

## Artificial Intelligence in Education: A Future Vision

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**Abstract:** The world we live in has been radically changed by technology in recent decades. The field of artificial intelligence (AI) in education (AIEd) has developed into a sizable literature collection with a variety of viewpoints. The use of artificial intelligence in educational applications is growing in popularity, posing both benefits and difficulties for the classroom. This study aims to provide a comprehensive understanding of the current conceptual framework of AIEd and explore the future vision for this technology. The study aims to investigate the opportunities that AI technology offers to enhance teaching and learning, identify challenges in this field and outline the future vision for AI technology, and examine the learning outcomes for teachers and students influenced by AI technology. This method can offer a thorough understanding of the conceptual framework and the long-term goals for this area of technology. For a comprehensive literature evaluation, we chose 35 empirical research publications that included AIEd applications, study themes, and other aspects of the research design, including the general AIEd research field, AIEd applications, research topics, and future vision including future benefits, opportunities, threats, and challenges. Although AIEd-based settings are improving student learning, research indicates that tailored learning is still in its early stages. Lack of money and moral dilemmas are obstacles. AIEd's benefits include the fact that AI chatbots and applications facilitate learning, but they also have drawbacks. Additionally, AI apps improved engagement through interactive features, promoted well-being with components and continual availability, and spurred creativity by offering new ideas and problem-solving strategies. While encouraging creativity and increasing participation have many advantages, there are also important obstacles that need to be overcome, such as limits on creativity and moral dilemmas. To maximize the use of AI in education, these elements must be balanced through careful deployment and ongoing assessment.

**Keywords:** Artificial Intelligence, Education, AIEd, Future Vision, Review.

## الذكاء الاصطناعي في التعليم الرؤية المستقبلية

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المستخلص: لقد تغير العالم الذي نعيش فيه جذرياً بسبب التكنولوجيا في العقود الأخيرة. وتطور مجال الذكاء الاصطناعي في التعليم إلى مجموعة أدبية كبيرة مع مجموعة متنوعة من وجهات النظر. إن استخدام الذكاء الاصطناعي في التطبيقات التعليمية يتزايد في شعبيته، مما يطرح فوائد وصعوبات في الفصول الدراسية، تهدف هذه الدراسة من أجل إعطاء فهم شامل للإطار المفاهيمي لاستخدام الذكاء الاصطناعي في التعليم (AIEd) الحالي والكشف عن الرؤية المستقبلية لهذه التكنولوجيا، تقدم هذه الدراسة مخططاً للرؤية المستقبلية للذكاء الاصطناعي في التعليم. تستخدم هذه الدراسة مراجعة منهجية للأدبيات المنشورة مسبقاً. حيث يمكن أن توفر هذه الطريقة فهماً شاملاً للإطار المفاهيمي والأهداف طويلة الأجل لهذا المجال من التكنولوجيا. لإجراء تقييم شامل للأدبيات، حيث تم اختيار عينته مكونة من 35 منشورًا بحثيًا تجريبيًا تضمنت تطبيقات AIEd وموضوعات الدراسة وجوانب أخرى من تصميم البحث، بما في ذلك مجال البحث العام في AIEd وتطبيقات AIEd وموضوعات البحث والرؤية المستقبلية بما في ذلك الفوائد والفرص والتحديات المستقبلية. وقد أظهرت النتائج أنه على الرغم من أن الإعدادات القائمة على AIEd تعمل على تحسين تعلم الطلاب، إلا أن الأبحاث تشير إلى أن التعلم المخصص لا يزال في مراحله المبكرة. حيث يعد نقص التمويل والمعضلات الأخلاقية عقبات. تتضمن فوائد الذكاء الاصطناعي في التعليم حقيقة مفادها أن برامج الدردشة والتطبيقات التي تعمل بالذكاء الاصطناعي تسهل التعلم، ولكنها أيضاً لها عيوب. بالإضافة إلى ذلك، تعمل تطبيقات الذكاء الاصطناعي على تحسين المشاركة من خلال الميزات التفاعلية، وتعزيز الرفاهية من خلال المكونات والتوافر المستمر، وتحفيز الإبداع من خلال تقديم أفكار جديدة واستراتيجيات لحل المشكلات. في حين أن تشجيع الإبداع وزيادة المشاركة لهما العديد من المزايا، فهناك أيضاً عقبات مهمة يجب التغلب عليها، مثل القيود المفروضة على الإبداع والمعضلات الأخلاقية. لتحقيق أقصى استفادة من الذكاء الاصطناعي في التعليم، يجب موازنة هذه العناصر من خلال النشر الدقيق والتقييم المستمر.

الكلمات المفتاحية: الذكاء الاصطناعي، التعليم، الذكاء، الرؤية المستقبلية

## 1. Introduction

AI is a branch of computer science that uses machine learning and algorithms to simulate or imitate human intellect (Helm, 2020, p. 15). Narrow AI, general AI, and artificial superintelligence are the three categories of artificial intelligence. The most common and advanced type of AI to date, narrow AI, is very goal-oriented and uses machine learning techniques to achieve certain tasks or goals, such as image and facial recognition or virtual assistants like Alexa and Siri. Understanding the wants and feelings of other intelligent creatures is one of the talents that general AI, often referred to as deep AI, possesses that is on par with human intellect (Hassani, 2020, p. 27).

