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Technological applications of automation and artificial intelligence in education: A systematic review

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Abstract Artificial Intelligence (AI) and automation have emerged as transformative forces within the educational landscape, reshaping how learning processes, institutional management, and pedagogical practices are conceived and implemented. The objective of this study is to provide a comprehensive understanding of the applications of these technologies in education through a systematic review based on the PRISMA methodology, complemented by a detailed bibliometric analysis. A total of 73 articles were selected from the Scopus, Web of Science, IEEE Xplore, and JSTOR databases, classified into four main categories: AI technologies for educators and intelligent tutoring systems, automation of academic and administrative processes, AI-driven learning analytics and personalization, and emerging trends related to ethics, data protection, and automated decision-making. The results indicate a consistent increase in scientific production since 2020, with a clear concentration of research originating from China, the United States, and India. This trend highlights the growing global relevance of AI and automation as tools for improving educational efficiency, supporting personalized learning experiences, and strengthening evidence-based pedagogical decisions. Despite the progress made, several gaps remain, such as the limited participation of regions with lower technological development, the scarcity of longitudinal or comparative studies, and the urgent need for robust ethical and regulatory frameworks that ensure data privacy and educational equity. Future research should focus on developing adaptive and inclusive AI models, encouraging international collaboration networks, and evaluating the sustained impact of automation in real educational environments. Overall, this study offers an integrated overview of the evolution of knowledge in the field and provides a foundation for advancing the responsible, equitable, and sustainable integration of AI in education.

Keywords: educational technology, adaptive learning systems, academic process automation, pedagogical innovation

1. Introduction

Today, artificial intelligence (AI) and automation represent a global technological revolution that is transforming various sectors (Sarker, 2022; Singh & Mishra, 2021), including education (Kamalov et al., 2023). Globally, there is a growing integration of smart technologies in educational institutions with the aims of personalizing learning (Zhang et al., 2024), automating administrative tasks (Nurmuhammedovna, 2025), and improving access to education in diverse sociocultural environments (Cheung et al., 2021). These technologies have been shown to improve academic performance (Qiu, 2024), promote digital inclusion (Mhlongo et al., 2023), and offer solutions adapted to different learning styles (Rane et al., 2023). Therefore, researching and organizing the use of AI and automation in education becomes essential for understanding their impact and guiding their implementation in an ethical and efficient manner.

Traditionally, educational processes have relied on face-to-face methodologies (Buhl-Wiggers et al., 2023), standardized teaching (Andrews-Dickert et al., 2024), and manual assessment (Cook et al., 2024). Although these methods are effective in traditional settings, they have limitations in meeting current educational needs, such as personalized learning or covering large student populations (Zhao et al., 2023). Furthermore, traditional tasks constitute a considerable portion of teachers' time, affecting the quality of the teaching process. Although educational digitalization initiatives exist, many have focused more on technological infrastructure than on comprehensive pedagogical solutions (Bi et al., 2023).

In response to these limitations, innovative strategies that combine automation and AI technologies to transform the educational experience have emerged (Onesi-Ozigagun et al., 2024; Strielkowski et al., 2025). These include intelligent tutors (Alam & Mohanty, 2023), adaptive learning systems (Ahamed, 2025), virtual assistants (Adiguzel et al., 2023), learning analytics (Ait Baha et al., 2024), and platforms with personalization algorithms (Abiola et al., 2024; Trivedi, 2023). Unlike traditional methods, these solutions facilitate the analysis of large amounts of data in real time to detect behavioral patterns (Lima et al., 2023), anticipate learning difficulties (Dogan et al., 2023), and provide immediate feedback (Owan et al., 2023). Furthermore, they favour the development of inclusive environments, where students can advance at their own pace, supported by systems that dynamically adapt to their cognitive and emotional needs.

The implementation of automation and AI has had a positive effect on education, according to various studies (García-Martínez et al., 2023; Mutambik, 2024; Slimi, 2023). Compared with conventional methods, intelligent tutoring systems can improve academic performance (Alam & Mohanty, 2023). Similarly, the use of virtual assistants facilitates the management of autonomous learning (Adiguzel et al., 2023), increasing content retention and decreasing dropout rates in virtual courses. Furthermore, automation facilitates the reduction of the administrative burden on teachers and improves institutional efficiency (Nurmuhammedovna, 2025). This evidence supports the need to continue exploring and integrating these technologies to optimize educational processes.

Despite progress, the literature still shows significant gaps; most studies focus on developed country contexts, ignoring the realities of countries with less digital infrastructure. Considerable research has focused on isolated case studies or experimental prototypes without deeply exploring the sustainability, scalability, and ethics of these solutions. Furthermore, more research is needed on the long-term impact of these technologies, their curricular integration, and teacher preparation for their pedagogical use. Furthermore, there is little evidence on the simultaneous application of automation and AI in hybrid or virtual models at different educational levels. These gaps justify conducting a systematic review to consolidate existing knowledge, identify emerging trends, and propose courses of action for future research.

Therefore, this study seeks to answer the following research questions: What are the main artificial intelligence technologies currently used in education? What automation technologies have been applied in education over the last decade?, What are the main automation and artificial intelligence technologies currently used in education?, What emerging trends and improvement opportunities are identified in the literature to optimize the use of AI in education?

This article is structured as follows: the theoretical definitions section addresses the theoretical aspects necessary to understand this study. This is followed by the methodology section, which describes the approach followed for the search, selection, and analysis of the studies included in the systematic review. The results and discussion section then presents the applications of automation and AI in education, assessing their effectiveness and pedagogical implications. Finally, the conclusions summarize the most relevant findings, discuss the study's limitations, and propose future lines of research in this area.

2. Theoretical Definitions: Background and Related Applications

2.1. Artificial intelligence

Artificial intelligence (AI) refers to systems capable of performing tasks that normally require human skills, such as learning and decision-making (Entwistle, 1988). Its use in education has experienced significant growth with the use of intelligent tutors, virtual assistants, and student performance analytics (Crompton & Burke, 2023; Ouyang et al., 2022). Tools such as ChatGPT (Jauhiainen & Guerra, 2023), Gemini, and Perplexity facilitate content adaptation, automatic feedback delivery, and automation of teaching processes (Gotavade, 2024). These solutions are deployed in universities, schools, and virtual platforms, improving learning personalization and efficiency.

