially, teachers observed an excessive reliance on the tool, which was later moderated, suggesting that overuse could hinder students' autonomy.

Fostering technological self-efficacy in both teachers and students is crucial (Pelaez et al., 2022), and parents' digital literacy plays a key role in supporting student learning (Han et al., 2024). Teacher characteristics and competencies, especially teachers' reflective attitude, self-efficacy, and professional development, significantly influence students' academic performance (López-Martín et al., 2023). Thus, collaboration among stakeholders is vital for addressing challenges and maximizing the opportunities that AI offers in education (Grassini, 2023).

Despite the increasing interest in AI integration in education, significant challenges persist, particularly in primary education. The limited research on contextual differences between urban and rural schools, the scarcity of practical guidance for teachers, and the need for strategies to balance AI use while preserving critical skill development highlight the necessity for further investigation.

Building on these considerations, this study seeks to examine teachers' perceptions, strategies, and challenges in integrating artificial intelligence into primary education. To this end, the systematic review presented in this article is guided by the following primary research question:

- How do teachers perceive, implement, and navigate the challenges associated with integrating artificial intelligence into primary education?

To comprehensively address this central inquiry, the study formulates the following sub-questions to be answered:

- **Q1:** How do teachers perceive AI education in primary education?
- **Q2:** What methods and strategies do primary school teachers use to incorporate AI tools into their educational practice?
- **Q3:** What training have primary school teachers who integrate AI into their teaching practices received, and how do they rate its effectiveness?
- **Q4:** What are the main challenges and constraints faced by primary school teachers in incorporating AI into their teaching?

Building on these research questions, this study seeks to provide a comprehensive understanding of how AI is being integrated into primary education by examining teachers' perceptions, strategies, and challenges. A systematic review aims to identify effective pedagogical approaches, assess the suitability of teacher training programs, and highlight key barriers to the adoption of AI in the classroom. The study contributes to the ongoing discourse on AI in education by addressing these aspects and offering insights that can inform policy, curriculum development, and professional development initiatives. Ultimately, it aims to support the creation of inclusive, effective, and ethically responsible AI-powered learning environments in primary education.

LITERATURE REVIEW

IMPLEMENTATION OF DIGITAL TECHNOLOGIES IN EDUCATION

The integration of digital curricula in primary education and automated adaptive guidance in K-12 teaching have proven effective in personalizing learning (Gerard et al., 2015; S.-W. Kim, 2023; Leaton, 2020; Rienties et al., 2020; Stringer et al., 2022). However, the effectiveness of these tools largely depends on teachers' digital competence (Consoli et al., 2023), posing specific challenges depending on the educational context.

Teachers face significant barriers to implementing digital technologies (DT) in the curriculum. In rural settings, the lack of technological infrastructure and connectivity limits AI adoption, whereas in underfunded urban schools, the digital divide and the absence of adequate devices hinder effective integration (Stringer et al., 2022). Additionally, insufficient training, a lack of familiarity with DT, and low teacher self-efficacy exacerbate the situation. Dong et al. (2023) point out that different training methods and emotional factors such as attitude, interest, and confidence influence the development of computational thinking (CT). In this regard, S.-W. Kim (2023) highlights the need for further research on how emotions, perceptions, and metaphors shape attitudes toward AI.

Recent case studies further illustrate these challenges. Zhang (2024) analyzed the application of AI in primary and secondary school information courses, emphasizing the need for contextualized approaches to AI integration. Han et al. (2024) explored perspectives from teachers, parents, and students on the use of generative AI in elementary literacy education, revealing concerns regarding its practical implementation and ethical implications. Meanwhile, Sharifuddin and Hashim (2024) conducted a systematic review on the integration of AI in English as a Second Language (ESL) classrooms, highlighting its potential benefits while also identifying key challenges that hinder its effective adoption.

The transition to online teaching has exposed the lack of teacher control over virtual environments and emotional disconnection from students (Pelaez et al., 2022). To overcome these challenges, it is crucial to provide continuous professional development tailored to the specific needs of each educational context (Stringer et al., 2022). Recent studies have shown that CT training enhances digital competencies in pre-service teachers (Dong et al., 2023), while interventions focused on developing pedagogical skills have a direct impact on student academic performance (López-Martín et al., 2023).

Despite advancements in technological integration, there is still no consensus on the appropriate age and approach for introducing DT in primary education (Stringer et al., 2022). Interdisciplinary collaboration is essential to develop a theoretical, empirical, and methodological understanding of the relationship between education and technology (Rienties et al., 2020). Moreover, a regulated and collective approach to AI adoption in education is necessary to ensure social inclusion and equity (Leaton, 2020).

Impact of AI on Education

AI technology must adapt and collaborate with teachers to optimize teaching and learning processes (Pelaez et al., 2022). Human-AI collaboration is essential in this context (X. Chen et al., 2022; Molenaar, 2022). AI can facilitate self-regulated learning through sensing, diagnosis, and action; however, teachers must retain control over the technology (Molenaar, 2022).

Tools like ChatGPT can enhance teaching, research, and student services (Dempere et al., 2023). Nevertheless, despite its potential to personalize education, grade assignments, and provide academic advising, concerns arise regarding the accuracy of AI-generated responses and the possible displacement of the teacher's role (Pradana et al., 2023). While AI can improve learning efficiency, it should not replace teachers (Pua et al., 2021).

Recent studies highlight the need to assess the impact of ChatGPT on learning and to address ethical and legal considerations (Pradana et al., 2023). S.-W. Kim (2023) suggests that it is crucial to design AI education programs specifying content and duration to ensure effective learning. Additionally, Dignum (2021) underscores the importance of preparing individuals for the digital age through responsible AI development.

Empirical research also demonstrates varied outcomes of AI integration in classrooms. Lee et al. (2023) investigated the application of AI translators among low-achieving primary school English learners, finding that while AI tools can enhance engagement, they must be carefully implemented to support pedagogical objectives. García-Peñalvo et al. (2024) analyzed the emergence of generative AI

in education, warning of the risks of over-reliance on such technologies without appropriate guidelines for use.

The effective integration of AI in education requires a balanced approach that enhances teaching without replacing teachers. Future research should establish clear guidelines for ethical and pedagogical AI use, while teacher training must prioritize AI literacy. Responsible implementation will maximize AI's potential to personalize learning, support diverse students, and improve teaching in the digital era.

Ethical Considerations of AI in Education

AI governance requires a multidisciplinary approach to address its ethical and social challenges (Dignum, 2021). It is essential to develop regulations and practices that respect pedagogical rights and ensure the fair and transparent use of AI in education (Leaton, 2020).

The impact of AI on teaching and learning underscores the need to consider ethics and accountability in its application within educational contexts (Dignum, 2021). Teachers must be informed about both the benefits and limitations of AI and ensure its implementation follows human-centered principles (Pua et al., 2021). Yan et al. (2024) emphasize the importance of addressing practical and ethical challenges in the development of educational innovations.

Ethical and legal concerns surrounding AI adoption in education must be carefully considered (Mallik & Gangopadhyay, 2023). Online education should be humanized, ensuring effective interaction between AI tools and students (Pelaez et al., 2022). The lack of transparency in the operation of Large Language Models (LLMs) poses a challenge for educational stakeholders, raising risks related to privacy, equity, and data interpretability (Dempere et al., 2023; Gillani et al., 2023; Yan et al., 2024).

Given these challenges, this study aims to provide a comprehensive perspective on the integration of AI in primary education, identifying key factors influencing its adoption and offering recommendations for its effective implementation in various school contexts. Additionally, it analyzes recent case studies of schools attempting to integrate AI into their classrooms, highlighting lessons learned and existing gaps in practical guidance for its application.

METHODOLOGY

To explore the contemporary landscape of the implementation of AI techniques and tools in the pedagogical domain, a systematic review has been conducted covering the period from 2014 to 2024, adhering to the guidelines of the Preferred Reporting Items for Systematic Reviews (PRISMA 2020) (Khan et al., 2022; Page et al., 2021).

To ensure the effectiveness of the systematic review, essential components such as research questions, participants, interventions or exposures compared, outcomes measured, and methodology of the studies have been considered. (Khan et al., 2022). These components have been appropriately structured to anticipate and manage possible variations that may arise during the review process. Page et al. (2021) state that the PRISMA 2020 guideline allows the assessment of the appropriateness of methods and reliability of findings in systematic reviews.

Search in Databases

The following editorial databases were selected to locate empirical studies on the application of AI in teaching in primary classrooms: Web of Science, Scopus, and ERIC. Filters were used for empirical research and peer-reviewed articles in the fields of education and educational research from January 2014 to February 2024.

IDENTIFICATION OF SEARCH TERMS

Based on the specific requirements of the bibliographic databases, the search strategies were designed to align with the research questions. The search terms were structured into five categories:

1. **Artificial Intelligence and AI applications**: Keywords such as "artificial intelligence" OR "AI" OR "AIED" OR "AI literacy" OR "artificial intelligence literacy" were included.
2. **Education**: Terms related to the educational context, including "education" OR "school" OR "classroom" OR "education system."
3. **Teaching and pedagogical improvement**: Keywords such as "teaching" OR "teaching behavior" OR "teacher behavior" were used to capture studies on instructional practices.
4. **Educational level**: The search was restricted to primary education, using terms like "primary school" OR "elementary school" OR "K-12" OR "primary education" OR "elementary education."
5. **Exclusion criteria**: To refine the search, studies referring to higher education were excluded by filtering out terms such as "higher education" OR "college" OR "university" OR "post-secondary" OR "postsecondary."

This systematic approach allowed for a comprehensive and focused literature search, as shown in Table 1.

Table 1. Search order applied in databases

Database	Search order
Web of Science	TS=(artificial intelligence) OR TS=(AI) OR TS=(AIEd) OR TS=(AI literacy) OR TS=(artificial intelligence literacy) AND TS=(EDUCATION) OR TS=(SCHOOL) OR TS=(CLASSROOM) OR TS=(EDUCATION SYSTEM) AND TS=(TEACHING) OR TS=(teaching behavior) OR TS=(teacher behavior) AND TS=(PRIMARY SCHOOL) OR TS=(ELEMENTARY SCHOOL) OR TS=(K-12) OR TS=(PRIMARY EDUCATION) OR TS=(ELEMENTARY EDUCATION) NOT TS=(HIGHER EDUCATION) NOT TS=(COLLEGE) NOT TS=(UNIVERSITY) NOT TS=(POST SECONDARY) NOT TS=(POSTSECONDARY)
Scopus	(TITLE-ABS-KEY (artificial AND intelligence) OR TITLE-ABS-KEY (ai) OR TITLE-ABS-KEY (aied) OR TITLE-ABS-KEY (ai AND literacy) OR TITLE-ABS-KEY (artificial AND intelligence AND literacy) OR TITLE-ABS-KEY (a.i.) AND TITLE-ABS-KEY (education) OR TITLE-ABS-KEY (school) OR TITLE-ABS-KEY (classroom) OR TITLE-ABS-KEY (education AND system) AND TITLE-ABS-KEY (teaching) OR TITLE-ABS-KEY (teaching AND behaviour) OR TITLE-ABS-KEY (teacher AND behaviour) AND TITLE-ABS-KEY (primary AND school) OR TITLE-ABS-KEY (elementary AND school) OR TITLE-ABS-KEY (primary AND education) OR TITLE-ABS-KEY (k12) OR TITLE-ABS-KEY (elementary AND education) AND NOT TITLE-ABS-KEY (higher AND education) AND NOT TITLE-ABS-KEY (college) AND NOT TITLE-ABS-KEY (university) AND NOT TITLE-ABS-KEY (post AND secondary) AND NOT TITLE-ABS-KEY (postsecondary))
Eric	SU (artificial intelligence or ai or a.i.) AND SU (education or school or learning or teaching or classroom or education system) AND SU (primary school or elementary school or primary education or elementary education) NOT SU (higher education or college or university or post-secondary or postsecondary)

SEARCH CRITERIA

The search criteria were designed to locate articles that focused on AI applications in education. Following the research objectives, the following inclusion and exclusion criteria were adopted (Table 2).

Table 2. Search criteria

Search criteria	Inclusion	Exclusion
Period	Published from 2014 to 2024 WOS: 512,205 SCOPUS: 291 ERIC: 2,423	Studies outside this period
Type of literature	Peer-reviewed journal articles WOS: 23,967 SCOPUS: 110 ERIC: 1,902	Literature other than peer-reviewed journal articles
Accessibility	Full text available WOS: 15,520 SCOPUS: 59 ERIC: 1,212	Not accessible
Categories	Education & Educational Research (6.11) and Social Science and Computer Science WOS: 1,019 SCOPUS: 48 (Social Sciences and Computer Science) ERIC: 1,065	Learning content is not the same
Search by title	WOS: 96 SCOPUS: 23 ERIC: 371	Excluding articles whose titles are not in line with the topic in question
Language	English and Spanish WOS: 96 SCOPUS: 23 ERIC: 344	Excluding articles not written in English or Spanish
Import to Mendeley	WOS: 87 SCOPUS: 22 ERIC: 314	Excluding duplicates and those not passed due to electronic failure (n= 40)
According to the title and abstract	78	Excluding articles whose title or abstract did not correspond to the subject in question (n=345)
Research design	Studies should report the effects of AI-supported instruction and teaching (n=28)	Studies that do not report on the effects of AI-supported instruction and learning (n=50)

STUDY SELECTION PROCESS

The selection process followed a structured strategy based on the inclusion and exclusion criteria defined in Table 2. It was divided into three phases – Identification, Selection, and Inclusion – ensuring the relevance, quality, and applicability of the selected studies while adhering to the guidelines of the PRISMA, as shown in Figure 1. Below, the specific filters and their impact on the final dataset are detailed:

1. ***IDENTIFICATION,*** the first phase aimed to establish a relevant timeframe for the literature review.
    - **Period:** Studies published between 2014 and 2024 were included to ensure up-to-date literature (*WOS: 512,205; SCOPUS: 291; ERIC: 2,423*). Studies published outside this period were excluded.
2. ***SCREENING,*** in this phase, additional selection criteria were applied to refine the dataset and ensure the relevance and quality of the included studies.

- **Type of Literature:** Only peer-reviewed journal articles were selected to guarantee scientific rigor (*WOS: 23,967; SCOPUS: 110; ERIC: 1,902*). Non-peer-reviewed sources were excluded (*WOS: 488,238; SCOPUS: 181; ERIC: 521*).
- **Accessibility:** Studies with full-text availability were included to allow for in-depth analysis (*WOS: 15,520; SCOPUS: 59; ERIC: 1,212*). Articles without full-text access were removed (*WOS: 8,447; SCOPUS: 51; ERIC: 690*).
- **Thematic Categories:** Only studies within the fields of **Education, Social Sciences, and Computer Science** were selected (*WOS: 1,019; SCOPUS: 48; ERIC: 1,065*). Articles unrelated to these disciplines were excluded (*WOS: 14,501; SCOPUS: 11; ERIC: 147*).
- **Title-Based Filtering:** Articles whose titles explicitly aligned with the research topic were retained, in general, "use of AI in primary education", (*WOS: 96; SCOPUS: 23; ERIC: 371*), while non-relevant titles were excluded (*WOS: 923; SCOPUS: 25; ERIC: 694*).
- **Language:** Studies in **English and Spanish** were considered to ensure accessibility (*WOS: 96; SCOPUS: 23; ERIC: 344*). Publications in other languages were excluded (*WOS: 0; SCOPUS: 0; ERIC: 27*).
- **Import to Mendeley:** Duplicates and records with electronic import errors (*n=40*) were removed (*WOS: 9; SCOPUS: 1; ERIC: 30*), leading to a refined dataset (*WOS: 87; SCOPUS: 22; ERIC: 314*).