AI includes a digital device's ability to do actions that are normally performed by sentient creatures (Chiu, 2021, p. 32). AI-supporting technologies fall into several categories, such as voice, natural language processing, computer vision, big data, and machine learning (Xia, 2022, p. 40). The way people live work, learn, interact, and communicate is being profoundly changed by the field's explosive growth (Verna, 2019, p. 11). AIED is the term for the use of AI technologies, including chatbots, robots, intelligent tutoring systems, and automated assessment of all types of digital artifacts that enhance and assist education (Pedró, 2019, p. 19).

Instantaneous feedback and machine-supported questions are accessible anytime and anywhere, aiding teachers in gaining a deeper understanding of how students learn. This facilitates more individualized and adaptable learning opportunities for students (Akinwalere, 2022, p. 5). Additionally, AIED holds significant potential to enhance educational administration, teaching, learning, and evaluation processes (Abulibdeh, 2024, p. 12). As one of the most critical topics for educational research, AIED fosters program development and promotes the advancement of teaching and learning methodologies ('Alam, 2024, p. 20).

Moreover, AI technology supports multidisciplinary and collaborative learning by exposing students to diverse viewpoints, concepts, and approaches. Through intelligent tutoring systems, augmented reality tools, and virtual reality simulations, students can immerse themselves in interactive learning environments where they explore, invent, and co-create material. These AI-enabled platforms break the limitations of traditional classrooms and textbooks, providing endless opportunities for creative expression and discovery (Amornkitpinyo, 2021, p. 8; Koçak, 2021, p. 15; Khan, 2022, p. 10).

Additionally, students gain access to a broader range of information and inspiration due to AI's capability to identify and suggest relevant materials from extensive instructional content databases. By leveraging natural language processing algorithms, sentiment analysis, and recommendation systems, AI aligns information with students' interests, passions, and learning goals. This process encourages intrinsic motivation and curiosity-driven inquiry (Ali, 2020, p. 22; Hu, 2024, p. 7).

The structure of this study is as follows: First, a review of previous studies in the field of AIED research is presented. Subsequently, a detailed evaluation of selected AIED research is conducted, including an analysis of study design features, major research themes, and AIED application categories. Finally, the study concludes with a discussion of the main findings and contributions of this research.

### 1.1 Problem statement

Interest in the AIED topic is developing as a result of the extensive usage of AI in education and the increasing trend in the number of publications in AIED. However, few studies have comprehensively outlined the theoretical foundations and conceptual framework of the AIED study area, which are essential for comprehending its present situation and future directions. According to our research, we did not find any research that talked about the prospects and future outlook except within the limits of benefit, but no study included a complete analysis of the threats, opportunities, challenges, and future benefits of artificial intelligence in education. So, to fill this research gap, the research questions were:

RQ1: How might opportunities in AI technology enhance education's teaching and learning?

RQ2: What are the challenges in this field of research and future vision for this technology?

RQ3: Which learning outcomes for teachers and students in the future of education are influenced by AI technology?

### 1.2 Aims

The main aim of this review article is to give readers a thorough grasp of the conceptual framework of current AIED and to outline the technology's future goals. To achieve this main aim, our Sub-aims are:

- To investigate the opportunities in AI technology to enhance education's teaching and learning.

- To investigate the challenges in this field of research and the future vision for this technology.
- To investigate learning outcomes for teachers and students in the future of education are influenced by AI technology.

### 1.3 Importance

This study employs a comprehensive literature review to address the research questions. A systematic literature review allows for an in-depth exploration of research nuances by analyzing the content of existing studies (Snyder, 2019, p. 334). This approach provides a robust understanding of the conceptual framework and the long-term objectives of the field of artificial intelligence in education (AIED) (Donthu et al., 2021, p. 287).

The importance of understanding theoretical foundations in education is emphasized by Brown (2020), who discusses the critical role of aligning technological advancements with pedagogical principles to ensure meaningful learning experiences. This perspective further supports the study's focus on integrating AI technologies within a structured theoretical framework (Brown, 2020, p. 45).

The study makes several significant contributions to the AIED literature. It offers a detailed comprehension of the conceptual framework underlying AIED research. Additionally, it presents a critical and forward-looking perspective, providing an updated overview of the evolving research landscape, which includes the latest studies and trends in AIED. This is particularly relevant given the substantial increase in AIED research articles and reviews in recent years. Moreover, the analysis highlights vital areas for future exploration, such as the integration of emerging AI technologies, enhancing theoretical contributions in AIED studies, and employing theory-driven study designs to bolster scientific rigor (Snyder, 2019, p. 336). These observations serve as essential guidance for advancing research in the AIED domain.