2.2. Automation

Automation involves the use of technology to execute processes without direct human intervention (Ng et al., 2021). In education, it is used to speed up administrative management (Prykhodniuk et al., 2025), assessment (Paiva et al., 2022), attendance tracking, and assignment submission (Ramesh & Sanampudi, 2022). Tools such as Moodle, Blackboard, and RPA (Robotic Process Automation)-based systems can reduce manual work in educational institutions, training centers, and corporate environments (Demir et al., 2022; Gamage et al., 2022). Their use improves operational efficiency and allows educators to focus on more strategic pedagogical aspects.

2.3. Virtual education

Virtual education is a teaching model based on digital technologies, without the need for overlapping physical time or space (Omole, 2021). This approach was consolidated after the COVID-19 pandemic, allowing for the continuation of distance learning processes through digital platforms (Sibrian et al., 2022; Zhou et al., 2022). Tools such as Google Classroom, Microsoft Teams, and Zoom are essential in educational institutions and universities because they facilitate real-time classes (Dash et al., 2022; Grynyshyna et al., 2023; Stecuła & Wolniak, 2022; Vorina et al., 2022), content management, remote assessment, and automated monitoring of student progress, improving flexibility and access to learning.

2.4. Applications of artificial intelligence in education

AI applications in education encompass technologies that support both teaching and learning (Son et al., 2025) through content personalization (Bond et al., 2024), data analysis (Labadze et al., 2023), and decision-making support. Among the most widely used tools are Century Tech, which adapts content in real time; Gradescope, which automatically grades exams; and Knewton, which adjusts the difficulty of activities. These solutions are used in hybrid classrooms (Shi et al., 2023), university courses, and self-directed environments to optimize the educational experience.

2.5. Automation applications in education

Automation applications aim to improve routine processes in education, such as class management, assessments, and institutional communications (Alalaq, 2025). Their purpose is to reduce traditional teacher time and improve productivity (Zhang, 2024). Tools such as educational ERPs, automated messaging bots, and platforms such as Socrative or Edmodo facilitate the automation of administrative and academic tasks (Kutukov & Vazhdaev, 2023). These technologies are applied in schools, universities, and virtual programs, promoting more efficient, organized, and learning-focused educational management.

3. Materials and Methods

Despite the growth of AI and automation in various fields, studies that systematically examine their educational applications remain scarce and limited. Most existing studies focus on specific technological applications or limited contexts and lack an integrative view that explores their broad-scale educational impact. This review seeks to fill this gap through a systematic, comparative, and updated analysis of the most relevant research in the area.

This review was developed following a structured strategy of searching, selecting, and analysing the academic literature. The process included internationally recognized databases and the use of bibliometric tools to ensure methodological rigor. The review focused on recent studies on AI, automation, and their educational application, using a descriptive and analytical approach to synthesize trends, gaps, and key contributions in the literature. In this context, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta- Analyses) is used because of its international recognition as a standard in systematic reviews (Rethlefsen et al., 2021). The PRISMA guarantees the transparency, replicability, and rigor of the study selection process. Compared with other techniques, such as scoping systematic review or mapping, PRISMA provides greater transparency in inclusion and exclusion criteria and is well suited to research seeking to synthesize existing evidence, as in this study.

3.1. Review approach

Searches were performed in the SCOPUS, Web of Science (WoS), IEEE Xplore, and JSTOR databases because of their high impact and interdisciplinary reach. Tools such as VOSviewer and Bibliometrix were used to identify keyword co-occurrence patterns, relevant authors, and thematic trends (Kumar, 2025; Lim et al., 2024). This approach combines qualitative and quantitative criteria, maximizing depth and accuracy in the collection of scientific information. The selected databases offer access to peer-reviewed literature specialized in education, technology, and AI. SCOPUS and WoS provide extensive interdisciplinary reach (Prada Núñez et al., 2024; Pranckutė, 2021), IEEE Xplore focuses on engineering and technology (Chigarev, 2025), and JSTOR offers complementary sources in social sciences and education. This combination allows for a complete overview of technical and pedagogical approaches.

The keyword group used to verify the title, abstract, and keywords of the articles collected from the Scopus database is as follows: (TITLE -ABS-KEY (artificial intelligence) AND TITLE-ABS-KEY (automat*) OR TITLE-ABS-KEY (intelligent systems) AND TITLE-ABS-KEY (educat*) OR TITLE-ABS-KEY (edtech) OR TITLE-ABS-KEY (e-learning) AND TITLE-ABS-KEY (digital learning)).

The keyword group used to verify the title, abstract, and keywords of articles collected from the Web of Science database: artificial intelligence (title) AND automat * (title) OR intelligent systems (abstract) AND educat * (title) AND edtech (title) AND e-learning (title) AND digital learning (title) AND intelligent tutoring (title) AND educational technology (title)

The keyword group was used to verify the title, abstract, and keywords of the articles collected from the IEEE Xplore database: ("Document title ": artificial intelligence) AND ("Document title ": automat*) OR ("Document title ": intelligent systems) AND ("Document title ": educat *) OR ("Abstract ": edtech) AND ("Document title ":e-learning) AND ("Document title ": digital learning) OR ("Document title ": intelligent tutoring) AND ("Document title ": educational technology)).