3. ***INCLUSION,*** the final phase focused on ensuring the thematic and methodological alignment of the selected studies with the research objectives.

    - **Title and Abstract Screening:** A detailed review of titles and abstracts was conducted. Articles misaligned with the research topic were discarded, reducing the dataset to **n=78** after excluding *n=345* irrelevant studies.
    - **Research Design:** Only studies that explicitly reported the effects of **AI-supported instruction and teaching** were included **(*n=28*)**. Articles that did not address this aspect were excluded (*n=50*).

The systematic application of these filters allowed us to refine a broad initial data set into a selection of highly relevant studies. The combination of criteria ensured that the final data set was current, scientifically rigorous, accessible, thematically relevant, and methodologically aligned with the study objectives. These measures improve the robustness, replicability, and impact of the research findings, ensuring that the results obtained are robust, replicable, and valuable for advancing knowledge in the field.

LIMITATIONS AND BIASES IN THE STUDY SELECTION PROCESS

While the selection process is rigorous and designed to ensure the relevance of the included studies, the applied filters may have introduced certain limitations and biases. These could affect the representativeness of the final sample and exclude valuable studies that might have enriched the research findings. The following section outlines the potential limitations and biases that may have arisen in this study:

- **Time Range (2014-2024):** Excluding studies before 2014 may omit valuable insights into the historical evolution of AI in primary education.
- **Literature Type (Peer-Reviewed Only):** Restricting selection to peer-reviewed articles excludes other relevant sources like reports, theses, books, and conference papers, potentially biasing findings toward academic journals.
- **Full-Text Accessibility:** Filtering out articles without full-text access may favor commercially available research while excluding significant but less accessible contributions.
- **Thematic Categories (Education, Social Sciences, Computer Science):** This restriction may overlook studies from fields like psychology, engineering, or cognitive sciences that could provide valuable perspectives on AI in education.

- **Language Filter (English and Spanish):** Excluding studies in other languages (e.g., French, German, Chinese) may introduce linguistic bias and limit the diversity of perspectives.
- **Title and Abstract Screening:** Filtering based on these sections may lead to the omission of relevant studies that do not explicitly reflect their full scope in the title or abstract.
- **Mendeley Import and Duplicate Removal:** Eliminating duplicate records and import errors may inadvertently exclude relevant studies, particularly those stored across multiple databases.

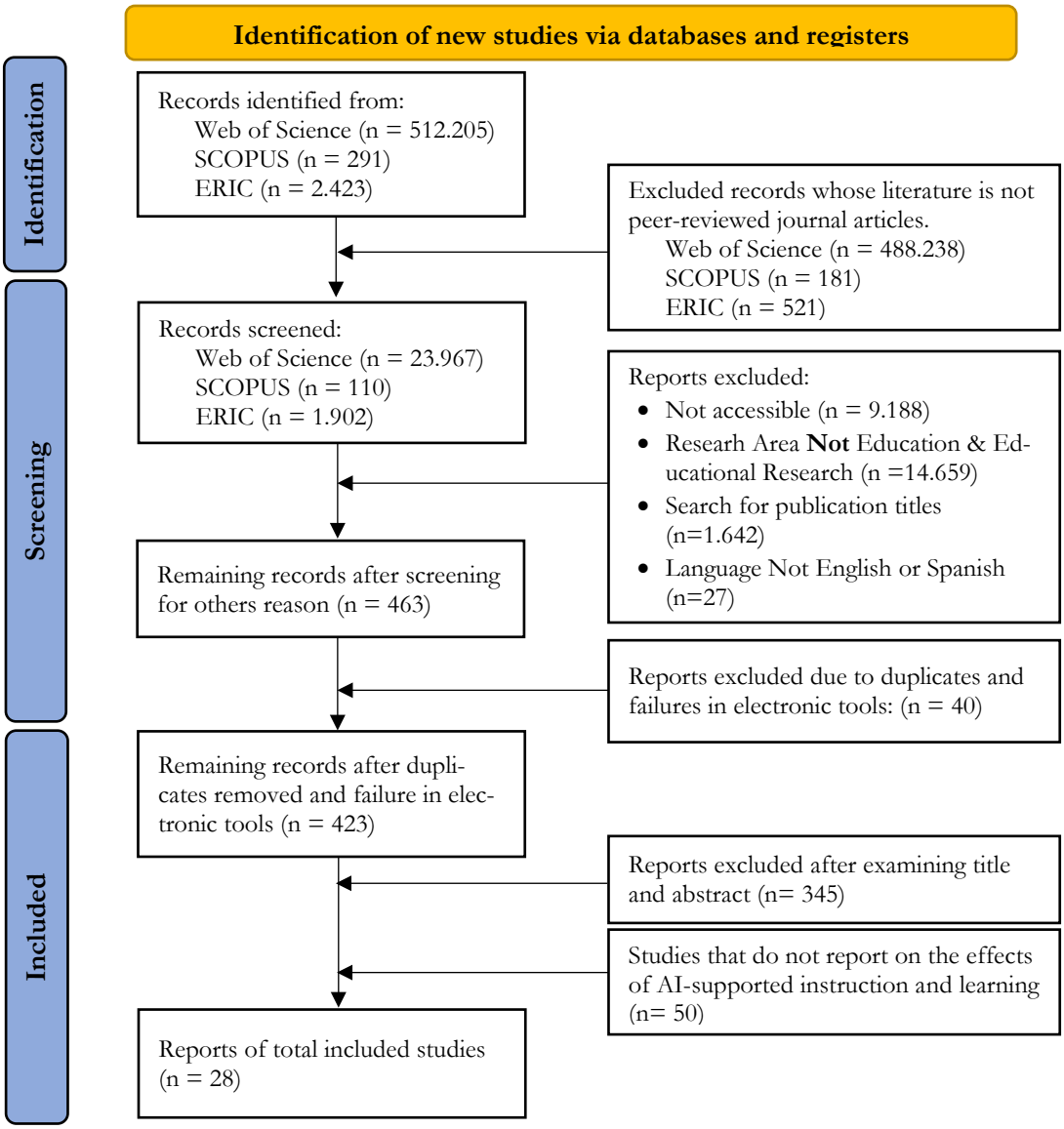

Figure 1. PRISMA diagram

RESULTS

After detailing and analyzing the search methodology, 28 selected articles were reviewed to identify patterns within the collected data. To facilitate this analysis, visual representations, including graphs, were created to highlight key data such as research designs, publication years, and the number of articles addressing each research question. These visual tools enabled a better understanding of the findings and helped identify relevant trends in the selected studies.

The studies employed a variety of research designs: 16 articles utilized qualitative methods, 8 adopted quantitative approaches, and 4 employed mixed methods designs. Notably, 92.8% of the articles in this systematic review were published within the last three years, highlighting the topic's contemporary relevance (Figure 2).

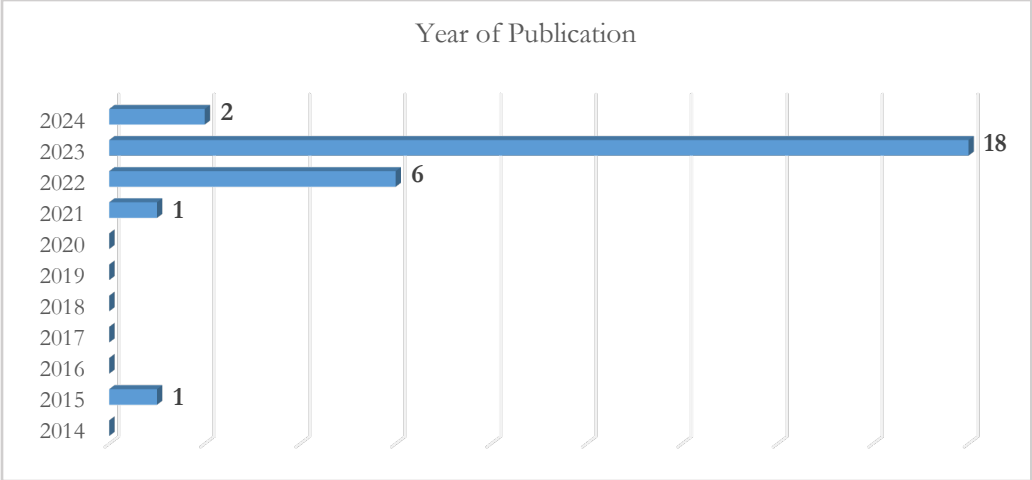

Figure 2. Publication year of selected studies

Articles published in 2014 and from 2016 to 2020 were excluded from this review, as no publications specifically addressed the research questions outlined in the study. Although some relevant articles were identified, they focused exclusively on higher education contexts, which fell outside the scope of this investigation. This exclusion was crucial to ensure that the analysis remained aligned with the research objectives.

To provide an in-depth interpretation of the data, the articles were analyzed about the research questions, resulting in the identification, construction, and discussion of codes and categories emerging from the 28 studies (Figure 3). It is important to note that a single article may address multiple research questions, contributing to a broader understanding of the themes analyzed.

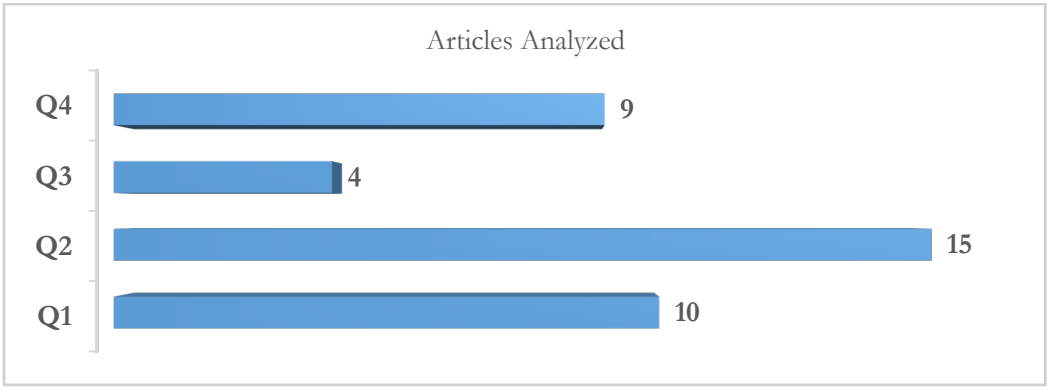

Figure 3. Number of articles analyzed by the research question

As a result of this analysis, a table was created summarizing the key findings for each research question (Annexes A, B, C, and D). While the annexes provide a more detailed and comprehensive breakdown of the information, the results have been condensed in Tables 3, 4, 5, and 6 to facilitate a clearer understanding of the main findings.

Table 3. Summary of the main findings of research question Q1

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
1	Q1-Q2	An, X., Chai, C. S., Li, Y., Zhou, Y., Shen, X., Zheng, C., & Chen, M. (2023).	Modeling English teachers' behavioral intention to use artificial intelligence in middle schools.	To investigate the perceptions, knowledge, and intended use of AI by English as a foreign language (EFL) teachers in secondary education. To examine factors influencing EFL teachers' intention to use AI in education.	EFL teachers have positive perceptions toward the use of AI in teaching, with Performance Expectancy and knowledge of AI-TPACK as influential factors in their intention to use it. Teachers' knowledge of AI-TPACK significantly predicts their intention to use it. Other factors, such as technological knowledge of the AI language and enabling conditions, are also influential.
2	Q1-Q2	Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023).	Artificial intelligence and human behavioral development: A perspective on new skills and competencies acquisition for the educational context.	Explore how digitization and artificial intelligence can promote 21st-century skills such as creativity, critical thinking, problem-solving, and computational thinking in educational contexts.	Integrating computational thinking, programming, and coding into school curricula is essential. Creativity can enhance computational thinking, and AI can foster creativity. Critical thinking is crucial for problem-solving and can be enhanced through computational thinking and programming with the help of AI.
3	Q1-Q2	Casal-Otero, L., Catala, A., Fernandez-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023)	AI literacy in K-12: A systematic literature review.	Understand how artificial intelligence is being integrated into K-12 education globally, identifying learning experience approaches and theoretical perspectives.	A growing interest in IA education in K-12 schools was identified, with a variety of approaches to teaching IA concepts to students.
4	Q1	Chalmers, C., Keane, T., Boden, M., & Williams, M. (2022).	Humanoid robots go to school.	To explore teachers' perceptions of the use of humanoid robots in the classroom and how they can enhance curriculum and student engagement.	Teachers reported benefits in the use of robots for student engagement and learning, highlighting innovation, creativity, and computational thinking.
5	Q1	Chen, S., Qiu, S., Li, H., Zhang, J., Wu, X., Zeng, W., & Huang, F. (2023).	An integrated model for predicting pupils' acceptance of artificially intelligent robots as teachers.	To investigate the acceptance of an AI teacher among primary school students in China, identify factors that influence this acceptance, and explore the role of technology in education.	Student acceptance of the AI teacher was moderate. The factors most influencing acceptance were perceived usefulness, ease of use, and task characteristics. Previous experience with IA teachers also affects acceptance.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
6	Q1	Gerard, L., Matuk, C., McElhaney, K., & Linn, M. C. (2015).	Automated, adaptive guidance for K-12 education.	Investigate the effectiveness of automated, adaptive guidance in K-12 education compared to traditional teacher-directed instruction. To explore specific features of automated guidance that enhance student learning.	Automated, adaptive guidance is generally as effective or more effective than traditional instruction in improving student learning outcomes. Enhanced guidance (with detailed feedback or motivational scaffolding) is more effective than simpler forms of guidance.
7	Q1-Q3	El Hajj, M., & Harb, H. (2023).	Rethinking education: An in-depth examination of modern technologies and pedagogic recommendations	Explore the integration of technology in education through the Technological Pedagogical Content Knowledge (TPCK) framework, emphasizing student-centered learning. Identify technological tools that facilitate interactive and engaging teaching strategies.	Technology-based education improves student learning by integrating technological tools into the teaching and learning process. Technology tools such as Tricider, AnswerGarden, and MindMeister, among others, can be used to facilitate teaching strategies such as flipped classrooms, inquiry-based learning, and peer feedback.
8	Q1-Q2	Kim, J., Lee, H., & Cho, Y. H. (2022).	Learning design to support student-AI collaboration: Perspectives of leading teachers for AI in education	Explore the integration of Artificial Intelligence (AI) in education, focusing on student-AI collaboration and how this can improve learning in K-12 schools.	Teachers view student-AI collaboration as a tool for achieving optimal learning objectives, emphasizing the importance of knowledge construction, interdisciplinary learning, authentic problem-solving, and creative assignments.
9	Q1-Q2	Lim, E. M. (2023).	The effects of preservice early childhood teachers' digital literacy and self-efficacy on their perception of AI Education for young children	To examine the relationship between digital literacy, self-efficacy, and perceptions of AI (Artificial Intelligence) education for young children among prospective early childhood education teachers.	The means of digital literacy, self-efficacy, and perception of AI education were 3.43, 3.31, and 3.36 respectively, indicating a positive relationship between these variables. Self-efficacy measured the relationship between digital literacy and perception of AI education.
10	Q1	Sanusi, I. T., Ayanwale, M. A., & Chiu, T. K. F. (2024).	Investigating the moderating effects of social good and confidence on teachers' intention to prepare school	To examine factors influencing teachers' intention to teach artificial intelligence (AI) in schools, including anxiety toward AI, perceived usefulness, atti-	AI relevance was the most significant predictor of intention to teach AI. Perception of AI for social good and confidence in teaching AI had significant impacts on the intention to teach AI.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
			students for artificial intelligence education.	tude toward AI, AI relevance, AI readiness, and behavioral intention. In addition, to investigate the moderating effects of AI for social good and confidence in teaching AI.	