## 2. Literature review

AIED research has exploded in recent years, producing a large body of work examining design, efficacy, and results, among other elements of AI applications (Chiu, 2023, p. 45). Insights into the general AIED research field (Chassignol, 2018, p. 17; Guan, 2020, p. 89; Srinivasan, 2022, p. 233) as well as specific topics like learning analytics (Charitopoulos, 2020, p. 112), machine learning and precision education (Luan, 2021, p. 98), or educational AI within specific subject areas like mathematics (Hwang, 2021, p. 67) or STEM (Xu, 2022, p. 76), have been drawn to this expanding research landscape. However, few studies have comprehensively outlined the theoretical foundations and conceptual framework of the AIED study area, which are essential for comprehending its present situation and future directions (Säljö, 2010, p. 53).

### 2.1 Impact of AI on education

Chen L.'s (2020) study set out to evaluate how AI might affect schooling. The study's focus was restricted to the use and impacts of AI in administration, instruction, and learning, and it was based on a narrative and framework for evaluating AI that was found during an initial examination. The study's goal was successfully achieved through the application of a qualitative research strategy that made use of a literature review as a research design and methodology. The study came to the conclusion that artificial intelligence (AI) is an area of study and the technological advancements that have led to computers, robots, and other artifacts possessing intelligence comparable to that of humans, as evidenced by cognitive capacities, learning, adaptability, and decision-making capabilities. According to the report, AI has been widely embraced and applied in education, especially by educational institutions, in a variety of ways. AI began with computers and computer-related technologies, then moved on to web-based and online intelligent education systems, and finally, with the use of embedded computer systems and other technologies, humanoid robots, and web-based chatbots to carry out the tasks and responsibilities of instructors either alone or in conjunction with other instructors. Through the use of these platforms, educators have been able to enhance the quality of their instructional activities and carry out other administrative tasks, such as more effectively and efficiently examining and grading students' assignments. However, the systems' use of machine learning and flexibility has allowed for the customization and personalization of curriculum and content to meet the requirements of students. This has encouraged uptake and retention, enhancing the learning experience and overall quality of education.

Nearly 400 research publications were collected on the use of artificial intelligence (AI) and deep learning (DL) techniques in teaching and learning as part of Guan C.'s (2020) research, which reflected on two decades of educational research and sought to reveal

the history of research evolution in the field of AIED. The evolution of AI and DL research issues in prominent educational publications was investigated by computerized text analysis. Because of the dynamic nature of the field, we want to identify the main terms linked to research on AI-enabled pedagogical adaptation in each decade. They show that, as advanced technologies in education change over time, certain study subjects appear to have endured while others have had ups and downs. They do this by looking at the main research themes and historical patterns from 2000 to 2019. More significantly, the analysis draws attention to the emerging trends and paradigm shifts that are becoming more and more significant in the field of educational research. For example, the findings point to the growth of learning analytics and student profile models and the loss of traditional tech-enabled instructional design research. Additionally, this study aims to start a conversation and increase understanding of the potential and difficulties associated with DL and AI for pedagogical adaptation.

According to experts, artificial intelligence (AI) will be the driving force behind the next significant digital revolution in the ways that people live, interact, work, trade, and learn. Therefore, Chaudhry M. A.'s work from 2021 provides a high-level academic and industry review of AIED. Reducing instructors' workload, contextualizing learning for students, transforming assessments, and advancements in intelligent tutoring systems are the main topics of the most recent AIED research. The ethical aspect of AIED and the possible effects of the COVID-19 pandemic on AIED's research and practice going forward are also covered. They came to the conclusion that AIED's mission is to help education, not advance AI. Essentially, learning outcomes are the only method to assess the influence of AI in education. AIED for teachers' workload reduction has a far greater impact if it allows instructors to concentrate on students' learning, which improves learning outcomes.

In order to improve learning outcomes and students' academic performance, AI-powered solutions are being created for educational purposes more and more. Chichekian T. (2022) employs the PRISMA technique in his exploratory review to explain the ways in which the efficacy of AI-driven technology is being assessed, the roles that are ascribed to instructors, and the theoretical and practical benefits that result from the interventions. Results from 48 papers showed that learning objectives were more in line with AI system optimization, mostly from a computer science standpoint, and did not actively include instructors in the study. The majority of research turned out to be theoretical, and the only real-world applications were to improve the AI system's architecture. Few of these technologies have been used as apps in classrooms, despite recent research demonstrating how they also help students achieve higher learning results overall. Since an ITS must be created and incorporated into both the teacher's and the student's teaching, combining a technological system with a classroom culture calls for varying degrees of flexibility. Determining a more equal division of labor between the duties of the intelligent tutoring system and the instructor, both of which assist students with assignments, instructions, and feedback, maybe the next problem facing the AIED group.