The keyword group used to verify the title, abstract and keywords of the articles collected from the JSTOR database: ((((((ab:"artificial" intelligence ") AND (ab:" automat *")) OR (ab:" intelligent systems ")) AND (ab:" educat *")) AND (ab:" educational technology ")) AND (ab:"e-learning ")) OR (ab:"digital learning "))

Figure 1 shows a flowchart describing the different stages of the information selection process. The initial search yielded 1,487 Scopus publications, 738 WoS publications, 596 IEEE Xplore publications, and 90 JSTOR publications, for a total of 2,911 documents across all the databases. In addition, filtering by thematic area was performed, which favoured the inclusion of studies related to the analysed topic. Furthermore, the search criteria were limited to journal articles and systematic reviews. This is because journal articles are peer reviewed and have more support than other types of studies do (Galster, 2023). Likewise, the inclusion of systematic reviews in this study corresponds to the relevance of their scope and the information provided. For this reason, other types of documents, such as conference papers, book chapters or patents, editorial notes, letters, and surveys, were discarded since they contribute very little to the results related to this topic. The selected articles do not have a time specification. After the search was filtered on the basis of the predefined inclusion and exclusion criteria, the number of relevant documents was 59 in Scopus, 93 in WoS, 54 in IEEE Xplore, and 65 in JSTOR. The titles and abstracts of each obtained document were subsequently examined to determine their relevance to the scope of this study. Finally, with a distribution of 19 from Scopus, 27 from WoS, 21 from IEEE Xplore, and 9 from JSTOR, the screening of titles and abstracts of these studies resulted in a total of 76 documents. The next filtering stage involved the use of Mendeley, a reference manager, to remove duplicate articles. A total of 3 duplicate documents were found, and 73 relevant documents were retained for in-depth review.

The selected databases facilitated access to high-impact literature in different areas of knowledge. SCOPUS, WoS, IEEE Xplore and JSTOR were used to collect highly relevant scientific literature. SCOPUS and WoS stand out for their varied and multidisciplinary scopes (Prada Núñez et al., 2024; Pranckutė, 2021), IEEE Xplore stands out for their technology orientation (Chigarev, 2025), and JSTOR stands out for its extension and breadth in social sciences and education. VOSviewer and Bibliometrix facilitated bibliometric analysis, generating co-occurrence maps and citation networks (Kumar, 2025; Lim et al., 2024), which allowed the visualization of thematic relationships and emerging trends.

As a result, this study's systematic analysis provides a comprehensive, up-to-date, and verifiable perspective on the current state of research on artificial intelligence and automation in education. Unlike other reviews, this methodology avoids bias in literature selection, ensures replicability, and provides solid evidence to inform future data-driven research, educational interventions, and technology policies.

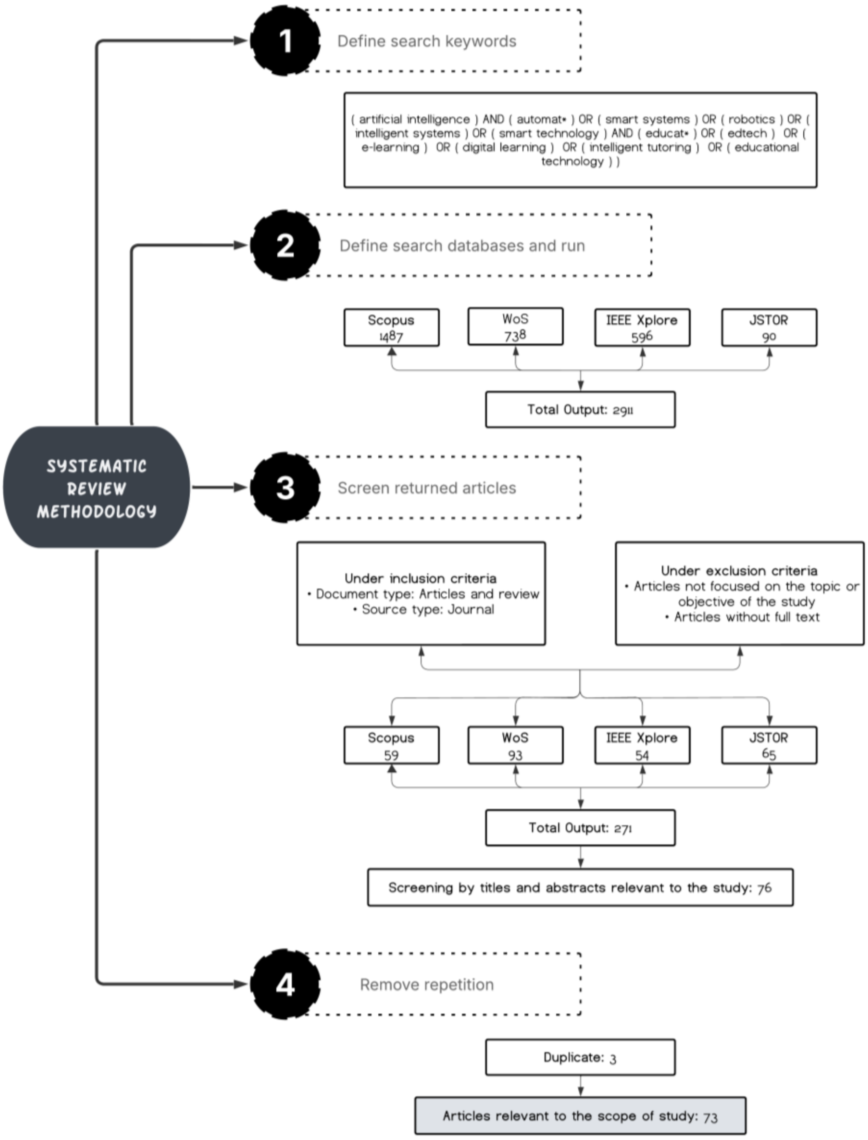

Figure 1 PRISMA-based flowchart.

3.2. Analysis

The initial phase of the analysis focused on reviewing bibliometric data collected from the selected databases. Elements such as the annual evolution of the number of publications, the geographical origin of the studies, the journals where they were published, and the methodological approaches used were examined. The initial results show a growing trend in the scientific production of AI and automation in education. Publications are concentrated mainly in journals specializing in educational technology, engineering, and computer science. Geographically, China, the United States, and India lead in scientific production, reflecting their advances in technological infrastructure, investments in research and development, and educational policies focused on digitalization. In contrast, countries with a lower volume of publications, such as the United Kingdom, Italy, and Spain, show a reduced share. This difference could be attributed to factors such as lower investment in research applied to educational settings, dependence on imported technologies, and a preference for other thematic areas in the country's scientific policy. Furthermore, the limited international collaboration in these countries could limit the reach and global visibility of their contributions in this field.