Q1. Teacher Perceptions of K-12 AI Education

The integration of artificial intelligence (AI) in education is transforming teaching and learning processes, particularly through its role in enhancing critical thinking and problem-solving skills (Benvenuti et al., 2023). Faculty members recognize that previous experience with similar technologies influences acceptance (S. Chen et al., 2023), while technology-based education optimizes learning by integrating digital tools into teaching (El Hajj & Harb, 2023). However, the implementation of AI varies depending on the educational context, particularly between urban and rural schools.

Urban schools, with greater infrastructure and access to resources, facilitate AI integration more effectively, whereas rural schools face technological and training limitations that hinder adoption (Casal-Otero et al., 2023; El Hajj & Harb, 2023). This disparity extends to AI tools: humanoid robots, which are costly, are more common in urban settings, while AI-based educational software is more accessible and widely used in both contexts (Chalmers et al., 2022). Furthermore, AI-driven personalized learning is constrained in rural areas due to limited connectivity and device availability (Gerard et al., 2015).

AI-enhanced guidance plays a crucial role in conceptual learning and strategy development (Gerard et al., 2015). Automated guidance benefits students with low to medium prior knowledge (Chalmers et al., 2022) and can be as effective as, or even more effective than, traditional instruction (Gerard et al., 2015). Teachers also perceive humanoid robots as beneficial for student engagement and skill development (Chalmers et al., 2022). Advanced guidance strategies incorporating detailed feedback and motivational scaffolding improve learning outcomes, surpassing simpler instructional approaches (Gerard et al., 2015).

Teachers highly value student-AI collaboration in learning. AI serves as a "learning partner," providing instructional scaffolding and fostering effective collaboration (J. Kim et al., 2022). Educators emphasize AI's role in knowledge construction, interdisciplinary learning, problem-solving, and creative tasks, while factors such as ease of use and task characteristics are deemed less influential (S. Chen et al., 2023). These perspectives align with broader trends in teacher attitudes toward AI adoption.

Studies indicate that elementary school teachers generally hold positive attitudes toward AI in education (An et al., 2023). Digital literacy and self-efficacy mediate their perceptions, reinforcing confidence in teaching AI (Lim, 2023). Expected performance benefits and knowledge levels significantly impact teachers' intent to adopt AI (An et al., 2023), though concerns persist regarding its long-term impact on education (Sanusi et al., 2024). Factors such as self-esteem, expected benefits, and perceived ease of use also shape attitudes toward AI integration in teaching (Nja et al., 2023).

The selection of AI tools is influenced by perceived usefulness, ease of use, and task characteristics, with prior experience playing a key role (S. Chen et al., 2023). Curriculum design that incorporates AI-based learning experiences strengthens teacher confidence in using such technologies (K. Kim & Kwon, 2023). Furthermore, teachers' confidence and recognition of AI's relevance for social good significantly impact their willingness to integrate AI into their teaching practices (Ayanwale et al.,

2022; Sanusi et al., 2024). This underscores the need for professional development programs to enhance teachers' AI-related competencies (Lim, 2023).

Overall, AI adoption in education is shaped by contextual factors, pedagogical perceptions, and technological accessibility. Addressing disparities in training opportunities and infrastructure, particularly in rural settings, is crucial for equitable AI integration.

A key real-life example of these trends is the use of humanoid robots in classrooms to foster student engagement and creativity, as observed in the study by Chalmers et al. (2022). This study shows how technology can transform the learning environment and motivate students in innovative ways.

Table 4. Summary of the main findings of research question Q2

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
	Q1-Q2	An, X., Chai, C. S., Li, Y., Zhou, Y., Shen, X., Zheng, C., & Chen, M. (2023).	Modeling English teachers' behavioral intention to use artificial intelligence in middle schools	To investigate the perceptions, knowledge, and intended use of AI by English as a foreign language (EFL) teachers in secondary education. To examine factors influencing EFL teachers' intention to use AI in education.	EFL teachers have positive perceptions toward the use of AI in teaching, with Performance Expectancy and knowledge of AI-TPACK as influential factors in their intention to use it. Teachers' knowledge of AI-TPACK significantly predicts their intention to use it. Other factors, such as technological knowledge of the AI language and enabling conditions, are also influential.
2	Q2-Q4	Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022).	Teachers' readiness and intention to teach artificial intelligence in schools	To explore the factors influencing teachers' intention to teach artificial intelligence (AI) in schools and to understand teachers' willingness to implement AI in education.	Factors such as AI literacy, confidence in learning, and AI relevance were significant predictors of behavioral intention. Confidence in teaching AI and AI relevance significantly predicted teachers' intention to teach AI.
3	Q1-Q2	Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023).	Artificial intelligence and human behavioral development: A perspective on new skills and competencies acquisition for the educational context.	Explore how digitization and artificial intelligence (AI) can promote 21st-century skills such as creativity, critical thinking, problem-solving, and computational thinking in educational contexts.	Integrating computational thinking, programming, and coding into school curricula is essential. Creativity can enhance computational thinking, and AI can foster creativity. Critical thinking is crucial for problem-solving and can be enhanced through computational thinking and programming with the help of AI.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
4	Q2-Q4	Bozkurt, A. (2023)	Generative Artificial Intelligence (AI) powered conversational educational agents: The inevitable paradigm shift	Explore the use and impact of generative artificial intelligence, with a focus on ChatGPT, in education.	Generative artificial intelligence, especially ChatGPT, has significant potential to transform teaching and learning methods.
5	Q1-Q2	Casal-Otero, L., Catala, A., Fernandez-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023)	AI literacy in K-12: A systematic literature review	Understand how artificial intelligence (AI) is being integrated into K-12 education globally, identifying learning experience approaches and theoretical perspectives.	A growing interest in IA education in K-12 schools was identified, with a variety of approaches to teaching IA concepts to students.
6	Q2	Chichekian, T., & Benteux, B. (2022)	The potential of learning with (and not from) artificial intelligence in education	Explore the potential of artificial intelligence (AI) in education, focusing on the effectiveness of AI-driven technologies, the role of teachers, and contributions to the field of education.	Most research focuses on the optimization of AI systems rather than on the quality of learning outcomes. The need for more theoretical investigations and a pedagogical perspective in AI research in education is emphasized.
7	Q2	Dimitriadou, E., & Lanitis, A. (2023).	A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms	Explore the role of artificial intelligence (AI) and other emerging technologies in smart classrooms, highlighting both the benefits and challenges of their use in education.	Enhance the learning experience by supporting interactive experiences and real-time feedback. Increased student and teacher engagement and performance through technologies such as VR/AR and robotics. Identification of challenges such as equipment costs needs for teacher training, data privacy concerns, and biases in AI systems.
8	Q2	Gentile, M., Città, G., Perna, S., & Allegra, M. (2023).	Do we still need teachers? Navigating the paradigm shift of the teacher's role in the AI era	Examine the changing role of teachers in the age of artificial intelligence (AI) and propose a manifesto to guide this evolution.	A need for teachers to adapt to new technologies and teaching methods. IA is transforming teacher-student relationships and teaching methods.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
9	Q2	Karalekas, G., Vologiannidis, S., & Kalomiros, J. (2023).	Teaching machine learning in K-12 using robotics	Discuss the importance of and approaches to integrating educational robotics and ML in K-12 education.	Identification of tools and platforms such as Scratch, Cognimates, Teachable Machine, and TensorFlow Playground. Presentation of six AI-powered educational robots: Zumi, RoboMaster S1, ClicBot, Cozmo, MINDSTORMS Robot Inventor, and Cogbots.
10	Q1-Q2	Kim, J., Lee, H., & Cho, Y. H. (2022).	Learning design to support student-AI collaboration: Perspectives of leading teachers for AI in education	Explore the integration of Artificial Intelligence (AI) in education, focusing on student-AI collaboration, and how this can improve learning in K-12 schools.	Teachers view student-AI collaboration as a tool for achieving optimal learning objectives, emphasizing the importance of knowledge construction, interdisciplinary learning, authentic problem-solving, and creative assignments.
11	Q2-Q4	Kim, K., & Kwon, K. (2023).	Exploring the AI competencies of elementary school teachers in South Korea	To explore the experiences of elementary school teachers in South Korea teaching AI curricula and identify the competencies needed for effective implementation of AI education.	Twenty-two AI competencies were identified for elementary school teachers based on the TPACK framework. Teachers felt most confident in their pedagogical knowledge, followed by technological knowledge and content knowledge.
12	Q1-Q2	Lim, E. M. (2023).	The effects of pre-service early childhood teachers' digital literacy and self-efficacy on their perception of ai education for young children	To examine the relationship between digital literacy, self-efficacy, and perceptions of AI (Artificial Intelligence) education for young children among prospective early childhood education teachers.	The means of digital literacy, self-efficacy, and perception of AI education were 3.43, 3.31, and 3.36, respectively, indicating a positive relationship between these variables. Self-efficacy measured the relationship between digital literacy and perception of AI education.
13	Q2-Q4	Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022).	Teachers' trust in AI-powered educational technology and a professional development program to improve it	Improve teachers' confidence in AI technology through a professional development program.	Teachers showed an increase in confidence toward AI technology in education, leading to a greater willingness to use AI tools in their classrooms.
14	Q2	Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S.,	A review of AI teaching and learning from 2000 to 2020.	Analyze trends in AI teaching and learning (AITL) research.	The most significant results of the study include the identification of methods and areas of study in AITL, and the analysis of

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
		& Chu, S. K. W. (2023).			trends and effects on education. The importance of understanding trends in AITL to improve the teaching and learning of artificial intelligence was confirmed. Notable trends were observed in the methodology used, fields of study addressed, and effects on education, suggesting growth and evolution in AITL research over time.
15	Q2	Nja, C. O., Idiege, K. J., Uwe, U. E., Meremikwu, A. N., Ekon, E. E. E., Erim, C. M., Ukah, J. U., Eyo, E. O., Anari, M. I., & Cornelius-Ukpepi, B. U. (2023).	Adoption of artificial intelligence in science teaching: From the vantage point of the African science teachers	Explore the use of technology in education, including artificial intelligence, online learning environments, and the uptake of ICT by different age groups. Highlight factors influencing technology adoption by teachers and the impact on student learning outcomes.	The most significant results of the study include the fact that self-esteem, expected benefits, and ease of use significantly impact teachers' attitudes toward the use of artificial intelligence in science teaching. In addition, teachers' location of residence was found to not influence their intention to use artificial intelligence in teaching. Overall, it was confirmed that science teachers show high approval toward the integration of artificial intelligence in the science classroom. No significant differences in the results were observed as a function of teachers' gender, age, or location of residence.

Q2. Methods and Strategies for Incorporating AI Tools Into Teaching Practice

Effective integration of technology in education is essential, particularly in the case of artificial intelligence (AI). Training teachers in AI and digital competencies is critical to ensuring its effective incorporation into pedagogical practices (Gentile et al., 2023; Nja et al., 2023). However, the extent of AI adoption varies significantly depending on factors such as infrastructure, resource availability, and teacher training opportunities, particularly when comparing urban and rural schools.

Urban schools, with greater access to infrastructure and funding, more easily implement AI-based educational tools. In contrast, rural schools face technological limitations and restricted access to teacher training, which hinders AI adoption (Karalekas et al., 2023; Nja et al., 2023). These disparities influence the types of AI tools utilized. For instance, platforms such as Scratch and Teachable Machine, which enhance STEM education, are widely used due to their accessibility. Schools with

greater resources, however, often adopt more advanced AI solutions, while others rely on simpler, cost-effective alternatives (Karalekas et al., 2023).

To address these disparities, methods and strategies for AI integration must focus on designing curricula that foster AI literacy and experiential learning. Educators must update teaching approaches to responsibly incorporate AI, leveraging hands-on activities and interdisciplinary learning (Bozkurt et al., 2023; K. Kim & Kwon, 2023; Nazaretsky et al., 2022). The combination of traditional teaching methods with AI technologies can enhance student engagement and learning outcomes (Dimitriadou & Lanitis, 2023).

In primary education, AI integration is driven by teacher training and competency development. The research underscores the importance of professional development programs that strengthen AI literacy, digital skills, and self-efficacy (Casal-Otero et al., 2023; K. Kim & Kwon, 2023; Nja et al., 2023). Furthermore, AI education policies must be formulated to support curriculum design, teacher capacity building, and a culture of collaborative learning (J. Kim et al., 2022).

The role of computational thinking, programming, and coding in AI education is crucial (Benvenuti et al., 2023). Pedagogical strategies like collaborative and project-based learning enhance AI integration and foster problem-solving skills. Creativity can also strengthen computational thinking, with AI tools supporting innovative learning experiences (Benvenuti et al., 2023; Ng et al., 2023). For example, teachers using humanoid robots report increased student engagement and the development of 21st-century skills (Chalmers et al., 2022).

AI adoption is also influenced by teachers' perceptions and expectations. Studies indicate that performance expectancy, AI-TPACK knowledge, and self-efficacy play a crucial role in educators' willingness to integrate AI into their teaching (An et al., 2023; Sanusi et al., 2024). However, psychological factors, such as anxiety about AI's future role in education, can hinder its adoption (Lim, 2023; Sanusi et al., 2024). Instructors teaching EFL, for instance, show a positive attitude toward AI, influenced by their expectations of its effectiveness and their familiarity with AI pedagogical tools (An et al., 2023).

To optimize AI integration in education, transparency in AI decision-making and teacher control over AI tools are essential (Nazaretsky et al., 2022). Targeted professional development, ongoing support, and competency frameworks can help educators navigate AI-driven education effectively (Casal-Otero et al., 2023). Digital literacy, particularly in prompt engineering, should also be emphasized to enable effective interaction with AI technologies (Bozkurt, 2023).

The implications of these findings highlight the importance of tailoring AI education to different learning contexts and balancing AI implementation with traditional teaching methodologies. By ensuring equitable access to AI resources and professional training, education systems can better prepare teachers and students for the transformative role of AI in the classroom (Bozkurt, 2023; Chichekian & Benteux, 2022).