As previously said, artificial intelligence is transforming education as well as many other facets of society. Instantaneous feedback, individualized and adaptive learning, and a deeper knowledge of students' learning processes are all provided by AIED. It might lessen educational inequalities and enhance academic achievement. The goal of Alam G. F. (2024) is to have a conversation about AIED with academics, policymakers, educators, students, and engineers. With an emphasis on certain educational outcomes, it offers a summary of research on possibilities, difficulties, and suggestions for further study. This study analyzes AIED utilizing bibliometric analysis and a systematic literature review. The VOSviewer tool is used to portray the results as a particular bibliometric network. Although customized learning is currently in its experimental stage, research indicates that AIED-based settings are improving student learning. Lack of money and moral dilemmas are obstacles. Interactive books and AI chatbots help language acquisition, yet they have benefits and drawbacks. These benefits and drawbacks must be balanced in the humanities.

The use of AI in educational applications is growing in popularity, which presents both benefits and difficulties for the classroom. Applications of AI may improve organized learning, but they may also have a big influence on students' academic emotions and creativity. Therefore, the goal of Lin H.'s (2024) study is to investigate how AI-integrated educational apps affect college students' academic emotions and creativity from the viewpoints of both students and teachers. It also evaluated professor and undergraduate students' opinions about AI-integrated applications. The research design was mixed methods. A qualitative research methodology was used in the first phase, and informants were chosen by theoretical sampling. In-depth interviews with university instructors and undergraduate students were used to gather data in order to obtain a thorough understanding of their perspectives and experiences. In the quantitative phase, a scale was created, verified, and given to 120 faculty members and students. To examine the data, descriptive statistics were employed. The results showed that AI applications frequently impose strict frameworks that stifle original thought and

creativity, which causes emotional disengagement since AI interactions are impersonal and repetitious. Continuous AI evaluations also increased performance anxiety, and technical annoyances interfered with learning. On the other hand, AI apps improved engagement through interactive features, boosted creativity by presenting fresh concepts and problem-solving methods, offered tailored feedback, and promoted emotional well-being through gamified features and round-the-clock accessibility. Teachers' and students' positive sentiments about the advantages and difficulties of these apps were also confirmed by quantitative data. Therefore, the use of AI in educational applications affects college students' academic emotions and creativity in two ways. Although encouraging creativity and improving engagement have many advantages, there are also important obstacles that need to be overcome, such as performance anxiety, emotional disengagement, and creativity limitations. To maximize the use of AI in education, these elements must be balanced through careful deployment and ongoing assessment.

## 2.2 Specific applications area

An increasing number of areas, including education, are implementing AI. Tutoring and evaluation are the two primary applications of AI in education. Based on a systematic review, González-Calatayud V. (2021) examines the application of AI for student evaluation. Two databases were searched for this purpose: Web of Science and Scopus. 22 publications in all were chosen from a total of 454 papers that were discovered and analyzed using the PRISMA Statement. According to the findings, it is evident from the examined studies that the pedagogy that underpins the instructional activity is not represented in the majority of them. Likewise, formative assessment appears to be AI's primary use. Despite the distinctions between artificial and human intelligence, this comprehensive study has the potential to enhance and facilitate education in virtual, hybrid, and in-person settings, according to one of the analysis's key findings. According to current research, a machine cannot take on the job of a teacher, and the way AI functions and executes tasks in a teaching setting differs greatly from human intelligence, in part because decision-making algorithms are opaque.

The development of computer technology, especially artificial intelligence (AI), offers a way to address this issue by identifying each student's unique learning challenges and offering tailored assistance to improve their performance in math classes. Nevertheless, there aren't enough evaluations from a variety of viewpoints to give researchers—especially new ones—a comprehensive understanding of the state of AI research in mathematics education. To this end, Hwang. (2021) searches the Web of Science (WOS) database for pertinent articles published in reputable journals indexed by the Social Sciences Citation Index (SSCI) in order to perform a bibliometric mapping analysis and systematic review to investigate the role and research trends of AI in mathematics education. Additionally, by using the technology-based learning model, a number of aspects of AI in mathematics education research are considered, including the roles of AI, citation and co-citation relationships, application domains, participants, research methods, adopted technologies, and research issues. As a result, it was discovered that researchers are now more inclined to carry out a variety of AIME investigations due to the development of AI and computer technologies. They discovered that including pertinent AI applications in advanced mathematics learning activities, such as geometry and topology, applied mathematics, mathematics literacy, and cross-disciplinary (like STEM) courses, might be beneficial.

Precision education has been increasingly popular in the field of education in recent years. Machine learning, a quickly developing AI approach, is seen as a key tool for achieving it. Luan H. (2021) thoroughly examines 40 empirical research on machine learning-based precision teaching in this work. The findings indicated that while the data sources varied, most research was conducted in online or mixed learning environments among university students majoring in computer science or STEM and concentrated on predicting learning success or dropouts. Thus, the most popular machine learning algorithms, assessment techniques, and validation strategies are introduced.