The methods identified in the literature were compared with the results of this systematic review to ensure a comprehensive analysis. Studies have focused on intelligent tutoring systems (Demir et al., 2022), adaptive e-learning platforms (Rigamonti et al., 2020), AI-based learning analytics (Bali et al., 2024), and the use of educational robots in face-to-face and remote environments (Maaz et al., 2025). The most common strategies include the use of machine learning algorithms (Munir et al., 2022), natural language processing for content personalization, and expert systems for automatic feedback. However, a lack of research that jointly integrates educational process automation, learning personalization, and adaptive assessment using AI was identified, highlighting the relevance of this systematic review in finding innovation opportunities and research gaps in the application of smart technologies in education.

4. Results and Discussion

Bibliometric analysis of records obtained from Scopus, Web of Science, IEEE Xplore, and JSTOR allowed us to identify key trends in research on AI and automation applied to the educational field. The number of publications per year, the geographical distribution of studies, the most commonly used keywords, and coauthorship networks among researchers were analysed. The results revealed a sustained increase in scientific production in this area, with notable changes. Analyses of coauthorship and international collaboration reveal consolidated research networks, with well-defined thematic clusters that reflect the interest of specific academic communities. This bibliometric analysis represents an essential tool within systematic reviews, as it allows us to evaluate the progress of a field of study, detect gaps in the literature, and understand the dynamics of scientific production. This allows us to establish solid foundations to guide future research and create technological innovations that promote the effective implementation of AI and automation in educational settings.

4.1. Bibliometric analysis

Bibliometric analysis is a quantitative approach aimed at examining scientific production through indicators such as publication volume, the number of citations obtained, and academic collaboration networks. This method allows for the identification of research patterns, the analysis of the development of a field, and the detection of the influence of certain authors or institutions. For this study, specialized tools such as VOSviewer and Bibliometrix, which are widely used in scientific research because of their ability to organize and represent complex information, were applied. VOSviewer was used to generate visualizations related to the co-occurrence of keywords and the connections between authors (Lim et al., 2024), whereas Bibliometrix, implemented in R, facilitated the processing of large volumes of data, allowing the recognition of publication trends and citation patterns in the academic literature (Ahn et al., 2024). The integration of these tools provides a structured and detailed perspective on the evolution of knowledge about automation and AI in the educational field, which is crucial for understanding the current landscape and projecting future lines of research.

4.1.1. Keyword co-occurrence map

A keyword co-occurrence map is a visual representation that illustrates the frequency and relationships between terms that appear regularly in the scientific literature (Kumar, 2025), using titles, abstracts and keywords of articles indexed in databases such as Scopus, Web of Science, IEEE Xplore, and JSTOR. Using clustering algorithms, these maps allow us to identify the thematic cores of a field of study and understand how concepts have evolved and interacted over time (Dekhnich & Litvinova, 2024). In this study, analysis is essential to highlight emerging trends in AI, automation, and digital education, helping to identify the most dynamic areas and those with the least academic exploration.

Using VOSviewer and a minimum of 3 keyword cooccurrences, 778 keywords cooccurred, and 4 significant clusters were identified. Figure 2 shows a network visualization map of the 4 cooccurring keyword groups with 35 elements, 243 links, and a total link strength of 412. The keywords with the highest number of links are understood as the most impactful and notable. The keywords with clearly larger nodes than the other keywords are “artificial intelligence”, “deep learning”, “e-learning”, and “automation”. The size of a keyword represents the number of times it has been mentioned as an author keyword in research papers, whereas keywords close to it represent their co-occurrence in research papers. Clusters are represented by colors and are indicators of the most frequently occurring keywords. In this case, the keywords "artificial intelligence", "deep learning", "automation", and "education" are represented by the color green, indicating that these terms frequently cooccur. This information can guide researchers when choosing appropriate keywords for their work, ensuring more effective indexing and retrieval of research.

The results of this bibliometric analysis show that the most prominent concepts are related to e-learning, digital education, intelligent systems, and learning automation. This demonstrates the increasing importance of these technologies in educational contexts. Similarly, the largest and most connected nodes indicate a strong connection between adaptive learning, virtual education, and intelligent tutors, demonstrating how automation and AI applications shape new pedagogical models. This interconnectedness underscores the importance of approaching education from a holistic perspective, in which technology not only supports learning but also transforms the way training processes are designed and implemented.

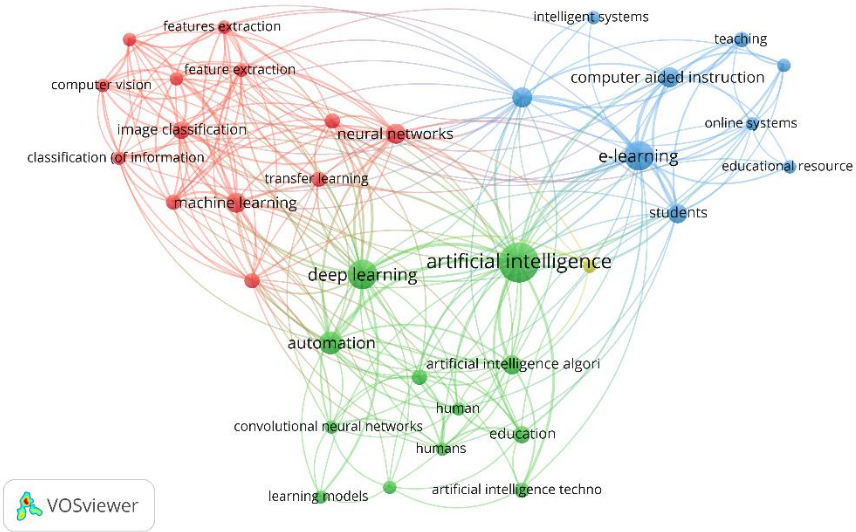

Figure 2 Keyword co-occurrence map in VOSviewer.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.1.2. International coauthorship map

Coauthorship analysis allows us to visualize collaborative networks among researchers and understand how scientific production is organized in a given field (Affonso et al., 2022). This approach allows us to recognize established academic communities, the interactions between institutions, and the importance of certain authors in the dissemination of knowledge. In the context of AI and automation applied to education, this analysis is essential for identifying the main research centers, as well as the patterns of international cooperation that drive the development and consolidation of the discipline.