Table 5. Summary of the main findings of research question Q3

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
1	Q3	Cheng, E. C. K., & Wang, T. (2023).	Leading digital transformation and eliminating barriers for teachers to incorporate artificial intelligence in basic education in Hong Kong	Exploring the impact of digital leadership on the integration of Artificial Intelligence in Education (AIED), with a focus on overcoming teacher barriers.	Digital leadership significantly predicts all three approaches to AI application in education, while internal teacher barriers negatively predict learning about AI.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
2	Q3	Dai, Y., Lin, Z., Liu, A., Dai, D., & Wang, W. (2024).	Effect of an analogy-based approach of artificial intelligence pedagogy in upper primary schools	Develop a scenario-based instrument to assess co-design expertise in humanitarian engineering and explore the use of analogies and metaphors in science education. In addition, investigates the teaching of artificial intelligence (AI) in K-12 classrooms and the importance of AI literacy.	Teaching IA using a pedagogical approach that demystifies IA and uses analogies significantly improves students' understanding, performance, and interest in IA. Students who learned with the analogy-based approach outperformed those with conventional instruction in IA knowledge, skills, and ethical awareness.
3	Q1-Q3	El Hajj, M., & Harb, H. (2023).	Rethinking education: An in-depth examination of modern technologies and pedagogic recommendations	Explore the integration of technology in education through the Technological Pedagogical Content Knowledge (TPCK) framework, emphasizing student-centered learning. Identify technological tools that facilitate interactive and engaging teaching strategies.	Technology-based education improves student learning by integrating technological tools into the teaching and learning process. Technology tools such as Tricider, AnswerGarden, MindMeister, among others, can be used to facilitate teaching strategies such as flipped classrooms, inquiry-based learning, and peer feedback.
4	Q3	Yau, K. W., Chai, C. S., Chiu, T. K. F., Meng, H., King, I., & Yam, Y. (2023)	A phenome graphic approach on teacher conceptions of teaching Artificial Intelligence (AI) in K-12 schools	To investigate teachers' conceptions of teaching Artificial Intelligence (AI) in K-12 schools using a phenome graphic approach.	The most significant results of the study include the identification of 6 categories of conceptions of Artificial Intelligence (AI) teaching in teachers. These categories cover aspects such as technological bridging, knowledge delivery, stimulation of interest, establishment of ethics, cultivation of skills, and intellectual development.

Q3. Teacher Training in AI and Assessment of Its Effectiveness in Classroom Integration

The effective integration of AI in education requires professional training, strengthening specific AI knowledge, and fostering a positive perception of its usefulness among teachers (An et al., 2023; Casal-Otero et al., 2023). Understanding teachers' diverse perspectives is essential to improving AI teaching in educational settings, as well as developing training programs that encourage a deeper pedagogical approach (K. Kim & Kwon, 2023; Lim, 2023; Yau et al., 2023).

Teachers' conceptions of AI education fall into six key categories: technological bridging, knowledge delivery, interest stimulation, ethical establishment, skill cultivation, and intellectual development (Yau et al., 2023). These perspectives significantly influence classroom practices and student learning (Chichekian & Benteux, 2022; Lim, 2023), underscoring the need to align professional development programs with these pedagogical conceptions. AI is recognized as a tool for fostering creativity, critical thinking, and problem-solving (Benvenuti et al., 2023). Performance expectancy and AI knowledge are strong predictors of teachers' intention to adopt AI, while effort expectancy does not directly influence their willingness to integrate it (An et al., 2023).

Different instructional strategies have been explored to enhance AI education, such as using analogies to facilitate comprehension, which suggests treating AI as an interdisciplinary subject rather than a standalone field (Dai et al., 2024). Furthermore, AI-driven tools like robot tutors and virtual reality contribute to personalized and collaborative learning experiences (Benvenuti et al., 2023). The role of educators is critical in guiding AI implementation, ensuring its ethical and effective integration into curricula (El Hajj & Harb, 2023; Nazaretsky et al., 2022).

Continuing professional development and training programs should focus on equipping teachers with AI knowledge and practical applications while emphasizing human agency in AI-assisted learning environments (El Hajj & Harb, 2023). Confidence-building and relevance-centered training programs can further support AI adoption (Ayanwale et al., 2022). Digital leadership also plays a crucial role in overcoming barriers to AI integration in education (Cheng & Wang, 2023).

Given the increasing role of AI in education, it is imperative to foster co-evolutionary learning, where students engage with AI in three ways: learning about AI, learning from AI, and learning alongside AI (J. Kim et al., 2022). The interconnectedness of creativity, computational thinking, and critical thinking is fundamental to achieving meaningful learning outcomes (Benvenuti et al., 2023). Consequently, AI education should be systematically incorporated into K-12 curricula, treating AI literacy as a core competency (Cheng & Wang, 2023). Teachers who have undergone AI training exhibit higher confidence and efficacy in integrating AI into their teaching practices (Nazaretsky et al., 2022; Sanusi et al., 2024), with AI literacy and perceived relevance acting as strong predictors of their behavioral intentions (Casal-Otero et al., 2023; Chalmers et al., 2022; Lim, 2023). AI adoption in schools varies depending on infrastructure and resources. With better access to technology and teacher training, urban schools integrate AI more easily, while rural schools face technological and training limitations (Karalekas et al., 2023; Nja et al., 2023). The availability of connectivity and devices also determines the feasibility of personalized AI-driven learning (Gerard et al., 2015).

In primary education, teacher training and competency development are central to AI integration. Digital literacy, curriculum updates, and active pedagogical strategies are emphasized as essential elements for effective AI adoption (Casal-Otero et al., 2023; K. Kim & Kwon, 2023; Nja et al., 2023). Combining traditional methods with advanced technologies and competency frameworks can guide AI implementation in classrooms (Dimitriadou & Lanitis, 2023; Nazaretsky et al., 2022). The importance of teacher expectations regarding AI performance, as well as their knowledge of AI-TPACK, is evident in their willingness to integrate AI into their teaching, as shown in studies on EFL instruction (An et al., 2023).

Real-world examples highlight the impact of innovative AI teaching strategies. For instance, Dai et al. (2024) demonstrate that analogy-based instruction significantly improves student understanding and engagement with AI compared to traditional methods. This finding underscores the need to adapt pedagogical strategies to leverage AI effectively in education. Similarly, Nazaretsky et al. (2022) emphasize the necessity of granting teachers control over AI recommendations and flexibility in using AI tools in diverse educational settings. The adaptability of AI tools to specific school environments is a critical factor for their successful adoption.

In conclusion, professional development, digital literacy, and pedagogical innovation are fundamental to ensuring the effective and ethical integration of AI in education. Providing teachers with agency

over AI-driven recommendations and fostering competency-based frameworks will facilitate AI adoption across diverse learning environments. The role of educators remains indispensable in guiding AI integration, ensuring that technology serves as a tool to enhance rather than replace traditional teaching methodologies.

Table 6. Summary of the main findings of research question Q4

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
1	Q4	Abylkasymova, A. E., Shishov, S. E., Kalney, V. A., & Ryakhimova, E. G. (2022).	Influence of high-tech society on the development of modern educational system.	To explore how high-tech society influences the development of the modern educational system, addressing the formation of a valid educational system, principles of interaction with high-tech education, effective methods and tools, and the role of machines in education.	A need to adapt the education system to the digital era by incorporating technologies such as VR/AR, mobile internet, and digital skills education.
2	Q2-Q4	Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022).	Teachers' readiness and intention to teach artificial intelligence in schools.	To explore the factors that influence teachers' intention to teach artificial intelligence (AI) in schools, and to understand teachers' willingness to implement AI in education.	Factors such as AI literacy, confidence in learning, and AI relevance were significant predictors of behavioral intention. Confidence in teaching AI and AI relevance significantly predicted teachers' intention to teach AI.
3	Q4	Barakina, E. Y., Popova, A. V, Gorokhova, S. S., & Voskovskaya, A. S. (2021).	Digital Technologies and Artificial Intelligence Technologies in Education.	Explore the use of digital and artificial intelligence (AI) technologies in education, evaluating their benefits, risks, and impact on teaching, learning, and evaluation of students. In addition, it seeks to understand the legal regulations and international experiences in the implementation of these technologies.	Benefits and risks of AI in education. Varied experiences from different countries in the implementation of AI technologies in education. Recommendations for the development of legal regulations in AI in education.
4	Q2-Q4	Bozkurt, A. (2023).	Generative Artificial Intelligence (AI) Powered Conversational Educational Agents: The Inevitable Paradigm Shift.	Explore the use and impact of generative artificial intelligence, with a focus on ChatGPT, in education.	Generative artificial intelligence, especially ChatGPT, has significant potential to transform teaching and learning methods.

Nº.	Question	Author/year of publication	Title	Objectives of the study	Most relevant results
5	Q4	Bozkurt, A., Xiao, J., Lambert, S., Pazurek, A., Crompton, H., Koseoglu, S., Farrow, R., Bond, M., Nerantzi, C., Honeychurch, S., Bali, M., M.., Dron, J., Mir, K., Stewart, B., Costello, E., Mason, J., Stracke, C. M., Romero-Hall, E., Koutropoulos, A., ... Jandric, P. (2023)	Speculative Futures on ChatGPT and Generative Artificial Intelligence (AI): A Collective Reflection from the Educational Landscape.	Explore the use and impact of artificial intelligence (AI), specifically ChatGPT, in education.	Widespread use of AI in education for tasks such as research, language learning, and personal support. Concerns about ethics, privacy, and AI bias. The potential of AI to improve or harm education and society.
6	Q4	Ipek, Z. H., Gözüm, A. I. C., Papadakis, S., & Kallogiannakis, M. (2023).	Educational Applications of the ChatGPT AI System: Systematic Review Research.	Investigate the impact of ChatGPT on education, exploring both the potential benefits and the ethical challenges and concerns.	ChatGPT has the potential to transform education, offering benefits such as literature review, complex answer generation, personalized learning, and cyberbullying prevention. However, it also raises concerns about academic integrity and ethical issues.
7	Q2-Q4	Kim, K., & Kwon, K. (2023).	Exploring the AI competencies of elementary school teachers in South Korea.	To explore the experiences of elementary school teachers in South Korea teaching AI curricula and identify the competencies needed for effective implementation of AI education.	Twenty-two AI competencies were identified for elementary school teachers based on the TPACK framework. Teachers felt most confident in their pedagogical knowledge, followed by technological knowledge and content knowledge.
8	Q4	Lo, C. K. (2023)	What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature.	Evaluate the performance of ChatGPT in different academic domains, its potential to improve teaching and learning, and associated problems.	ChatGPT showed outstanding performance in critical thinking and economics but struggled in law, medical education, and mathematics.
9	Q2-Q4	Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022).	Teachers' Trust in AI-Powered Educational Technology and a Professional Development Program to Improve It.	Improve teachers' confidence in AI technology through a professional development program.	Teachers showed an increase in confidence toward AI technology in education, leading to a greater willingness to use AI tools in their classrooms.

Q4. Challenges and Limitations in Integrating AI Into Teaching Practice

Internal barriers faced by teachers, such as negative perceptions and lack of training and resources, significantly affect the integration of AI-driven education (AIED) (Chalmers et al., 2022; Cheng & Wang, 2023; Yau et al., 2023). Although teachers recognize the importance of AI integration in K-12 education to prepare students for the future and express confidence in their pedagogical knowledge (Yau et al., 2023), they acknowledge significant challenges due to inadequate training, infrastructure, and support for AI curriculum design and implementation (Gentile et al., 2023; K. Kim & Kwon, 2023; Lo, 2023). These barriers hinder the adoption of AI tools in educational settings, limiting their potential benefits.

To address these challenges, professional development programs must focus on AI core competencies, providing teachers with the necessary knowledge and skills to integrate AI effectively (Cheng & Wang, 2023; Chichekian & Benteux, 2022; Gentile et al., 2023; K. Kim & Kwon, 2023; Lim, 2023; López-Martín et al., 2023; Sanusi et al., 2024; Stringer et al., 2022). A holistic approach to teacher training is required, ensuring that educators not only acquire technical knowledge but also develop critical thinking and ethical leadership in AI use (Bozkurt et al., 2023; Gentile et al., 2023). Enhancing teachers' confidence in AI literacy, along with addressing misconceptions, is crucial for fostering AI adoption in classrooms (Nazaretsky et al., 2022).

While AI holds great potential for personalizing learning and improving educational outcomes, studies emphasize that the teacher's role remains central (Barakina et al., 2021; Chalmers et al., 2022; Dimitriadou & Lanitis, 2023). AI is perceived as a tool to enhance education rather than replace educators, underscoring the need for trustworthy and effective AI implementations (Barakina et al., 2021; Leaton, 2020). Ethical considerations surrounding AI integration, including transparency, bias mitigation, and responsible use, must be prioritized (Bozkurt et al., 2023; Dignum, 2021; Pelaez et al., 2022).

Educational institutions must evolve by strengthening their technological infrastructure, providing adequate staff training, and establishing ethical data management practices to overcome emerging challenges (Dimitriadou & Lanitis, 2023). Moving beyond basic digital literacy, AI education should incorporate competencies in stability, IT skills, communication skills, and emotional intelligence (Abylkasymova et al., 2022). This comprehensive approach prepares students for high-tech environments while ensuring responsible AI use.

A key example illustrating these principles is the professional development program for secondary school biology teachers in Israel conducted by Nazaretsky et al. (2022). This initiative included AI literacy sessions, efforts to debunk misconceptions, and strategies for integrating AI recommendations into pedagogy. Teachers used an AI-powered assessment tool, AI-Grader, which led to increased confidence in AI technology and greater willingness to incorporate AI tools into their classrooms. This case highlights the potential of structured professional development programs in addressing barriers to AI adoption in education.

Generative AI applications such as ChatGPT further demonstrate AI's potential to support education. These tools assist in generating course materials, designing assessment tasks, and synthesizing information for students (Lo, 2023). However, concerns remain regarding biased data, outdated knowledge, and ethical challenges such as plagiarism and misinformation (Bozkurt, 2023; Dempere et al., 2023; Gillani et al., 2023; Ipek et al., 2023; Lo, 2023). Addressing these issues requires critical reflection on AI's role in education and the development of frameworks that ensure ethical and responsible use (Bozkurt, 2023; Mallik & Gangopadhyay, 2023; Yan et al., 2024).

Ultimately, overcoming the barriers to AI integration in education demands targeted teacher training, enhanced technological infrastructure, and ethical AI practices. While AI offers promising opportunities to enrich learning, its implementation must prioritize teacher agency, ethical considerations, and the reinforcement of the human element in education.

DISCUSSION

The integration of AI into K-12 education is reshaping traditional teaching and learning paradigms, offering transformative opportunities while posing complex challenges. Educators worldwide recognize AI's potential to personalize and optimize learning experiences, particularly in underprivileged communities, where disparities in educational resources are most pronounced (S.-W. Kim, 2023; Leaton, 2020; Pua et al., 2021). For instance, S.-W. Kim (2023) conducted a study in underserved South Korean schools, revealing how AI-powered adaptive learning platforms dynamically adjusted content difficulty based on student's performance, leading to notable improvements in literacy and math scores. This capacity for personalization demonstrates AI's ability to bridge educational gaps and provide equitable learning opportunities, which is a priority in global education initiatives.

One of AI's most promising contributions is fostering critical skills essential for 21st-century learners, such as creativity, problem-solving, and critical thinking. In Taiwanese classrooms, S. Chen et al. (2023) investigated the use of humanoid robots to teach computational thinking and programming. The study found that students engaged with these AI-powered tools demonstrated stronger problem-solving abilities and more perseverance when tackling complex tasks than those relying on traditional teaching methods. This aligns with the findings of Chalmers et al. (2022), who emphasize the importance of constructivist, inquiry-based approaches in maximizing AI's educational impact.

Additionally, AI tools are being increasingly utilized to enhance collaboration and teamwork among students. El Hajj and Harb (2023) studied AI-driven collaboration platforms in Lebanon, where AI played a pivotal role in facilitating team-based projects. By assigning roles, monitoring progress, and offering real-time feedback, these tools enhanced students' critical thinking and teamwork skills, demonstrating AI's potential as a "learning partner" rather than a passive tool. Such advancements represent a paradigm shift, positioning AI as an active agent in the learning process that can support instructional scaffolding, encourage collaboration, and deepen engagement.