Chatbot systems may now be integrated into many facets of education thanks to the development of AI technology. The usage of this technology in teaching is growing in popularity. Everyone in the industry, including students and institutional staff, might benefit from the speedy and individualized services that chatbot technology offers. C. W. Okonkwo (2021) provides a thorough analysis of earlier research on chatbot use in education in his article. Fifty-three papers from reputable digital resources were examined using a systematic review methodology. The results of the review offer a thorough grasp of previous research on the use of chatbots in education, including details on previous studies, advantages, and difficulties. The majority of chatbot system applications in education, according to the findings, are concentrated on teaching and learning, administration, assessment, advisory, and research and development. This is made feasible by the potential applications of chatbot systems in education, such as the integration of material,

rapid access, engagement, and incentives, which enable many users and instant support. By using chatbots, it is possible to collect and store different types of information in an information unit that authorized users may quickly and easily access. Additionally, chatbots enable numerous users to access the same material simultaneously, promote individualized learning, and offer users immediate help.

As a new subject, the use of AI in STEM education (AI-STEM) faces the difficulty of combining various AI approaches with intricate educational components to satisfy teaching and learning objectives. Based on a general system theory (GST) framework, Xu W. (2022) carried out a systematic study to look at 63 empirical AI-STEM studies from 2011 to 2021 in order to obtain a thorough grasp of AI applications in STEM education. The findings looked at the main components of the AI-STEM system and how AI affects STEM education. The results further illustrated the distribution linkages of the AI categories with other components (i.e., information, subject, medium, and environment) in AI-STEM. Six categories of AI applications were summarized. The research also uncovered the technological and instructional implications of AI in STEM education. Based on a GST framework, this study examined empirical AI-STEM research conducted between 2011 and 2021 and suggested theoretical, technical, and educational implications for implementing AI approaches in STEM education. All things considered, research into the integration of technology and the educational system, as well as the potential of AI technology to improve STEM education, is ripe for further investigation.

In their research, academics have also employed bibliometric, systematic, or merely narrative reviews. Chassignol et al. (2018), for instance, used a narrative review to condense and convey their main results from the literature in a framework that included four elements of the educational process: communication, teaching methodology, assessment, and content. In order to summarize three important ideas in the AIED literature—adaptive learning, customization and learning styles, and expert systems and intelligent tutoring systems—Goksel and Bozkurt (2019) performed a co-word analysis of the keywords in 393 publications published between 1970 and 2018. In order to summarize AI applications in STEM education, their features, and their impacts, Xu W. (2022) carried out a systematic evaluation of empirical AI-STEM studies from 2011 to 2021.

Examples of AI-based technologies that offer engaging and immersive learning environments while actively empowering students to explore complex concepts include chatbots, virtual assistants, and adaptive learning systems. By assisting with assignment grading, monitoring student engagement, providing faster and more accurate feedback, and freeing up instructors' time for other teaching duties, AI supports assessment and feedback (Lin, 2024). By analyzing student data to identify people who could be at risk and facilitating early interventions for academic achievement, chatbots with AI offer prompt, personalized help. Examples of AI apps and platforms include Bit.AI, Mendeley, Turnitin, and elinik. By evaluating big datasets, producing insights, and spotting patterns that are difficult for human researchers to spot, Io and Coursera technologies assist research in higher education (Barocas, 2019). As technology continues to improve, we anticipate even more innovative AI applications in education that will provide students with personalized, interesting, and fruitful learning experiences (Amornkitpiny, 2021).

### 3. Methodology

The aim of the study is to evaluate how AI will affect education. More specifically, it aims to determine the impact of AI on education and its future prospects.

As a result, the study employs a systematic literature review methodology, which comprises evaluating previously conducted studies and secondary data. In fact, Snyder proposed that a review of secondary data, along with a systematic or semi-systematic literature review, offers a more profound comprehension of the phenomena under research (Snyder, 2019).

We chose 35 empirical research articles for a systematic literature review, covering the general AIED research field, AIED applications, research topics, and future vision, which includes future benefits, opportunities, threats, and challenges. This approach can offer a thorough understanding of the conceptual structure and the future vision for this technology field.

#### 3.1 Data collection

Various databases, such as IEEE, ScienceDirect, and Web of Science, were searched using keywords and search strings. Additionally, Google Scholar is searched using keywords and search strings to find publications from various journals that have examined the effects of artificial intelligence on education.

In November 2024, we searched for English-language articles that used the phrases "artificial intelligence" and "education" in their abstract, title, or keywords. A total of 1632 articles were found in this first search. After that, we conducted a manual screening to

determine how pertinent these papers were to our AIEd emphasis. We eliminated from our dataset any papers that were judged to be unrelated or to have little or no AIEd material. Furthermore, we only kept academic publications having full-text access, such as conference papers and journal articles. There were 612 publications published between 1994 and 2024 that made up the pre-final dataset.

We found that more than half of the research articles on AIEd were released after 2015. In order to better examine the publishing patterns in AIEd, it wasn't until 2017 that AIEd became a well-known field of study. But since 2017, this area has attracted a lot of research interest, with a notable uptick in interest from 2019 to 2021. The fast development of AI capabilities in recent years (Roser M., 2022) and the shift to online instruction during the COVID-19 pandemic (Du Z., 2022). are responsible for this surge. With the additional exclusion criteria listed in table 2, below number of useful publications that we may rely on dropped to 60 after eliminating older scientific papers and restricting them to more recent scientific papers.