The minimum number of documents identified in VOSviewer per author was set to 1 to filter the maximum range of coauthorship and, in turn, analyse possible improvements in that aspect. This generated 256 authors, including the main author and their coauthors. These connected elements generated 1 cluster and 91 links. The visualization coauthorship network in Figure 3 shows that researchers Fu Q. and Lai J. are the most frequent collaborators. This coauthorship network represents an improvement in the collaborative capabilities of an international network of researchers, which represents a great advance in the area of AI for education.

4.1.3. Collaboration map by country

International collaboration analysis allows us to identify the global distribution of scientific production around AI and automation in education, highlighting both leading countries and those with less representation on the topic. For this study, the VOSviewer tool was used, where the number of documents from a country was set at 2, to maximize country analysis for greater sustained identification. The number of countries detected by the software was 42, 17 of which met the established criteria. Figure 4 shows the countries active in research in this field, organized into 4 clusters, 21 links, and a total link strength of 22. The largest nodes represent China, the United States, and India. These findings indicate that researchers from these countries play a leading role in the scientific production of applications of AI and automation in education.

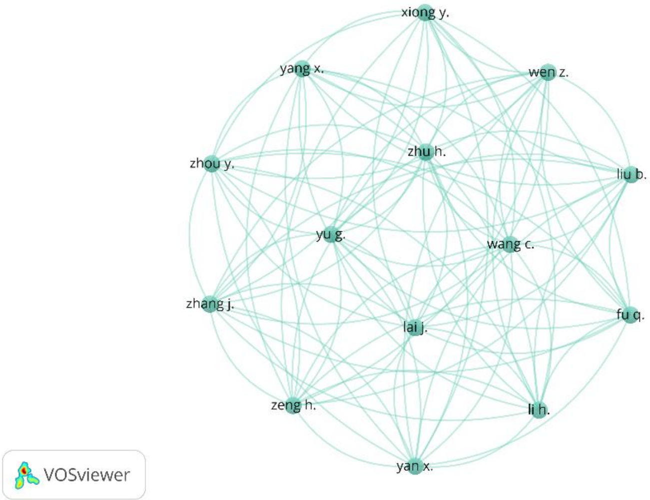

Figure 3 Coauthorship map in VOSviewer.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

These results are consistent with previous research indicating that academic output in educational technologies is heavily concentrated in countries with high levels of investment in innovation, digital infrastructure, and educational transformation policies (Levchenko et al., 2021; Liu et al., 2024). In contrast, regions such as Latin America and Africa have lower participation rates due to funding constraints, a lack of access to digital networks, and less access to international collaborative networks (Jarrín-V et al., 2021; Pedraja-Rejas et al., 2023; Rivera-Lozada et al., 2023).

Similarly, China's leadership has been recorded as linked to large-scale digital education initiatives and intelligent tutoring systems (Ma, 2025), whereas the United States has promoted progress in automatic assessment technologies and adaptive learning platforms (Ruiz et al., 2025). India, for its part, has emerged as a key player due to the growth of online education and the development of low-cost intelligent systems applied in contexts of high educational demand (Joshi, 2024; More, 2024; Singh et al., 2021). However, European countries such as the United Kingdom, Italy, and Spain present a smaller presence relative to their technological capabilities (Marín et al., 2023). This may be due to their prioritizing other fields of research or to their more fragmented approach to education.

In short, the fact that research is focused on a limited number of countries emphasizes the need to promote international collaborative initiatives to strengthen knowledge transfer and reduce inequalities in access to these technologies. Identifying these gaps not only facilitates the current dynamic but also guides investment and collaboration policies toward more inclusive and representative scientific production at the global level.

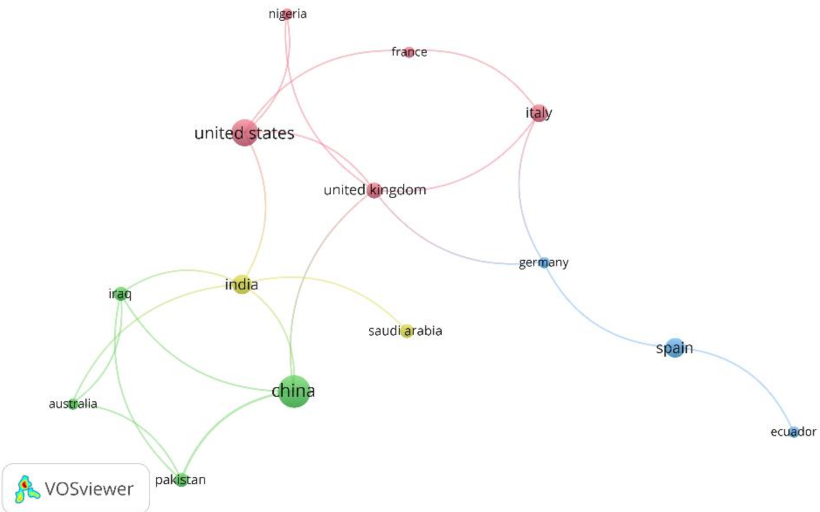

Figure 4 Country co-occurrence map in VOSviewer.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.1.4. Distribution of publications by year

Analysing the distribution of publications over time allows us to identify trends and key moments in the evolution of AI and automation in education. Figure 5 shows the number of articles published on related topics. In the early years, from 2002-

-2014, production was very low, with only one publication each in 2002, 2003, 2013, and 2014, demonstrating a nascent interest in the topic. Later, an increase was observed in 2018, with one publication each, followed by an increase in 2019 and 2020.

Sustained expansion began in 2021, with significant growth reaching 10 publications. In 2022, the peak was reached with 17 articles, indicating a consolidated interest in the field among the scientific community. Although a decrease to 10 publications was recorded in 2023, the increase in 2024 to 13 articles corroborates the continued importance of the field. By 2025, with only 6 publications, considerable activity persists, although this study is considered to be conducted in a period in which that year has not yet ended.