Case studies from South Korea, Taiwan, Lebanon, and Turkey illustrate the diverse ways in which AI can transform education when implemented thoughtfully and strategically. For example, S.-W. Kim's (2023) work with underprivileged schools underscores AI's potential to level the playing field for underserved students. Similarly, S. Chen et al. (2023) and El Hajj and Harb (2023) demonstrate how AI can foster essential 21st-century skills, from computational thinking to teamwork. These real-world applications reveal that AI's effectiveness is contingent on context-specific strategies that consider the unique challenges and opportunities of each educational setting.

Despite these advancements, educators face persistent barriers to the successful integration of AI. Among these are insufficient training, limited access to resources, and ethical concerns such as data privacy, academic integrity, and biases embedded in AI algorithms (Bozkurt et al., 2023; Grassini, 2023). For example, Ipek et al. (2023) examined the ethical implications of AI integration in Turkish schools, highlighting the challenges of protecting student data while ensuring transparency and fairness. Their recommendations – legal frameworks, teacher training programs, and the development of ethical guidelines – illustrate the critical steps needed to address these issues. Similarly, educators in other contexts report apprehensions regarding their preparedness to navigate the complexities of AI tools effectively (Dignum, 2021; Molenaar, 2022).

Integrating AI requires addressing critical gaps in digital literacy and teacher preparedness effectively. Many educators express the need for comprehensive training programs that focus on technical skills and the interpersonal competencies necessary for success in technology-driven environments

(Abylkasymova et al., 2022; Bozkurt et al., 2023). These programs should prioritize self-efficacy and equip educators with tools to incorporate AI into their teaching practices, particularly in resource-constrained settings (Chichekian & Benteux, 2022; Karalekas et al., 2023). For example, Abylkasymova et al. (2022) advocate for professional development programs that combine hands-on experimentation with theoretical knowledge, enabling educators to explore AI's potential while building confidence in its application.

Beyond technical implementation, ethical considerations remain central to discussions about AI in education. Generative AI tools, such as ChatGPT, exemplify both the opportunities and challenges of integrating these technologies. While they offer innovative applications, such as personalized feedback and content generation, they also raise concerns about data security, plagiarism, and biases that could perpetuate systemic inequities (Lo, 2023; Yan et al., 2024). To mitigate these risks, a human-centered approach to AI development is a necessary one that emphasizes transparency, fairness, and accountability. Ipek et al. (2023) underline the importance of establishing ethical frameworks that balance technological innovation with respect for human values.

Another critical factor in AI integration is the design of curriculum and pedagogy that align with the demands of an AI-driven world. The incorporation of computational thinking, programming, and coding into digital curricula has been shown to enhance students' creativity and AI literacy (Bozkurt, 2023; Dimitriadou & Lanitis, 2023). Moreover, project-based learning approaches that utilize AI tools can simultaneously promote problem-solving skills and ethical awareness, fostering a deeper understanding of the social implications of these technologies (Dai et al., 2024; Lim, 2023).

In conclusion, the integration of AI into education represents a powerful tool for addressing persistent inequities, fostering critical skills, and transforming learning experiences. However, its successful adoption hinges on a collective effort among educators, policymakers, and technologists to design ethical, user-friendly systems and targeted training programs. A holistic framework that balances technological innovation with human-centric values is essential to harnessing AI's full potential. As real-world case studies demonstrate, when implemented responsibly, AI has the power to redefine education, preparing students to thrive in an increasingly AI-driven future.

Despite these promising prospects, the present study highlights several limitations that reveal significant gaps in the analysis of AI implementation in education. One of the main gaps is the lack of empirical studies that assess how AI integration impacts school contexts with limited resources, where technological infrastructure and access to advanced tools are often inadequate. Moreover, there has been insufficient investigation into how different AI tools, such as virtual tutors or learning analytics systems, influence student engagement and participation in diverse environments. These shortcomings, coupled with the inadequate preparation of educators in digital and AI-specific competencies (Abylkasymova et al., 2022; Bozkurt et al., 2023; Casal-Otero et al., 2023; Gentile et al., 2023; J. Kim et al., 2022; K. Kim & Kwon, 2023; Nja et al., 2023), as well as ethical concerns related to privacy and algorithmic biases (Bozkurt et al., 2023; Dimitriadou & Lanitis, 2023; Ipek et al., 2023; Lo, 2023; Yan et al., 2024), hinder the effective adoption of these technologies in education.

LIMITATIONS, RECOMMENDATIONS, AND IMPLICATIONS

The scope and methodology of any research inherently shape its findings and implications, yet certain limitations can constrain the generalizability and depth of the results.

In this study, several constraints were identified, delineating the contextual boundaries within which the analysis was conducted. While these limitations are critical to acknowledge, they also underscore opportunities for further exploration and refinement in future research. First, the study exclusively focused on articles written in English, potentially excluding relevant studies published in other languages. Second, the selected studies were limited to applying open-ended inquiry methodologies

within social science qualifications and school-based contexts, thereby neglecting other academic disciplines and educational settings. Third, the analysis primarily relied on publications from research journals, which may introduce a publication bias by excluding insights from other sources, such as conference proceedings or grey literature. Finally, the articles reviewed were predominantly sourced from academic databases like WOS, Scopus, and ERIC, potentially overlooking valuable studies available in non-indexed or alternative repositories.

The implementation of artificial intelligence (AI) in education faces several limitations that must be addressed to ensure effective and ethical integration. First, one of the main barriers is the lack of preparedness and readiness of teachers to use these technologies efficiently. Digital literacy and educator self-efficacy are areas that require immediate attention. AI, moreover, is not completely transparent to educational stakeholders and does not always adequately consider privacy and equality, which can lead to distrust and resistance among educators and students (Yan et al., 2024). There are also ethical and legal concerns in the adoption of AI technologies in education that need to be addressed, such as transparency, privacy, and bias in AI algorithms (Mallik & Gangopadhyay, 2023). Another significant limitation is the lack of adequate training for educators. Teachers who have not received specific training in AI may feel insecure and ineffective in integrating this technology into the classroom (Casal-Otero et al., 2023; Chalmers et al., 2022). This lack of confidence may hinder the adoption and effective use of AI tools in education. Also, insufficient technological infrastructure represents a barrier, as many educational institutions lack the necessary resources to implement these technologies effectively (Abylkasymova et al., 2022).

To overcome these limitations, several recommendations are proposed. First, it is essential to develop continuing education programs for educators that focus on concrete pedagogical tasks and confidence building in the use of AI (An et al., 2023; Casal-Otero et al., 2023). These programs should provide procedural knowledge about AI and address misconceptions to increase teachers' confidence in this technology (Bozkurt, 2023). Training should go beyond basic digital literacy and include competencies in stability, IT skills, communication skills, and emotional intelligence (Abylkasymova et al., 2022). In addition, human agency should be emphasized in AI recommendations by developing regulations and practices that respect pedagogical rights and ensure fair and transparent use of AI in educational settings. It must be ensured that educators maintain control over pedagogical decisions (El Hajj & Harb, 2023; Leaton, 2020; Nazaretsky et al., 2022). Humanizing online education and promoting effective interaction between AI tools and learners is essential to ensure a positive learning experience (Pelaez et al., 2022). Finally, it is critical to address ethical and legal concerns by implementing clear and transparent policies that protect privacy and promote equality (Dempere et al., 2023; Gillani et al., 2023). Creating a robust regulatory framework can help mitigate the risks associated with the use of AI in education.

The integration of AI in education has significant implications for the future of learning and teaching. To maximize the benefits of this technology, it is essential to prepare both educators and students for an AI-enabled educational environment (Sanusi et al., 2024). AI literacy, confidence in learning, and the perceived relevance of AI are critical predictors of teacher behavioral intentions. Therefore, training programs should focus on these aspects to foster effective adoption of AI in educational settings (Casal-Otero et al., 2023; Chalmers et al., 2022; Lim, 2023). In addition, AI offers the possibility of promoting more personalized and collaborative learning, using technologies such as robot tutors and virtual reality, which can significantly enrich the educational experience (Benvenuti et al., 2023). However, it is essential to maintain a balance between the implementation of these advanced technologies and traditional teaching methods to ensure quality learning outcomes (Bozkurt, 2023).

A major limitation identified in this review is the lack of intervention studies evaluating the implementation of artificial intelligence (AI) in the classroom. The absence of empirical research analyzing the outcomes of such interventions hinders a complete understanding of the real impact of AI in education. Therefore, it underscores the need for future intervention studies that address this gap, thus allowing them to optimize its application and maximize its benefits in the educational setting. In this

way, it will be possible to more precisely identify areas for improvement and develop more effective strategies that maximize the benefits of AI in education.

Key areas for future research are identified to address these deficiencies. It is essential to expand the analysis to include multicultural and multilingual perspectives, explore AI applications across various disciplines and educational levels, and encourage interdisciplinary research that considers ethical, social, and pedagogical aspects. Conducting long-term intervention studies in real-world contexts will allow for the evaluation of AI's impact on learning, while the development of advanced teacher training programs will help increase confidence and effectiveness in using these technologies. Additionally, it is crucial to investigate models of sustainable technological infrastructure to ensure the accessibility of AI in resource-limited communities and to design robust ethical and regulatory frameworks that promote the responsible use of technology. These actions will be fundamental to optimizing the impact of AI in education and ensuring its equitable and ethical integration.

CONCLUSIONS

The integration of AI into K-12 and primary education has emerged as a transformative trend, promising to redefine teaching and learning processes. This systematic literature review, encompassing studies from 2014 to 2024, has highlighted both the potential and the challenges associated with AI adoption in education. On the one hand, AI offers immense opportunities to personalize learning, foster 21st-century skills such as computational thinking, creativity, and teamwork, and prepare students for an increasingly digitized world. On the other hand, this integration raises pressing concerns that necessitate a multifaceted and ethically grounded approach to ensure its effectiveness and fairness.

One of the key findings of the reviewed studies is the critical role of teacher training in successfully integrating AI into the classroom. Advanced training programs that enhance educators' confidence and competency in AI technology are essential. Such programs must focus on both theoretical and practical aspects, equipping teachers with the skills to effectively incorporate AI tools into their pedagogical practices. Additionally, ongoing support is crucial to help educators design and implement AI-enhanced curricula that are both innovative and pedagogically sound.

From a policy perspective, there is a pressing need to develop curricular frameworks that integrate computational thinking, programming, and project-based learning. These approaches not only improve students' AI literacy but also enable them to critically engage with the social and ethical implications of AI technologies. Simultaneously, sustainable technological infrastructure must be established to ensure equitable access to AI tools, particularly in resource-constrained communities. Without addressing these systemic disparities, the potential of AI to democratize education and bridge learning gaps cannot be fully realized.

Ethical considerations are paramount in the adoption of AI in education. Issues such as data privacy, algorithmic biases, and academic integrity must be addressed through robust regulatory frameworks. The implementation of transparent and accountable AI systems will not only mitigate ethical risks but also foster trust among stakeholders, including students, educators, and policymakers. These frameworks should be designed to promote human agency, ensuring that technology complements rather than replaces the vital role of educators.

Another significant insight from the analysis is the need to expand research on AI integration in education to include multicultural and multilingual perspectives. Current studies predominantly focus on English-language contexts, overlooking the diverse linguistic and cultural environments in which AI can be applied. Furthermore, interdisciplinary research that examines AI applications across various disciplines and educational levels is crucial to understanding its broader implications. Long-term intervention studies in real-world settings will also provide valuable insights into the sustained impact of AI on learning outcomes and student engagement.

The effectiveness of AI in education is deeply tied to its context-specific application. Strategies that consider the unique challenges and opportunities of different educational environments are critical. By tailoring AI tools to the needs of specific contexts, whether rural schools with limited resources or urban classrooms with advanced technological access, the full potential of AI can be harnessed to enhance teaching and learning.

In conclusion, the successful integration of AI into education requires a collaborative effort among educators, policymakers, and technologists. Ethical, user-friendly systems must be designed alongside targeted teacher training programs and inclusive educational policies. A holistic approach that balances technological innovation with human-centric values is essential to optimizing the impact of AI in education. This approach will not only address persistent challenges but also ensure the equitable and ethical integration of AI, preparing students to thrive in a rapidly evolving technological landscape. By embracing these recommendations, the transformative potential of AI in shaping the future of education can be fully realized.

REFERENCES

Abylkasymova, A. E., Shishov, S. E., Kalney, V. A., & Ryakhimova, E. G. (2022). Influence of high-tech society on the development of modern educational system. *Journal of Higher Education Theory and Practice, 22*(5), 201-206. https://doi.org/10.33423/jhetp.v22i5.5214

An, X., Chai, C. S., Li, Y., Zhou, Y., Shen, X., Zheng, C., & Chen, M. (2023). Modeling English teachers' behavioral intention to use artificial intelligence in middle schools. *Education and Information Technologies, 28*(5), 5187-5208. https://doi.org/10.1007/s10639-022-11286-z

Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence, 3*, 100099. https://doi.org/10.1016/j.caeai.2022.100099

Barakina, E. Y., Popova, A. V., Gorokhova, S. S., & Voskovskaya, A. S. (2021). Digital technologies and artificial intelligence technologies in education. *European Journal of Contemporary Education, 10*(2), 285-296. https://doi.org/10.13187/ejced.2021.2.285

Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023). Artificial intelligence and human behavioral development: A perspective on new skills and competencies acquisition for the educational context. *Computers in Human Behavior, 148*, 107903. https://doi.org/10.1016/j.chb.2023.107903

Bozkurt, A. (2023). Generative artificial intelligence (AI) powered conversational educational agents: The inevitable paradigm shift. *Asian Journal of Distance Education, 18*(1), 198-204. https://doi.org/10.5281/zenodo.7716416

Bozkurt, A., Xiao, J., Lambert, S., Pazurek, A., Crompton, H., Koseoglu, S., Farrow, R., Bond, M., Nerantzi, C., Honeychurch, S., Bali, M., Dron, J., Mir, K., Stewart, B., Costello, E., Mason, J., Stracke, C. M., Romero-Hall, E., Koutropoulos, A., … Jandric, P. (2023). Speculative futures on ChatGPT and generative artificial intelligence (AI): A collective reflection from the educational landscape. *Asian Journal of Distance Education, 18*(1), 53-130. https://doi.org/10.5281/zenodo.7636568

Casal-Otero, L., Catala, A., Fernandez-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023). AI literacy in K-12: A systematic literature review. *International Journal of Stem Education, 10*, Article 29. https://doi.org/10.1186/s40594-023-00418-7

Chalmers, C., Keane, T., Boden, M., & Williams, M. (2022). Humanoid robots go to school. *Education and Information Technologies, 27*(6), 7563-7581. https://doi.org/10.1007/s10639-022-10913-z

Chen, S., Qiu, S., Li, H., Zhang, J., Wu, X., Zeng, W., & Huang, F. (2023). An integrated model for predicting pupils' acceptance of artificially intelligent robots as teachers. *Education and Information Technologies, 28*(9), 11631-11654. https://doi.org/10.1007/s10639-023-11601-2

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two decades of artificial intelligence in education: Contributors, collaborations, research topics, challenges, and future directions. *Educational Technology & Society, 25*(1), 28-47. https://www.jstor.org/stable/48647028