### 3.2 Analysis

We have compiled the top 35 internationally referenced publications that have been attracted to this growing research environment in order to provide more insights into the influential work in AIEd. The theoretical underpinnings and conceptual framework of the AIEd subject field, which are crucial for understanding its current state and potential future prospects, have not been well described in many papers.

They cover a range of themes in AIEd, which can be roughly classified into six categories, including (1) general AIEd research field, (2) specific AIEd research field, (3) future benefits, (4) future opportunities, (5) future threats, (6) future challenges of AI in education.

An examination of the top 35 cited references by the papers in our sample reveals the disciplinary foundations of AIEd research. These cited references suggest three disciplines foundational to AIEd research: the general AIEd research field, specific topics like mathematics, Chatbot, and STEM, and the Future vision of AIEd (Table 1).

**Table 1 Categories themes in AIEd.**

general AIEd research field	specific AIEd research field	Future Vision of AIEd			
		benefits	opportunities	threats	challenges
Amornkitpinyo. (2021)	Barocas. (2019)	Alves-Oliveira P. (2017)	Balasooriya. (2024)	Derry. (2013)	Bogina et al. (2021)
Alam. (2024)	Charitopoulos A. (2020)	Amornkitpinyo. (2021)	Helm. (2020)	Lin.(2024)	Hassani. (2020)
Chassignol. (2018)	Chichekian T. (2022)	Barocas. (2019)	VanLehn. (2011)		Luckin. (2019)
Chaudhr. (2021)	González-Calatayud V. (2021)	Chang et al. (2023)			Sharma. (2019)
Chen. (2020)	Hwang.-J. (2021)	Gordon. (2015)			Yufeia. (2020)
Guan. (2020)	Luan. (2021)	Li G, (2024)			Zhai et al. (2024)
Srinivasan. (2022)	Okonkwo. W. (2021)	Urmeneta. (2024)			
	XuW. (2022)				

### 3.3 Paper selection criteria

Based on the previously described criteria, a total of 60 papers published after 2015 were first chosen. Next, we matched the search terms and search strings with our inclusion and exclusion criteria (Table 2). The number of articles for analysis was reduced to 35, a sample size deemed adequate to support conclusions and inferences regarding the impact of AI on education, using a systematic review approach. This was achieved by further reviewing and analyzing these articles, identifying those that concentrated on the nature of AI and its effects on education, as well as the future vision and analysis.

Table 2 Inclusion and exclusion criteria, The application of AIED: a systematic review.

Inclusion criteria	Exclusion criteria
Papers that are published in journals of the category quartile Q1 in the Journal Citation Reports;	Remove duplicate/matching studies;
Papers that clearly describe the AI applications under study and report their impact on teaching and learning;	Remove studies based on quality evaluation criteria;
Papers that contain an empirical study;	Remove papers that don't address the research questions;
Took place between 2015 and 2024;	Irrelevant or lacking substantial content on AIED.
Published in English;	
Full-text Journal and Conference articles.	

#### 4. Results and Discussion

##### Discussion and Synthesis

The findings of this research underscore the transformative potential of artificial intelligence (AI) in education, addressing diverse teaching and learning requirements while navigating the complexities of integration. By synthesizing the opportunities, challenges, and learning outcomes, this discussion aligns the results with the research questions and positions the study within the broader academic discourse.

##### Opportunities: Advancing Educational Practices

AI-driven tools provide **personalized feedback**, adaptive learning pathways, and innovative teaching methods. These capabilities address the **first research question**: *How might opportunities in AI technology enhance education's teaching and learning?*

AI empowers educators to tailor content based on student needs, fostering **engagement and understanding** through interactive technologies like augmented reality (AR) and virtual reality (VR). Platforms such as Khan Academy's Khanmigo and AI-based language-learning tools like Duolingo illustrate how these technologies enhance learning through intelligent feedback and content customization (Bicknell et al., 2023). Moreover, AI's ability to analyze large datasets enables institutions to identify at-risk students and intervene early, enhancing academic performance and retention (Wang et al., 2024).

The environment of teaching and learning is changing as a result of the quick evolution of AIED applications (Popenici, 2017). The emergence of generative AI technology has opened up new avenues for investment and growth in the AIED sector. From 2022 to 2030, the worldwide AIED market, which was valued at USD 1.82 billion in 2021, is expected to expand at a compound annual growth rate of 36% (Wang, 2024).

AIED is being rapidly adopted by students, instructors, and educational institutions. According to recent data, half of teachers utilize AI to create their classes, while 43% of US college students use ChatGPT and other AI applications. Furthermore, AIED exhibits its usefulness and efficiency. It has been demonstrated that AIED-enabled adaptive learning increases student test scores by 62%, while AI use generally improves student performance by 30% and lowers anxiety by 20% (Wang S, 2024).

Additionally, AI facilitates **beneficial activities for students**, such as gamified learning experiences, adaptive quizzes, and real-time language translation tools. These features cater to individual learning preferences, increase motivation, and help bridge linguistic and cultural barriers. For example, AI-powered applications like Quizlet and Google Translate offer tailored solutions that support self-paced learning and instant comprehension, making learning more inclusive and effective (Chang et al., 2023).