This trend is linked to the growth of digitalization and the search for new solutions for education, which has driven the growing digitalization and search for innovative teaching solutions. In particular, the impact of the COVID-19 pandemic accelerated the adoption of online learning systems and the application of AI in educational personalization, which stimulated greater scientific interest (Anthony & Noel, 2021; Aristovnik et al., 2023; Pokhrel & Chhetri, 2021). Furthermore, investment in research and development by academic institutions and international organizations has contributed to this increase, establishing AI and automation as pillars of the future of education.

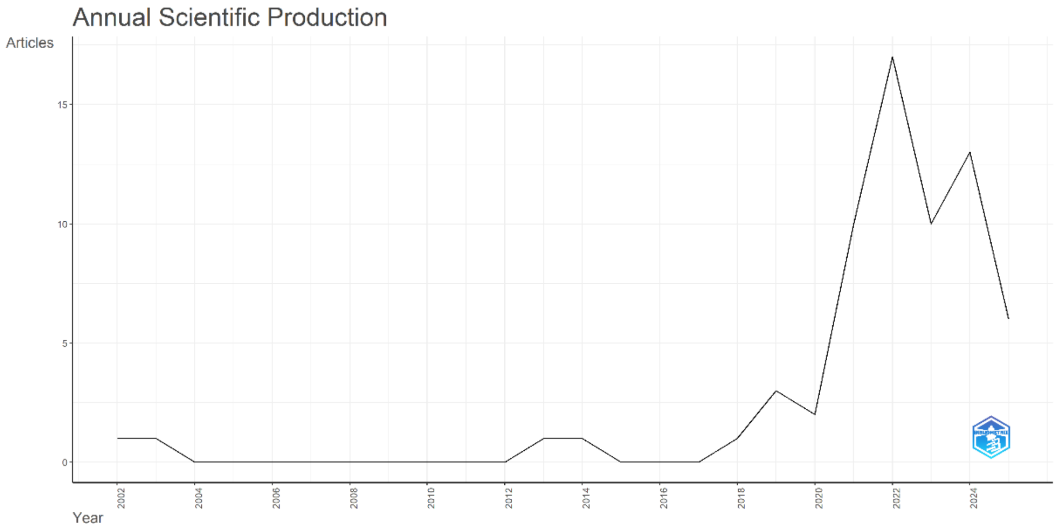

Figure 5 Distribution of publications by year.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.1.5. Distribution of publications by journal

Analysing the distribution of publications by journal allows us to understand the disciplines that contribute most to research on AI and automation in education, as well as the predominant approaches in this field.

Figure 6 presents the distribution of the articles included in the analysis by journal title. IEEE Access stands out as the leading journal, with a total of 16 publications, which demonstrates its central role in the dissemination of research related to smart technologies and their application in various educational environments. It is followed by Educational Technology Research and Development, with 4 publications, and Frontiers in Artificial Intelligence, International Journal of Advanced Computer Science and Applications and Mobile Information Systems, each with 3 articles. Likewise, Wireless Communications and Mobile Computing also has 3 publications, whereas other journals, such as Computers, Materials and Continua, Electronics (Switzerland) and the Journal of Mobile Multimedia, have 2 publications each. Finally, Africa Development contributed a publication to the analysis.

This pattern shows how scientific production in this field is distributed among journals specializing in applied technologies, computer science, education, and digital communication, demonstrating its multidisciplinary nature. The most predominant journals focus on high-impact research aimed at creating practical solutions. In contrast, the variety of publications in other journals underscores the diverse perspectives present in this field. These results suggest that AI and automation in education are being addressed from both the perspective of technological innovation and the perspective of social and pedagogical sciences (Damioli et al., 2025; Wang & Siau, 2019), emphasizing the need for cooperation between fields to consolidate significant progress.

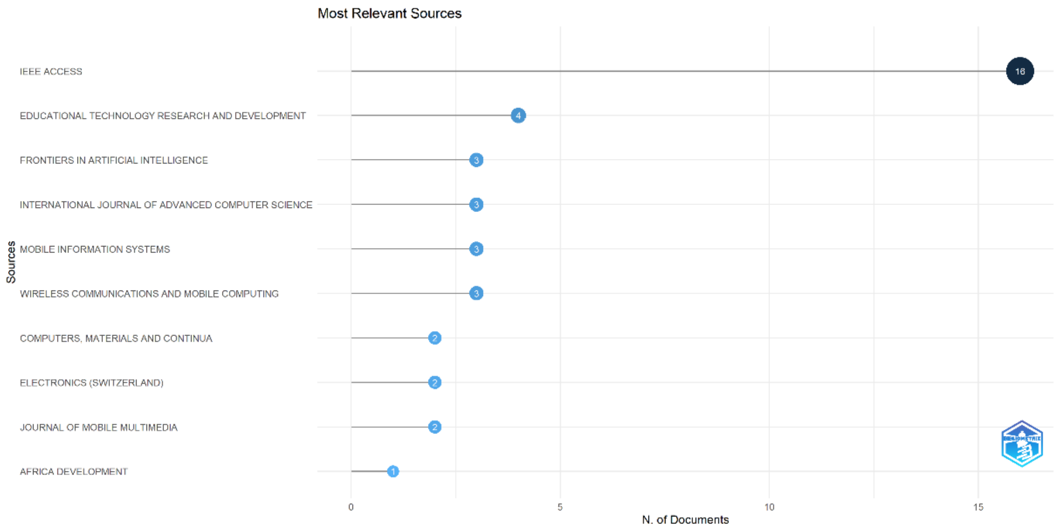

Figure 6 Distribution of articles published by journal title.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.2. Content review

The final analysis included 73 documents selected via the PRISMA methodology, covering studies on the application of artificial intelligence (AI) and automation technologies in education. The selection focused on publications investigating the technological tools used, their implementation in academic and training environments, and the main challenges and opportunities identified in the literature. The thematic distribution reflected a predominance of research on AI applied to education, automation technologies for teaching and learning, and intelligent student support platforms, which allowed for a systematic and focused overview of the field. This approach organized the review around four key questions.

- What are the main artificial intelligence technologies currently used in education?
- What automation technologies have been applied in education over the last decade?
- What are the main automation and artificial intelligence technologies currently used in education?
- What emerging trends and opportunities for improvement are identified in the literature to optimize the use of AI in education?