Chen, Y., & Zou, Y. (2024). Enhancing education quality: Exploring teachers' attitudes and intentions towards intelligent MR devices. *European Journal of Education*, *59*(4), e12692. https://doi.org/10.1111/ejed.12692

Cheng, E. C. K., & Wang, T. (2023). Leading digital transformation and eliminating barriers for teachers to incorporate artificial intelligence in basic education in Hong Kong. *Computers and Education: Artificial Intelligence, 5*, 100171. https://doi.org/10.1016/j.caeai.2023.100171

Chichekian, T., & Benteux, B. (2022). The potential of learning with (and not from) artificial intelligence in education. *Frontiers in Artificial Intelligence, 5,* 903051. https://doi.org/10.3389/frai.2022.903051

Consoli, T., Désiron, J., & Cattaneo, A. (2023). What is "technology integration" and how is it measured in K-12 education? A systematic review of survey instruments from 2010 to 2021. *Computers & Education, 197*, 104742. https://doi.org/10.1016/j.compedu.2023.104742

Dai, Y., Lin, Z., Liu, A., Dai, D., & Wang, W. (2024). Effect of an analogy-based approach of artificial intelligence pedagogy in upper primary schools. *Journal of Educational Computing Research, 61*(8), 159-186. https://doi.org/10.1177/07356331231201342

Dempere, J., Modugu, K., Hesham, A., & Ramasamy, L. K. (2023). The impact of ChatGPT on higher education. *Frontiers in Education, 8*, 1206936. https://doi.org/10.3389/feduc.2023.1206936

Dignum, V. (2021). The role and challenges of education for responsible Al. *London Review of Education, 19*(1), 1-11. https://doi.org/10.14324/LRE.19.1.01

Dimitriadou, E., & Lanitis, A. (2023). A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms. *Smart Learning Environments, 10*, Article 12. https://doi.org/10.1186/s40561-023-00231-3

Dong, W., Li, Y. J., Sun, L. H., & Liu, Y. R. (2023). Developing pre-service teachers' computational thinking: A systematic literature review. *International Journal of Technology and Design Education 34*, 191-227. https://doi.org/10.1007/s10798-023-09811-3

Elayyan, S. (2021). The future of education according to the fourth industrial revolution. *Journal of Educational Technology and Online Learning, 4*(1), 23-30. https://doi.org/10.31681/jetol.737193

El Hajj, M., & Harb, H. (2023). Rethinking education: An in-depth examination of modern technologies and pedagogic recommendations. *IAFOR Journal of Education, 11*(2), 97-113. https://doi.org/10.22492/ije.11.2.05

García-Peñalvo, F. J., Llorens-Largo, F., & Vidal, J. (2024). La nueva realidad de la educación ante los avances de la inteligencia artificial generativa. *RIED-Revista Iberoamericana de Educación a Distancia, 27*(1). https://doi.org/10.5944/ried.27.1

Gentile, M., Città, G., Perna, S., & Allegra, M. (2023). Do we still need teachers? Navigating the paradigm shift of the teacher's role in the AI era. *Frontiers in Education, 8*, 1161777. https://doi.org/10.3389/feduc.2023.1161777

Gerard, L., Matuk, C., McElhaney, K., & Linn, M. C. (2015). Automated, adaptive guidance for K-12 education. *Educational Research Review, 15*, 41-58. https://doi.org/10.1016/j.edurev.2015.04.001

Gillani, N., Eynon, R., Chiabaut, C., & Finkel, K. (2023). Unpacking the "Black Box" of AI in education. *Educational Technology & Society, 26*(1), 99-111. https://doi.org/10.30191/ETS.202301_26(1).0008

Grassini, S. (2023). Shaping the future of education: Exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences, 13*(7), 692. https://doi.org/10.3390/educsci13070692

Han, A., Zhou, X., Cai, Z., & Han, S. (2024). Teachers, parents, and students' perspectives on integrating generative AI into elementary literacy education. *Proceedings of the CHI Conference on Human Factors in Computing Systems* (Article 678). Association for Computing Machinery. https://doi.org/10.1145/3613904.3642438

Ipek, Z. H., Gözüm, A. I. C., Papadakis, S., & Kallogiannakis, M. (2023). Educational applications of the ChatGPT AI system: A systematic review research. *Educational Process: International Journal, 12*(3), 26-55. https://doi.org/10.22521/edupij.2023.123.2

Karalekas, G., Vologiannidis, S., & Kalomiros, J. (2023). Teaching machine learning in K-12 using robotics. *Education Sciences, 13*(1), 67. https://doi.org/10.3390/educsci13010067

Khan, K. S., Bueno Cavanillas, A., & Zamora, J. (2022). Revisiones sistemáticas en cinco pasos: I. Cómo formular una pregunta para la que se pueda obtener una respuesta válida [Systematic reviews in five steps: I. Framing questions to obtain valid answers]. *Medicina de Familia – Semergen, 48*(5), 356-361. https://doi.org/10.1016/j.semerg.2021.12.005

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning design to support student-AI collaboration: Perspectives of leading teachers for AI in education. *Education and Information Technologies, 27*(5), 6069-6104. https://doi.org/10.1007/s10639-021-10831-6

Kim, K., & Kwon, K. (2023). Exploring the AI competencies of elementary school teachers in South Korea. *Computers and Education: Artificial Intelligence, 4,* 100137. https://doi.org/10.1016/j.caeai.2023.100137

Kim, S.-W. (2023). Change in attitude toward artificial intelligence through experiential learning in artificial intelligence education. *International Journal on Advanced Science, Engineering and Information Technology, 13*(5), 1953-1959. https://doi.org/10.18517/ijaseit.13.5.19039

Leaton, S. (2020). Artificial intelligence in schools: Towards a democratic future. *London Review of Education, 18*(2), 163-177. https://doi.org/10.14324/LRE.18.2.02

Lee, S., Chang, K., & Lee, K. (2023). A classroom-based study on the application of artificial intelligence translator: The use and perception of AI by low-achieving primary school English learners. *The Korea Association of Primary English Education*. https://doi.org/10.25231/pee.2023.29.1.31

Lim, E. M. (2023). The effects of pre-service early childhood teachers' digital literacy and self-efficacy on their perception of AI education for young children. *Education and Information Technologies, 28*(10), 12969-12995. https://doi.org/10.1007/s10639-023-11724-6

Lo, C. K. (2023). What is the impact of ChatGPT on education? A rapid review of the literature. *Education Sciences, 13*(4), 410. https://doi.org/10.3390/educsci13040410

López-Martín, E., Gutiérrez-de-Rozas, B., González-Benito, A. M., & Expósito-Casas, E. (2023). Why do teachers matter? A meta-analytic review of how teacher characteristics and competencies affect students' academic achievement. *International Journal of Educational Research, 120*, 102199. https://doi.org/10.1016/j.ijer.2023.102199

Mallik, S., & Gangopadhyay, A. (2023). Proactive and reactive engagement of artificial intelligence methods for education: A review. *Frontiers in Artificial Intelligence, 6*, 1151391. https://doi.org/10.3389/frai.2023.1151391

Molenaar, I. (2022). Towards hybrid human-AI learning technologies. *European Journal of Education, 57*(4), 632-645. https://doi.org/10.1111/ejed.12527

Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022). Teachers' trust in AI-powered educational technology and a professional development program to improve it. *British Journal of Educational Technology, 53*(4), 914-931. https://doi.org/10.1111/bjet.13232

Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2023). A review of AI teaching and learning from 2000 to 2020. *Education and Information Technologies, 28*, 8445-8501. https://doi.org/10.1007/s10639-022-11491-w

Nja, C. O., Idiege, K. J., Uwe, U. E., Meremikwu, A. N., Ekon, E. E., Erim, C. M., Ukah, J. U., Eyo, E. O., Anari, M. I., & Cornelius-Ukpepi, B. U. (2023). Adoption of artificial intelligence in science teaching: from the vantage point of the African science teachers. *Smart Learning Environments, 10*, Article 42. https://doi.org/10.1186/s40561-023-00261-x

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). Declaración PRISMA 2020: una guía actualizada para la publicación de revisiones sistemáticas [The PRISMA 2020 statement: An

updated guideline for reporting systematic reviews]. *Revista Española de Cardiología, 74*(9), 790-799. https://doi.org/10.1016/j.recesp.2021.06.016

Pelaez, A., Jacobson, A., Trias, K., & Winston, E. (2022). The Turing teacher: Identifying core attributes for AI learning in K-12. *Frontiers in Artificial Intelligence, 5*, 1031450. https://doi.org/10.3389/frai.2022.1031450

Pradana, M., Elisa, H. P., & Syarifuddin, S. (2023). Discussing ChatGPT in education: A literature review and bibliometric analysis. *Cogent Education, 10*(2), Article 2243134. https://doi.org/10.1080/2331186X.2023.2243134

Pua, S., Ahmad, N. A., & Khambari, M. N. M. (2021). Identification and analysis of core topics in educational artificial intelligence research: A bibliometric analysis. *Cypriot Journal of Educational Sciences*, *16*(3), 995-1009. https://doi.org/10.18844/cjes.v16i3.5782

Rienties, B., Køhler Simonsen, H., & Herodotou, C. (2020). Defining the boundaries between artificial intelligence in education, computer-supported collaborative learning, educational data mining, and learning analytics: A need for coherence. *Frontiers in Education, 5*, 128. https://doi.org/10.3389/feduc.2020.00128

Sanusi, I. T., Ayanwale, M. A., & Chiu, T. K. F. (2024). Investigating the moderating effects of social good and confidence on teachers' intention to prepare school students for artificial intelligence education. *Education and Information Technologies, 29*(1), 273-295. https://doi.org/10.1007/s10639-023-12250-1

Sharifuddin, N. S., & Hashim, H. (2024). Benefits and challenges in implementing artificial intelligence in education (AIED) in ESL classroom: A systematic review (2019-2022). *International Journal of Academic Research in Business and Social Sciences, 14*(1), 146-164. https://doi.org/10.6007/IJARBSS/v14-i1/20422

Stringer, L. R., Lee, K. M., Sturm, S., & Giacaman, N. (2022). A systematic review of primary school teachers' experiences with digital technologies curricula. *Education and Information Technologies, 27*(9), 12585-12607. https://doi.org/10.1007/s10639-022-11127-z

Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., Li, X., Jin, Y., & Gašević, D. (2024). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology, 55*(1), 90-112. https://doi.org/10.1111/bjet.13370

Yau, K. W., Chai, C. S., Chiu, T. K. F., Meng, H., King, I., & Yam, Y. (2023). A phenomenographic approach on teacher conceptions of teaching artificial intelligence (AI) in K-12 schools. *Education and Information Technologies, 28*, 1041-1064. https://doi.org/10.1007/s10639-022-11161-x

Zhang, Y. (2024). Analysis of the application of artificial intelligence in information courses in primary and secondary schools. *Lecture Notes in Education Psychology and Public Media, 59*, 241-250. https://doi.org/10.54254/2753-7048/59/20241783