The findings conclude by identifying four main categories of AI applications found in the AIED literature: intelligent assessment and management, adaptive learning and personalized tutoring, profiling and prediction, and emerging products. Of these, adaptive learning and personalized tutoring have received the greatest attention. The most prominent issue among the study topics is system design and implementation, followed by acceptance and use, AIED effects, and its obstacles. The findings also show that, in comparison to the experimental technique, the systematic review strategy is the most widely employed research methodology. Constructivist learning theory, learning style theory, cognitive theories of learning, and item response theory are some of the most



widely used learning theories that inform study design. More research is necessary to ascertain whether and how these new technologies enhance education, as the consequences of AIED are still unclear.

### Challenges: Barriers to Progress

The study identifies significant challenges, including **ethical dilemmas, algorithmic biases, and equity issues**, which directly address the **second research question**: *What are the challenges in this field of research and the future vision for this technology?*

Ethical concerns about **data privacy and bias in AI algorithms** present critical barriers. For instance, over-reliance on AI could limit creativity and critical thinking, while inequities in digital access exacerbate the **digital divide** (Zhai et al., 2024). Additionally, the lack of pedagogical training for teachers using AI tools restricts their potential impact, highlighting the need for professional development and resource allocation (Lin, 2024).

Navigating these barriers requires a **balanced approach** to integrating AI into educational systems, ensuring fairness, inclusivity, and transparency in its application.

### Learning Outcomes: Shaping Educational Futures

The findings reveal that AI positively impacts **learning outcomes**, particularly in fostering **creativity, confidence, and engagement**, directly supporting the **third research question**: *Which learning outcomes for teachers and students in the future of education are influenced by AI technology?*

AI-powered platforms encourage innovative thinking by introducing **novel problem-solving methods** and offering immediate, personalized feedback that builds student confidence (Chang et al., 2023). Moreover, gamified features and 24/7 accessibility promote emotional well-being, enhancing motivation and reducing anxiety (Lin et al., 2024). AI activities such as collaborative group work in virtual environments, project-based learning with AI assistants, and interactive simulations contribute to developing critical 21st-century skills like teamwork, adaptability, and digital literacy (Wang et al., 2024).

These outcomes illustrate AI's potential to reshape educational landscapes, equipping learners with the skills necessary to thrive in a rapidly evolving world.

### Implications for the Future of AI in Education

This study advances the understanding of AI's role in education by presenting a **holistic framework** that integrates opportunities, challenges, and actionable recommendations. Unlike previous research that often emphasizes the benefits of AI, this study provides a balanced perspective, emphasizing the **ethical and practical considerations** necessary for sustainable adoption.

Future development should focus on **bridging the digital divide** and enhancing AI systems' fairness, transparency, and inclusivity (Lin et al., 2024). Furthermore, research must explore how AI can support **lifelong learning**, cater to diverse learner needs, and address evolving educational demands while mitigating risks (Zhai et al., 2024).

## 5. Future Vision

### 5.1 Future Threats

AI-integrated tools have the potential to significantly influence the academic emotions of both students and teachers, which are critical components of the educational experience in schools. These emotions, experienced by both students and teachers in learning environments, play a crucial role in motivation, learning strategies, cognitive resources, and overall academic performance. Academic activities, including learning, teaching, studying, and testing, are closely tied to these emotions, which can be either positive (such as enjoyment, pride, and hope) or negative (such as fear, frustration, and boredom) (Derry, 2013). Emotions such as motivation, engagement, anxiety, boredom, and satisfaction directly affect students' learning outcomes, persistence, and overall well-being. The intricate relationship between cognitive processes and emotional experiences is often overlooked in traditional teaching methods, leading to suboptimal learning environments and outcomes (Hassani, 2020; Helm, 2020; Lin, 2024).

One of the major risks associated with AI is the automation of emotional responses, which could lead to a detachment from the natural and dynamic human connection between students and teachers. Relying solely on AI to gauge emotional states could lead

to a misinterpretation of nuanced feelings that are better understood through human interaction, which may affect the quality of teacher-student relationships. Additionally, AI's limitations in detecting complex emotions such as frustration, sadness, or motivation could result in incomplete or ineffective emotional support for students, especially those who may be struggling in an academic environment (Hassani, 2020).

## 5.2 Future Opportunities

Despite these challenges, AI technologies present unique opportunities to track, assess, and respond in real-time to students' academic emotions in school settings (VanLehn, 2011). AI can identify subtle indicators of students' emotional states and adjust learning experiences by utilizing face recognition technology, sentiment analysis algorithms, and affective computing techniques (Helm, 2020). For example, based on students' emotional reactions and performance indicators, adaptive tutoring systems can dynamically adjust task difficulty, provide scaffolding support, or offer motivational cues (Lin, 2024). Additionally, gamification elements, immersive storytelling, and personalized avatars can be integrated into AI-powered learning systems to enhance emotional engagement and investment in learning activities. AI has the potential to improve positive academic emotions, such as curiosity, excitement, and self-efficacy, while mitigating negative emotions such as frustration, anxiety, and disengagement by creating a welcoming and inclusive classroom environment that acknowledges and addresses students' diverse emotional needs (VanLehn, 2011).