The results were organized according to these research questions, allowing for a clear analytical structure. As shown in Figure 7, this framework guided a thorough, systematic, and deductive review of the studies, helping to identify the most significant contributions, gaps in the literature, and directions for future research.

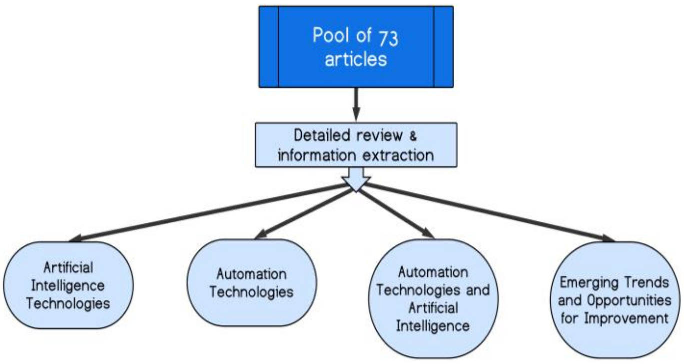

Figure 7 Structure of the systematic content review.

4.2.1. Artificial intelligence technologies

Figure 8 shows the distribution of the 22 studies included in this review on AI technologies in education. The analysis of the filters indicates that there is a predominant interest in intelligent tutoring systems (Alfaro et al., 2020), which stand out for being able to personalize learning and offer automated assistance to the student. Furthermore, AI programs for teachers represent an expanding field (Fakhar et al., 2024), which focuses on improving pedagogical planning, evaluation, and feedback. A relevant number of studies focus on conversational AI through chat (Matthew et al., 2023), highlighting the importance of educational chatbots in reinforcing interaction and student support. Finally, a smaller number of publications related to assistive robots have been published (Maaz et al., 2025), which shows that although this application is promising, it is still in a stage of exploration and has evident possibilities for future studies. In general, these findings indicate that the application of AI in education is growing and is crucial to consolidating its integration into contemporary pedagogical practices.

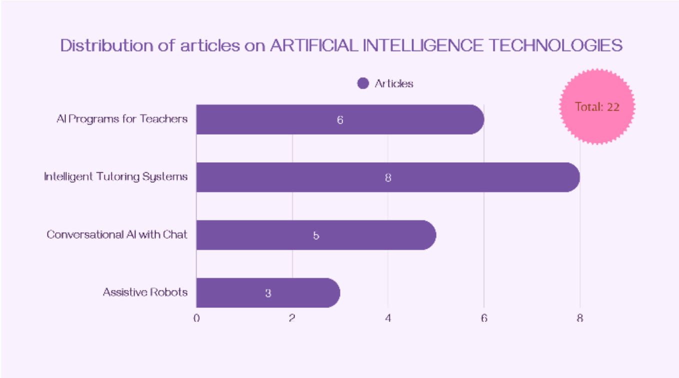

Figure 8 Article distribution by AI technologies.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.2.2. Automation technologies

The distribution of the 16 studies on automation technologies in the education sector is illustrated in Figure 9. The study demonstrates a balanced interest among the three identified applications: automation in multiple access (Valadares et al., 2022), which seeks to optimize the simultaneous management of resources and users in educational environments; automated and robotic grading systems (Alshammari et al., 2022), which are aimed at assisting teachers in the objective and effective evaluation of academic performance; and automation in decision-making (Pawus et al., 2024), which is aimed at facilitating academic and pedagogical management processes. Although the three categories receive similar levels of attention, the development of systems to automate grading and support teachers stands out as one of the most significant applications because of its direct impact on educational practice. These findings indicate that although automation technologies already have a solid field of application in education, there is still great potential for further development, especially in the integration of intelligent solutions that optimize management and personalize learning. Overall, it is evident that automation is expanding, and its consolidation requires an interdisciplinary approach to ensure its effectiveness and accessibility in different academic contexts.

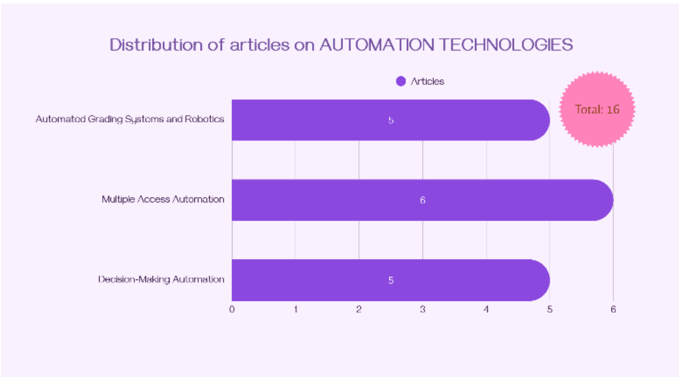

Figure 9 Distribution of articles by automation technology.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.2.3. Artificial intelligence and automation technologies

Figure 10 shows the distribution of the 20 studies that address the integration of AI and automation technologies in education. The analysis reveals a greater interest in the application of automation in monitoring and control, aimed at efficiently supervising academic performance and managing educational resources. Similarly, systems with automatic recognition and tracking stand out as a key line of research, as they focus on personalizing learning and adapting educational environments to the individual needs of students. On the other hand, adaptive curricula constitute the least explored category to date, despite their great importance, as they aim to adjust content and pedagogical strategies according to the teacher's teaching style and student progress (Villegas-Ch et al., 2024). These findings indicate that although the combination of AI and automation is gaining ground in areas of educational management and personalization, a greater push is still needed in the design of adaptive programs. In this sense, the results indicate that the development of these technologies is moving toward the creation of smarter and more personalized learning environments, requiring an interdisciplinary and collaborative approach to ensure their application and effectiveness in different academic contexts.