APPENDIX A

Summary of the main findings of research question Q1

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
1	Q1-Q2	An, X., Chai, C. S., Li, Y., Zhou, Y., Shen, X., Zheng, C., & Chen, M. (2023).	Education and Information Technologies, 28(5), 5187-5208.	Modeling English teachers' behavioral intention to use artificial intelligence in middle schools.	To investigate the perceptions, knowledge, and intended use of AI by English as a foreign language (EFL) teachers in secondary education.	Use of surveys and data analysis based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK).	EFL teachers have positive perceptions toward the use of AI in teaching, with Performance Expectancy and knowledge of AI-TPACK as influential factors in their intention to use it.	Performance Expectations and knowledge of AI-TPACK are determinants of teachers' intention to use AI. Effort Expectation does not directly predict intention to use.
					To examine factors influencing EFL teachers' intention to use AI in education.	Development and validation of a scale to measure teachers' perceptions of TPACK and UTAUT concerning AI, through surveys and data analysis.	Teachers' knowledge of AI-TPACK significantly predicts their intention to use it. Other factors such as technological knowledge of the AI language and Enabling Conditions are also influential.	Specific knowledge about AI and pedagogical integration is key to teachers' intention to use it.
2	Q1-Q2	Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023).	Computers in Human Behavior, 148.	Artificial intelligence and human behavioral development: A perspective on new skills and competencies acquisition for the educational context.	Explore how digitization and artificial intelligence (AI) can promote 21st-century skills such as creativity, critical thinking, problem-solving, and computational thinking in educational contexts.	Literature review using the PRISMA protocol, focusing on articles related to education, IA, and critical thinking.	Integrating computational thinking, programming, and coding into school curricula is essential. Creativity can enhance computational thinking, and AI can foster creativity. Critical thinking is crucial for problem-solving and can be enhanced through computational thinking and programming with the help of AI.	IA can be a valuable tool for improving skills such as creativity, critical thinking, and problem-solving.
								The interrelationship between creativity, computational thinking, and critical thinking is fundamental to effective learning.
								Technology, including AI, robot tutors, and virtual reality, can promote more personalized and collaborative learning.
3	Q1-Q2	Casal-Otero, L., Catala, A., Fer-	*International Journal of Stem Education*, *10*(1).	AI literacy in K-12: A systematic literature review.	Understand how artificial intelligence (AI) is being integrated into K-	Systematic literature review using Scopus, ana-	A growing interest in IA education in K-12 schools was identified,	Need for a competency framework to guide IA literacy proposals.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
		nandez-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023).			12 education globally, identifying learning experience approaches and theoretical perspectives.	lyzing 179 articles focused on learning experiences and theoretical perspectives.	with a variety of approaches to teaching IA concepts to students.	Importance of teacher training and systemic approaches to IA education. IA literacy should enhance learning in core subjects and promote interdisciplinary and critical approaches.
4	Q1	Chalmers, C., Keane, T., Boden, M., & Williams, M. (2022).	*Education and Information Technologies, 27*(6), 7563-7581.	Humanoid robots go to school.	To explore teachers' perceptions of the use of humanoid robots in the classroom, and how they can enhance curriculum and student engagement.	Questionnaires, reflective diaries, and semi-structured interviews were used with 29 teachers from 10 schools.	Teachers reported benefits in the use of robots for student engagement and learning, highlighting innovation, creativity, and computational thinking.	Humanoid robots have a positive impact on student learning, increasing engagement and the development of transferable skills. Teachers adopted a social constructivist learning approach, using robots to develop 21st-century skills and perseverance.
5	Q1	Chen, S., Qiu, S., Li, H., Zhang, J., Wu, X., Zeng, W., & Huang, F. (2023).	*Education and Information Technologies*, *28*(9), 11631-11654.	An Integrated Model for Predicting Pupils' Acceptance of Artificially Intelligent Robots as Teachers.	To investigate the acceptance of an AI teacher among primary school students in China, identify factors that influence this acceptance, and explore the role of technology in education.	An AI teacher was developed, and its acceptance was evaluated through questionnaires and interaction in elementary schools. An extended Technology Acceptance Model (TAM) was used to analyze the acceptance factors.	Student acceptance of the AI teacher was moderate. The factors most influencing acceptance were perceived usefulness, ease of use, and task characteristics. Previous experience with IA teachers also affects acceptance.	Perceived usefulness is the most critical factor affecting IA teacher acceptance. Ease of use and task characteristics are also important but to a lesser extent. Previous experience with similar technologies may influence acceptance.
6	Q1	Gerard, L., Matuk, C., McElhaney, K., & Linn, M. C. (2015).	*Educational Research Review*, *15*, 41-58.	Automated, adaptive guidance for K-12 education.	Investigate the effectiveness of automated, adaptive guidance in K-12 education compared to traditional teacher-directed instruction. To explore specific features of automated guidance	Meta-analysis of 41 studies and 57 independent effect sizes on automated guidance in K-12 education. Classification of studies into automated adaptive	Automated, adaptive guidance is generally as effective or more effective than traditional instruction in improving student learning outcomes. Enhanced guid-	Automated guidance is particularly beneficial for students with low to medium prior knowledge. Enhanced orientation favors conceptual learning and the development of self-monitoring strategies.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
					that enhance student learning.	guidance vs. typical instruction.	ance (with detailed feedback or motivational scaffolding) is more effective than simpler forms of guidance.	Features such as scaffolding of generative tasks and the use of generative tasks for assessment lead to better learning outcomes.
7	Q1-Q3	El Hajj, M., & Harb, H. (2023).	*IAFOR Journal of Education*, *11*(2), 97-113.	Rethinking Education: An In-Depth Examination of Modern Technologies and Pedagogic Recommendations.	Explore the integration of technology in education through the Technological Pedagogical Content Knowledge (TPCK) framework, emphasizing student-centered learning.	Literature review on technology integration in education and analysis of teaching strategies using technology.	Technology-based education improves student learning by integrating technological tools into the teaching and learning process.	The critical importance of teachers in guiding and supporting student growth and success in technology-based learning environments. There is a need for ongoing professional development and training programs for teachers to effectively integrate technology into the classroom.
					Identify technological tools that facilitate interactive and engaging teaching strategies.	List of technological tools used to facilitate various teaching strategies.	Technology tools such as Tricider, AnswerGarden, and MindMeister, among others, can be used to facilitate teaching strategies such as flipped classrooms, inquiry-based learning, and peer feedback.	These tools help create interactive and engaging learning experiences for students. They promote collaboration, critical thinking, and self-regulated learning skills.
8	Q1-Q2	Kim, J., Lee, H., & Cho, Y. H. (2022).	*Education and Information Technologies*, *27*(5), 6069-6104.	Learning Design to Support Student-AI Collaboration: Perspectives of Leading Teachers for AI in Education.	Explore the integration of Artificial Intelligence (AI) in education, focusing on student-AI collaboration, and how this can improve learning in K-12 schools.	It is not explicitly described in the excerpts provided but is inferred to be based on the exploration of teacher perspectives on student-AI collaboration.	Teachers view student-AI collaboration as a tool for achieving optimal learning objectives, emphasizing the importance of knowledge construction, interdisciplinary learning, authentic problem-solving, and creative assignments.	The importance of student-AI collaboration in learning. Need for systematic AIED policies to improve AI applications in education. AI as a "learning companion" that provides instructional scaffolding.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
9	Q1-Q2	Lim, E. M. (2023).	Education and Information Technologies, 28(10), 12969-12995.	The Effects of Pre-Service Early Childhood Teachers' Digital Literacy and Self-Efficacy on Their Perception of AI Education for Young Children.	To examine the relationship between digital literacy, self-efficacy, and perceptions of AI (Artificial Intelligence) education for young children among prospective early childhood education teachers.	Surveys were conducted with 212 prospective early childhood education teachers, using descriptive statistics, correlation analysis, and hierarchical multiple regression analysis.	The means of digital literacy, self-efficacy, and perception of AI education were 3.43, 3.31, and 3.36 respectively, indicating a positive relationship between these variables. Self-efficacy measured the relationship between digital literacy and perception of AI education.	Digital literacy and self-efficacy have a positive impact on the perception of AI education for young children. Self-efficacy plays a mediating role between digital literacy and perception of AI education.
10	Q1	Sanusi, I. T., Ayanwale, M. A., & Chiu, T. K. F. (2024).	Education and Information Technologies, 29(1), 273-295.	Investigating the Moderating Effects of Social Good and Confidence on Teachers' Intention to Prepare School Students for Artificial Intelligence Education.	To examine factors influencing teachers' intention to teach artificial intelligence (AI) in schools, including anxiety toward AI, perceived usefulness, attitude toward AI, AI relevance, AI readiness, and behavioral intention. In addition, to investigate the moderating effects of AI for social good and confidence in teaching AI.	Data were collected from 320 in-service teachers in Nigeria using a variance-based structural equation modeling approach.	AI relevance was the most significant predictor of intention to teach AI. Perception of AI for social good and confidence in teaching AI had significant impacts on the intention to teach AI.	Teachers generally have positive attitudes toward the use of AI and confidence in teaching it but may have some anxiety about the future impact of AI. The relevance of AI and the perception of AI for social good are crucial factors influencing teachers' intention to teach AI. Confidence in AI teaching moderates some relationships in the model.

APPENDIX B

Summary of the main findings of research question Q2

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
1	Q1-Q2	An, X., Chai, C. S., Li, Y., Zhou, Y., Shen, X., Zheng, C., & Chen, M. (2023).	Education and Information Technologies, 28(5), 5187-5208.	Modeling English Teachers' Behavioral Intention to Use Artificial Intelligence in Middle Schools.	To investigate the perceptions, knowledge, and intended use of AI by English as a foreign language (EFL) teachers in secondary education.	Use of surveys and data analysis based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK).	EFL teachers have positive perceptions toward the use of AI in teaching, with Performance Expectancy and knowledge of AI-TPACK as influential factors in their intention to use it.	Performance Expectations and knowledge of AI-TPACK are determinants of teachers' intention to use AI. Effort Expectation does not directly predict intention to use.
					To examine factors influencing EFL teachers' intention to use AI in education.	Development and validation of a scale to measure teachers' perceptions of TPACK and UTAUT about AI through surveys and data analysis.	Teachers' knowledge of AI-TPACK significantly predicts their intention to use it. Other factors such as technological knowledge of the AI language and Enabling Conditions are also influential.	Specific knowledge about AI and pedagogical integration is key to teachers' intention to use it.
2	Q2-Q4	Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022).	Computers and Education: Artificial Intelligence, 3.	Teachers' readiness and intention to teach artificial intelligence in schools.	To explore the factors influencing teachers' intention to teach artificial intelligence (AI) in schools, and to understand teachers' willingness to implement AI in education.	The PLS-SEM method was used to analyze the relationships among various factors such as perceived usefulness, attitude, confidence, AI relevance, and behavioral intention of teachers. Data were collected from 368 Nigerian teachers.	Factors such as AI literacy, confidence in learning, and AI relevance were significant predictors of behavioral intention. Confidence in teaching AI and AI relevance significantly predicted teachers' intention to teach AI.	Anxiety does not significantly predict teachers' behavioral intentions.
								The perceived usefulness of AI and AI for social good are significant predictors.
								Trust, relevance, and social good strongly predict teachers' willingness to teach AI.
3	Q1-Q2	Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E.,	Computers in Human Behavior, 148.	Artificial intelligence and human behavioral development: A	Explore how digitization and artificial intelligence (AI) can promote 21st-century skills such	Literature review using the PRISMA protocol, focusing on ar-	Integrating computational thinking, programming, and coding into school curricula is essential. Creativity can	IA can be a valuable tool for improving skills such as creativity, critical thinking, and problem-solving.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
		Benassi, M., Barbaresi, M., & Orsoni, M. (2023).		perspective on new skills and competencies acquisition for the educational context.	as creativity, critical thinking, problem-solving, and computational thinking in educational contexts.	ticles related to education, IA, and critical thinking.	enhance computational thinking, and AI can foster creativity. Critical thinking is crucial for problem-solving and can be enhanced through computational thinking and programming with the help of AI.	The interrelationship between creativity, computational thinking, and critical thinking is fundamental to effective learning.
								Technology, including AI, robot tutors, and virtual reality, can promote more personalized and collaborative learning.
4	Q2-Q4	Bozkurt, A. (2023).	Asian Journal of Distance Education, 18(1), 198-204.	Generative Artificial Intelligence (AI) Powered Conversational Educational Agents: The Inevitable Paradigm Shift.	Explore the use and impact of generative artificial intelligence, with a focus on ChatGPT, in education.	Not specified in the extracts provided.	Generative artificial intelligence, especially ChatGPT, has significant potential to transform teaching and learning methods.	The importance of preparing for an AI-dominated future in education.
								The need to develop prompts engineering as a form of digital literacy.
								The importance of adopting a critical and reflective stance towards the use of generative AI in education.
5	Q1-Q2	Casal-Otero, L., Catala, A., Fernandez-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023)	International Journal of Stem Education, 10(1).	AI literacy in K-12: a systematic literature review.	Understand how artificial intelligence (AI) is being integrated into K-12 education globally, identifying learning experience approaches and theoretical perspectives.	Systematic literature review using Scopus, analyzing 179 articles focused on learning experiences and theoretical perspectives.	A growing interest in IA education in K-12 schools was identified, with a variety of approaches to teaching IA concepts to students.	Need for a competency framework to guide IA literacy proposals.
								Importance of teacher training and systemic approaches to IA education.
								IA literacy should enhance learning in core subjects and promote interdisciplinary and critical approaches.
6	Q2	Chichekian & Benteux (2022).	Frontiers in Artificial Intelligence, 5.	The potential of learning with (and not from) artificial intelligence in education.	Explore the potential of artificial intelligence (AI) in education, focusing on the effectiveness of AI-driven technologies, the role of teachers, and contributions to the field of education.	Literature review, including meta-analyses on intelligent tutoring systems, self-determination theory in the classroom, and the impact of AI on teaching and learning.	Most research focuses on the optimization of AI systems rather than on the quality of learning outcomes. The need for more theoretical investigations and a pedagogical perspective in AI research in education is emphasized.	AI has the potential to improve learning outcomes and educational experience.
								There is a lack of focus on the quality of learning outcomes and student experience in current research.
								Teachers play a crucial role in integrating AI technologies to improve learning outcomes.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
7	Q2	Dimitriadou & Lanitis (2023).	Smart Learning Environments, 10(1).	A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms.	Explore the role of artificial intelligence (AI) and other emerging technologies in smart classrooms, highlighting both the benefits and challenges of their use in education.	Literature review related to emerging technologies in education, including AI, virtual reality (VR), augmented reality (AR), robotics, and adaptive learning systems.	Enhance the learning experience by supporting interactive experiences and real-time feedback.	AI and related technologies have a positive impact on education, improving interaction, engagement, and academic performance.
							Increased student and teacher engagement and performance through technologies such as VR/AR and robotics.	The challenges identified require attention to maximize the benefits of these technologies in educational settings.
							Identification of challenges such as equipment costs, need for teacher training, data privacy concerns, and biases in AI systems.	
8	Q2	Gentile, M., Città, G., Perna, S., & Allegra, M. (2023).	Frontiers in Education, 8.	Do we still need teachers? Navigating the paradigm shift of the teacher's role in the AI era.	Examine the changing role of teachers in the age of artificial intelligence (AI) and propose a manifesto to guide this evolution.	Systematic analysis of the literature on the use of IA in education, focusing on the integration of technologies in teaching and learning.	A need for teachers to adapt to new technologies and teaching methods.	Teachers must develop digital skills and understand IA to effectively integrate it into their teaching practices.
							IA is transforming teacher-student relationships and teaching methods.	AI enables personalized learning and improves student monitoring.
								There is an exponential growth in publications on the role of teachers and IA in education, especially in China.
9	Q2	Karalekas, G., Vologiannidis, S., & Kalomiros, J. (2023).	Education Sciences, 13(1).	Teaching Machine Learning in K-12 Using Robotics.	Discuss the importance of and approaches to integrating educational robotics and ML in K-12 education.	Literature review and discussion of educational tools and platforms.	Identification of tools and platforms such as Scratch, Cognimates, Teachable Machine, and TensorFlow Playground.	Educational robotics and ML can make abstract concepts more tangible and enhance STEM education.
							Presentation of six AI-powered educational robots: Zumi, RoboMaster S1, ClicBot, Cozmo, MINDSTORMS Robot Inventor, and Cogbots.	Use of educational robots and proposed robotic arms to teach ML in secondary education classes.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
10	Q1-Q2	Kim, J., Lee, H., & Cho, Y. H. (2022).	Education and Information Technologies, 27(5), 6069-6104.	Learning Design to Support Student-AI Collaboration: Perspectives of Leading Teachers for AI in Education.	Explore the integration of Artificial Intelligence (AI) in education, focusing on student-AI collaboration, and how this can improve learning in K-12 schools.	It is not explicitly described in the excerpts provided but is inferred to be based on the exploration of teacher perspectives on student-AI collaboration.	Teachers view student-AI collaboration as a tool for achieving optimal learning objectives, emphasizing the importance of knowledge construction, interdisciplinary learning, authentic problem solving, and creative assignments.	The importance of student-AI collaboration in learning. Need for systematic AIED policies to improve AI applications in education. AI as a "learning companion" that provides instructional scaffolding.
11	Q2-Q4	Kim, K., & Kwon, K. (2023).	Computers and Education: Artificial Intelligence, 4.	Exploring the AI competencies of elementary school teachers in South Korea.	To explore the experiences of elementary school teachers in South Korea teaching AI curricula and identify the competencies needed for effective implementation of AI education.	Surveys and interviews with elementary school teachers to collect quantitative and qualitative data on their experiences and competencies in teaching AI.	Twenty-two AI competencies were identified for elementary school teachers based on the TPACK framework. Teachers felt most confident in their pedagogical knowledge, followed by technological knowledge and content knowledge.	Teachers face difficulties in designing and implementing AI curricula due to a lack of training, infrastructure, and support. Teacher confidence is higher in designing and implementing curricula that promote learning experiences with AI-based technologies. Teachers recognize the importance of integrating AI concepts into various subjects and promoting hands-on activities for students.
12	Q1-Q2	Lim, E. M. (2023).	Education and Information Technologies, 28(10), 12969-12995.	The Effects of Pre-Service Early Childhood Teachers' Digital Literacy and Self-Efficacy on Their Perception of AI Education for Young Children.	To examine the relationship between digital literacy, self-efficacy, and perceptions of AI (Artificial Intelligence) education for young children among prospective early childhood education teachers.	Surveys were conducted with 212 prospective early childhood education teachers, using descriptive statistics, correlation analysis, and hierarchical multiple regression analysis.	The means of digital literacy, self-efficacy, and perception of AI education were 3.43, 3.31, and 3.36 respectively, indicating a positive relationship between these variables. Self-efficacy measured the relationship between digital literacy and perception of AI education.	Digital literacy and self-efficacy have a positive impact on the perception of AI education for young children. Self-efficacy plays a mediating role between digital literacy and perception of AI education.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
13	Q2-Q4	Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022).	British Journal of Educational Technology, 53(4), 914-931.	Teachers' Trust in AI-Powered Educational Technology and a Professional Development Program to Improve It.	Improve teachers' confidence in AI technology through a professional development program.	The program included sessions on AI literacy, demystifying misconceptions, and how to integrate AI recommendations into pedagogy. In-service high school biology teachers in Israel participated, using an AI-powered assessment tool called AI-Grader.	Teachers showed an increase in confidence toward AI technology in education, leading to a greater willingness to use AI tools in their classrooms.	Providing procedural knowledge about AI and addressing misconceptions improves teachers' confidence in AI technology. Transparency in how the AI makes recommendations and gives teachers control over these is crucial. The importance of increasing both teachers' theoretical and practical knowledge of AI in educational contexts.
14	Q2	Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2023).	Education and Information Technologies, 28(7), 8445-8501.	A review of AI teaching and learning from 2000 to 2020.	Analyze trends in AI teaching and learning (AITL) research.	Formulation of objectives, review, and analysis of methodological approaches, fields of study, purposes, theories, platforms, and effects.	The most significant results of the study include the identification of methods and areas of study in AITL, and the analysis of trends and effects on education. The importance of understanding trends in AITL to improve the teaching and learning of artificial intelligence was confirmed. Notable trends were observed in the methodology used, fields of study addressed, and effects on education, suggesting growth and evolution in AITL research over time.	Increasing popularity of teaching artificial intelligence at primary/secondary educational levels and in non-computer-related universities. Use of varied pedagogical approaches such as collaborative and project-based learning. Application of various teaching tools such as MATLAB programming.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
15	Q2	Nja, C. O., Idiege, K. J., Uwe, U. E., Meremikwu, A. N., Ekon, E. E., Erim, C. M., Ukah, J. U., Eyo, E. O., Anari, M. I., & Cornelius-Ukpepi, B. U. (2023).	Smart Learning Environments (2023), 10	Adoption of Artificial Intelligence in Science Teaching: From the Vantage Point of the African Science Teachers.	Explore the use of technology in education, including artificial intelligence, online learning environments, and the uptake of ICT by different age groups. Highlight factors influencing technology adoption by teachers and the impact on student learning outcomes.	Analysis of various studies on technology in education.	The most significant results of the study include that self-esteem, expected benefits, and ease of use have a significant impact on teachers' attitudes toward the use of artificial intelligence in science teaching. In addition, teachers' location of residence was found to not influence their intention to use artificial intelligence in teaching. Overall, it was confirmed that science teachers show high approval toward the integration of artificial intelligence in the science classroom. No significant differences in the results were observed as a function of teachers' gender, age, or location of residence.	Effective integration of technology in education is crucial. The importance of training teachers in the use of technology, especially in areas such as artificial intelligence, is highlighted. Challenges and opportunities in the implementation of technology in education are identified.