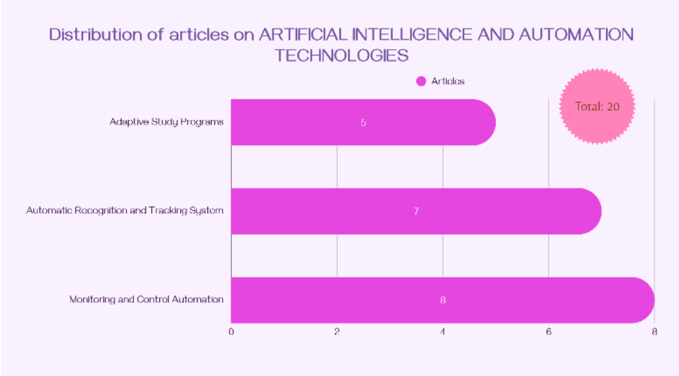

Figure 10 Distribution of items by AI and automation technologies.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

4.2.4. Emerging technologies and opportunities for improvement

The distribution of the 15 studies on emerging technologies and their opportunities for improvement in education is illustrated in Figure 11. The study reveals that the automatic categorization of environments with AI is one of the main trends, since it allows the generation of personalized and adaptive learning scenarios that favour more effective pedagogical decision-making. On the other hand, the field of automatic negotiations is expanding and seeks to improve academic administration and resource distribution by optimizing the interaction processes between educational systems and users. In contrast, ethical and protection techniques represent a critical field that is still developing (Munir et al., 2022) since they address the importance of ensuring privacy, security, and transparency in the handling of student data, which is a fundamental aspect of achieving the responsible adoption of these technologies. In general, the data show that although AI in education is advancing towards more sophisticated applications, challenges related to ethics, trust, and acceptance in school and university environments still persist. These findings emphasize the importance of fostering an inclusive and diverse approach that ensures not only technical effectiveness but also the sustainability and legitimacy of innovations in education.

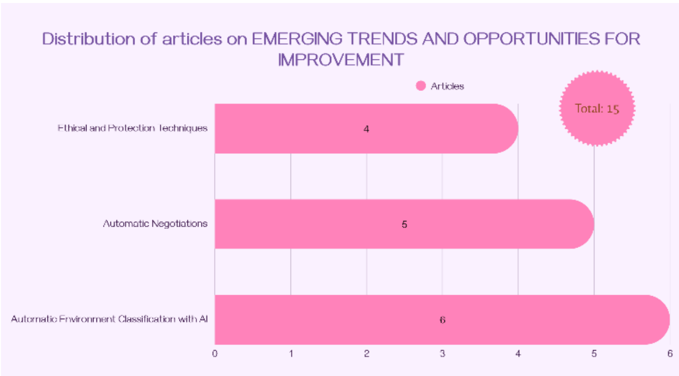

Figure 11 Article distribution by emerging technologies and improvement opportunities.
Source: Author's visualization based on the Scopus, WoS, IEEE Xplore and JSTOR databases (2025).

5. Conclusions

This study demonstrated that automation and artificial intelligence are becoming established as key tools in the educational field. Following a review of 73 articles and a bibliometric analysis, four key areas of application were identified: AI technologies, automation technologies, AI and automation technologies, and emerging trends along with opportunities for improvement.

The results indicate that scientific production has grown steadily since 2020, with a significant increase between 2021 and 2024. This trend confirms the growing interest of the academic and technological community in the integration of AI in education, driven by the search for solutions that improve both teaching–learning processes and institutional management. Geographically, China, the United States, and India have established themselves as the largest producers of knowledge in this field, whereas Latin American and European countries have a lower share. This distribution shows that scientific development is concentrated and that it is necessary to foster more international cooperation initiatives to balance production and access to these technologies.

Likewise, the keyword analysis confirmed the centrality of concepts such as “artificial intelligence”, “deep learning”, “e-learning”, and “automation”, reflecting the main trends in the literature. The coauthorship study allowed us to observe the consolidation of scientific collaboration networks, which strengthened the production and dissemination of knowledge in this area. Although considerable improvements have been achieved, areas of research remain insufficiently developed, especially in the design of adaptive programs, the practical application of ethical data protection techniques, and the incorporation of automated negotiation systems in educational contexts. These limitations demonstrate the need to continue expanding the field with interdisciplinary perspectives that combine technological, pedagogical, and ethical aspects.

Taken together, the results of this study confirm that AI and automation are transforming the educational landscape, not only by optimizing academic processes but also by posing new challenges for equity, accessibility, and sustainability in education.

6. Gaps Found in the Literature

Despite advances in research on the application of AI and automation in education, there are still significant limitations in the literature. One of the main limitations is the lack of empirical studies evaluating the impact of these technologies in real-life teaching and learning contexts. Most research has been conducted in experimental or highly controlled settings, making it difficult to predict the results in diverse educational environments. Furthermore, there is a perceived scarcity of longitudinal studies analysing the long-term effects of implementing automated systems on both academic performance and teacher workload. This lack of understanding limits the understanding of the true impact of these tools on the sustainability of educational processes. Another point is the geographic bias in scientific production, with a marked concentration in countries such as China, the United States, and India, which are considered technological powerhouses, whereas countries such as Latin America show limited participation. This reveals a gap in the access to and development of these technologies, which restricts the possibility of having more diverse perspectives adapted to different educational realities.

Similarly, gaps related to the ethical and social dimensions of AI in education, particularly with respect to data protection, transparency in grading automation processes, and the acceptance of automated decision-making systems, have been identified. These issues are critical to ensuring that AI is integrated into educational settings in a responsible and equitable manner. Ultimately, comparative literature on different automation applications is scarce, making it difficult to identify which approaches are most effective and sustainable depending on the educational context. These gaps demonstrate the need to promote interdisciplinary studies that incorporate pedagogical, technological, and ethical perspectives to strengthen the understanding and application of AI and automation in education.

7. Considerations for Future Research

- The effectiveness of different AI systems applied to diverse educational environments should be compared.
- Investigate the role of AI in fostering inclusion and accessibility in learning.
- Develop longitudinal studies that evaluate the sustained impacts of automation on teaching–learning processes.
- Investigate the influence of AI on teachers' administrative and pedagogical workloads.
- Interdisciplinary approaches that link pedagogy, artificial intelligence and sociotechnological analysis should be integrated.
- The economic and technological sustainability of implementing AI in large-scale educational systems should be analysed.

Ethical Considerations

Not applicable.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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