APPENDIX C

Summary of the main findings of research question Q3

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
1	Q3	Cheng, E. C. K., & Wang, T. (2023).	Computers and Education: Artificial Intelligence, 5, 100171.	Leading digital transformation and eliminating barriers for teachers to incorporate artificial intelligence in basic education in Hong Kong.	Exploring the impact of digital leadership on the integration of Artificial Intelligence in Education (AIED), with a focus on overcoming teacher barriers.	A quantitative questionnaire survey was used, administered to 204 participants from primary and secondary schools. Confirmatory Factor Analysis (CFA) and reliability tests were used to validate the instrument.	Digital leadership significantly predicts all three approaches to AI application in education, while internal teacher barriers negatively predict learning about AI.	Digital leadership is crucial to promote AIED and overcome internal and external barriers for teachers. Internal teacher barriers, such as perception and lack of training, negatively affect AIED integration.
2	Q3	Dai, Y., Lin, Z., Liu, A., Dai, D., & Wang, W. (2024).	Journal of Educational Computing Research, 61(8), 159-186.	Effect of an Analogy-Based Approach of Artificial Intelligence Pedagogy in Upper Primary Schools.	Develop a scenario-based instrument to assess co-design expertise in humanitarian engineering and explore the use of analogies and metaphors in science education. In addition, investigates the teaching of artificial intelligence (AI) in K-12 classrooms and the importance of AI literacy.	Thematic analysis and analogy-based pedagogical approaches to teaching IA, compared to conventional direct instruction.	Teaching IA using a pedagogical approach that demystifies IA and uses analogies significantly improves students' understanding, performance, and interest in IA. Students who learned with the analogy-based approach outperformed those with conventional instruction in IA knowledge, skills, and ethical awareness.	The pedagogical approach involving IA demystification and the use of analogies is effective in teaching IA to upper elementary students. Analogies help students better understand IA concepts and foster greater ethical awareness.
3	Q1-Q3	El Hajj, M., & H. Harb (2023).	IAFOR Journal of Education, 11(2), 97-113.	Rethinking Education: An In-Depth Examination of Modern Technologies and Pedagogic Recommendations.	Explore the integration of technology in education through the Technological Pedagogical Content Knowledge (TPCK) framework, emphasizing student-centered learning.	Literature review on technology integration in education and analysis of teaching strategies using technology.	Technology-based education improves student learning by integrating technological tools into the teaching and learning process.	The critical importance of teachers in guiding and supporting student growth and success in technology-based learning environments. There is a need for ongoing professional development and training programs for teachers to effectively integrate technology into the classroom.

Nº.	Question	Author/year of publication	Journal	Title	Objectives of the study	Methodology	Most relevant results	Key findings/ conclusions
					Identify technological tools that facilitate interactive and engaging teaching strategies.	List of technological tools used to facilitate various teaching strategies.	Technology tools such as Tricider, AnswerGarden, MindMeister, among others, can be used to facilitate teaching strategies such as flipped classrooms, inquiry-based learning, and peer feedback.	These tools help create interactive and engaging learning experiences for students. They promote collaboration, critical thinking, and self-regulated learning skills.
4	Q3	Yau, K. W., Chai, C. S., Chiu, T. K. F., Meng, H., King, I., & Yam, Y. (2023)	Education and Information Technologies (2023) 28:1041-1064	A phenome graphic approach on teacher conceptions of teaching Artificial Intelligence (AI) in K-12 schools.	To investigate teachers' conceptions of teaching Artificial Intelligence (AI) in K-12 schools using a phenome graphic approach.	Interviews were conducted to identify six categories of teachers' conceptions of AI teaching.	The most significant results of the study include the identification of 6 categories of conceptions of Artificial Intelligence (AI) teaching in teachers. These categories cover aspects such as technological bridging, knowledge delivery, stimulation of interest, establishment of ethics, cultivation of skills, and intellectual development.	The key findings of this study reveal six categories of teachers' conceptions of AI teaching, from technological bridging to intellectual development. These insights into teachers' beliefs impact classroom practices and student learning, emphasizing the need for teacher training programs that support a deeper approach to AI teaching in education.

APPENDIX D

Summary of the main findings of research question Q4

Nº.	Question	Author/Year of publication	Journal	Title	Objectives of the Study	Methodology	Most Relevant Results	Key Findings / Conclusions
1	Q4	Abylkasymova, A. E., Shishov, S. E., Kalney, V. A., & Ryakhimova, E. G. (2022).	Journal of Higher Education Theory and Practice, 22(5), 201-206.	Influence of High-Tech Society on the Development of Modern Educational System.	To explore how high-tech society influences the development of the modern educational system, addressing the formation of a valid educational system, principles of interaction with high-tech education, effective methods and tools, and the role of machines in education.	Analysis of national and international academic papers.	A need to adapt the education system to the digital era by incorporating technologies such as VR/AR, mobile internet, and digital skills education.	The importance of developing digital skills for success in the high-tech market. The need to go beyond basic digital literacy, including stability, IT skills, communication skills, and emotional intelligence.
2	Q2-Q4	Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022).	Computers and Education: Artificial Intelligence, 3.	Teachers' readiness and intention to teach artificial intelligence in schools.	To explore the factors that influence teachers' intention to teach artificial intelligence (AI) in schools, and to understand teachers' willingness to implement AI in education.	The PLS-SEM method was used to analyze the relationships among various factors such as perceived usefulness, attitude, confidence, AI relevance, and behavioral intention of teachers. Data were collected from 368 Nigerian teachers.	Factors such as AI literacy, confidence in learning, and AI relevance were significant predictors of behavioral intention. Confidence in teaching AI and AI relevance significantly predicted teachers' intention to teach AI.	Anxiety does not significantly predict teachers' behavioral intentions. The perceived usefulness of AI and AI for social good is a significant predictor. Trust, relevance, and social good strongly predict teachers' willingness to teach AI.
3	Q4	Barakina, E. Y., Popova, A. V., Gorokhova, S. S., & Voskovskaya, A. S. (2021).	European Journal of Contemporary Education, 10(2), 285-296.	Digital Technologies and Artificial Intelligence Technologies in Education.	Explore the use of digital and artificial intelligence (AI) technologies in education, evaluating their benefits, risks, and impact on teaching, learning, and evaluation of students. In addition, it seeks to understand the legal regulations and international experiences in the implementation of these technologies.	Not specified in the text provided.	Benefits and risks of AI in education. Varied experiences from different countries in the implementation of AI technologies in education. Recommendations for the development of legal regulations in AI in education.	Despite advances in AI, most respondents still value the role of teachers in the learning process. AI is seen as a tool to improve the quality of education, but it is crucial to consider the reliability and effectiveness of these technologies.

Nº.	Question	Author/Year of publication	Journal	Title	Objectives of the Study	Methodology	Most Relevant Results	Key Findings / Conclusions
4	Q2-Q4	Bozkurt (2023).	Asian Journal of Distance Education, 18(1), 198-204.	Generative Artificial Intelligence (AI) Powered Conversational Educational Agents: The Inevitable Paradigm Shift.	Explore the use and impact of generative artificial intelligence, with a focus on ChatGPT, in education.	Not specified in the extracts provided.	Generative artificial intelligence, especially ChatGPT, has significant potential to transform teaching and learning methods.	The importance of preparing for an AI-dominated future in education.
								The need to develop prompts engineering as a form of digital literacy.
								The importance of adopting a critical and reflective stance towards the use of generative AI in education.
5	Q4	Bozkurt, A., Xiao, J., Lambert, S., Pazurek, A., Crompton, H., Koseoglu, S., Farrow, R., Bond, M., Nerantzi, C., Honeychurch, S., Bali, M., Dron, J., Mir, K., Stewart, B., Costello, E., Mason, J., Stracke, C. M., Romero-Hall, E., Koutropoulos, A., … Jandric, P. (2023).	Asian Journal of Distance Education, 18(1), 53-130.	Speculative Futures on ChatGPT and Generative Artificial Intelligence (AI): A Collective Reflection from the Educational Landscape.	Explore the use and impact of artificial intelligence (AI), specifically ChatGPT, in education.	Systematic literature review and analysis of speculative narratives about possible futures with AI in education.	Widespread use of AI in education for tasks such as research, language learning, and personal support.	AI can offer significant benefits in education, such as personalized learning and efficiency.
							Concerns about ethics, privacy, and AI bias.	There are significant risks, including algorithmic bias, lack of creativity, and ethical concerns.
							The potential of AI to improve or harm education and society.	The need for a human-centered approach to integrating AI into education.
6	Q4	Ipek, Z. H., Gözüm, A. I. C., Papadakis, S., & Kallogiannakis, M. (2023).	Educational Process: International Journal, 12(3), 26-55.	Educational Applications of the ChatGPT AI System: Systematic Review Research.	Investigate the impact of ChatGPT on education, exploring both the potential benefits and the ethical challenges and concerns.	A systematic review of the literature was performed, selecting 40 relevant studies using specific inclusion and exclusion criteria.	ChatGPT has the potential to transform education, offering benefits such as literature review, complex answer generation, personalized learning, and cyberbullying prevention. However, it also raises concerns about academic integrity and ethical issues.	ChatGPT can significantly enhance education through various applications. - There are legitimate concerns about deception, bias, and ethical and legal implications.

Nº.	Question	Author/Year of publication	Journal	Title	Objectives of the Study	Methodology	Most Relevant Results	Key Findings / Conclusions
7	Q2-Q4	Kim, K., & Kwon, K. (2023).	Computers and Education: Artificial Intelligence, 4.	Exploring the AI competencies of elementary school teachers in South Korea.	To explore the experiences of elementary school teachers in South Korea teaching AI curricula and identify the competencies needed for effective implementation of AI education.	Surveys and interviews with elementary school teachers to collect quantitative and qualitative data on their experiences and competencies in teaching AI.	Twenty-two AI competencies were identified for elementary school teachers based on the TPACK framework. Teachers felt most confident in their pedagogical knowledge, followed by technological knowledge and content knowledge.	Teachers face difficulties in designing and implementing AI curricula due to a lack of training, infrastructure, and support. Teacher confidence is higher in designing and implementing curricula that promote learning experiences with AI-based technologies. Teachers recognize the importance of integrating AI concepts into various subjects and promoting hands-on activities for students.
8	Q4	Lo, C. K. (2023).	Education Sciences, 13(4).	What Is the Impact of ChatGPT on Education? A Rapid Review of Literature.	Evaluate the performance of ChatGPT in different academic domains, its potential to improve teaching and learning, and associated problems.	A quick review of the literature on the use of ChatGPT in education.	ChatGPT showed outstanding performance in critical thinking and economics but struggled in law, medical education, and mathematics.	ChatGPT is useful for generating course materials and assessment tasks, and for helping students answer questions and summarize information. Problems such as the use of biased data limited up-to-date knowledge, and concerns about plagiarism were identified.
9	Q2-Q4	Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022).	British Journal of Educational Technology, 53(4), 914-931.	Teachers' Trust in AI-Powered Educational Technology and a Professional Development Program to Improve It.	Improve teachers' confidence in AI technology through a professional development program.	The program included sessions on AI literacy, demystifying misconceptions, and how to integrate AI recommendations into pedagogy. In-service high school biology teachers in Israel participated, using an AI-powered assessment tool called AI-Grader.	Teachers showed an increase in confidence toward AI technology in education, leading to a greater willingness to use AI tools in their classrooms.	Providing procedural knowledge about AI and addressing misconceptions improves teachers' confidence in AI technology. Transparency in how the AI makes recommendations and gives teachers control over these is crucial. The importance of increasing both teachers' theoretical and practical knowledge of AI in educational contexts.

AUTHORS

Olga Arranz-García is accredited as a Profesor Contratado Doctor and Profesor Titular de Universidad Privada at the Universidad Pontificia de Salamanca (UPSA). She has extensive experience in teaching and academic management. Her main research areas focus on the integration of ICT in education, blended and distance learning, the development of digital competencies in teachers and students, and the impact of artificial intelligence on education. She currently serves as the Vice Dean of the Academic Organization at the Faculty of Education. She has authored numerous research articles in high-impact journals and has presented papers at national and international conferences. Additionally, she is a member of the Technological Management and Knowledge Ethics Research Group (GESTECON) at UPSA and has participated as a researcher in various national and regional projects.

María del Carmen Romero García is an Associate Professor and Coordinator of the Department of Mathematics and Experimental Sciences at the International University of La Rioja (UNIR). She is the author of research articles in high-impact journals, numerous communications to national and international conferences, book chapters, and teaching material. Her main lines of work focus on the training and evaluation of competencies and the application of digital resources and active methodologies in virtual environments. She is a member of the Development and Innovation of Educational Models research group (HUM-833) at the University of Seville and the Principal Researcher of the Active Methodologies and Mastery Learning group (MAML) at UNIR. She is the editor of the *Journal of Technology and Science Education* (JOTSE) and Profesorado, Revista de Currículum y Formación del profesorado.

Vidal Alonso-Secades was born in Luanco, Spain. He is a Full Professor in the Faculty of Computer Science at the Pontifical University of Salamanca (UPSA). He has held the position of Dean of the faculty since 2020 and has held the position of Vice Rector until 2015. He works in the field of education with data analytics, seeking to improve the teaching/learning processes offered to students and teachers. He is the author of several research articles in high-impact journals and has published papers in national and international conferences. He directs the research of the Technological Management and Knowledge Ethics Research Group (GESTECON) at UPSA and has been Principal Investigator in several national and regional projects.