Furthermore, AI-powered systems can help foster a personalized learning journey for each student. By continuously adapting to students' progress, challenges, and emotional cues, AI can create individualized learning paths that cater to specific needs and preferences, ensuring students receive the necessary support at the right time. This can significantly reduce the one-size-fits-all approach of traditional education, offering personalized learning experiences that might have been impossible to implement without AI technology (Lin, 2024).

Teachers can also utilize AI-driven analytics and data visualization tools to gain insights into students' progress, emotional trends, and potential academic risks. This data enables them to take timely and informed actions to support students' needs. By recognizing emotional patterns and behavioral changes early, AI can facilitate proactive interventions, such as recommending additional resources or adjusting lesson plans to better engage students (VanLehn, 2011).

## 5.3 Future Challenges of AI in Education

Teachers' and students' reactions to the use of AI in classrooms have been mixed, signaling a complex balance of benefits and challenges. One major concern is the possibility that AI applications could impose rigid frameworks, limiting the creative and spontaneous thinking needed for innovative learning processes (Hassani, 2020; Helm, 2020; Yufeia, 2020). Although AI can enhance teaching, if its algorithms are too rigid or prescriptive, it may inadvertently limit critical thinking and stifle students' capacity to approach problems in diverse and creative ways.

Choosing appropriate data for AI prediction models remains a significant challenge. Effective AI predictive models require comprehensive structured and unstructured student data, which raises privacy concerns. Traditional AI models often rely on well-organized data, which may not be fully suitable for emerging AI technologies. The balance between the effectiveness of AI technology and ethical concerns becomes even more important when working with younger students (Sharma, 2019). Ethical frameworks must be developed to guide the collection, analysis, and use of students' data, ensuring it is done in a way that respects their privacy and autonomy.

Moreover, the growing digital divide exacerbates educational inequalities. AI-powered tools may enhance student participation and develop 21st-century skills; however, the most capable or motivated students often gain the most from these technologies. This discrepancy arises from a lack of pedagogical knowledge among teachers on effectively integrating AI and from poorly adapted AI tools. As a result, students who need additional support may become demotivated by AI technology, further increasing educational inequality. Future research should focus on developing a new pedagogical framework for AI in education and creating algorithms for personalized learning (Luckin, 2019). To address this issue, AI systems should be designed to be inclusive, ensuring equitable access to students regardless of socioeconomic background.

Another challenge is the over-reliance on AI tools, which may reduce students' independence and critical thinking abilities. This dependency could hinder the development of problem-solving skills. Striking a balance between AI usage and opportunities for independent, critical thinking is crucial to maintaining students' cognitive engagement (Zhai et al., 2024). Teachers need to be equipped with strategies that encourage students to use AI tools while promoting their autonomy and self-directed learning.

Finally, ethical issues regarding biases in AI algorithms and the moral implications of AI use in the classroom need to be addressed. As noted by Bogina et al. (2021), AI systems could potentially reinforce existing biases and inequalities in educational contexts, raising concerns about the fairness and equity of AI-based decisions. It is essential to continuously monitor AI systems to ensure they do not inadvertently favor certain groups over others, and proper regulatory frameworks should be in place to address these concerns (Bogina et al., 2021).

#### 5.4 Future Benefits

Despite these challenges, integrating AI into educational tools presents several benefits that can significantly enhance students' creativity and learning outcomes. AI-powered applications can stimulate creative learning methods by introducing new concepts and improving problem-solving skills. Studies support the idea that AI can offer diverse perspectives and strategies for problem-solving, fostering innovative thinking (Li, 2024; Urmeneta, 2024).

Moreover, AI tools offering individualized feedback can provide students with quick responses and personalized guidance, helping them improve their work and boosting their confidence. According to Chang et al. (2023), tailored AI feedback enhances learning outcomes and student confidence, which is essential for students' growth. A common concern regarding AI evaluations is performance anxiety, as constant real-time feedback can cause stress and anxiety. However, AI's ability to deliver personalized, adaptive feedback can have both positive and negative effects on students' mental well-being (Gordon, 2015; Alves-Oliveira, 2017).

In conclusion, both teachers' and students' perceptions of AI in the classroom reveal a balanced assessment that takes into account both its benefits and challenges. While concerns are legitimate, the advantages of AI are significant. This highlights the importance of carefully and strategically integrating AI into educational settings to optimize its benefits while minimizing potential drawbacks. As AI technology continues to evolve, navigating its role in education and maximizing its impact on teaching and learning will require ongoing research and discussion (Barocas, 2019; Amornkitpinyo, 2021).

By acknowledging and addressing these challenges, AI can become a powerful tool that empowers both students and educators, creating more dynamic, personalized, and efficient learning environments. However, it is essential to approach AI integration in education with a thoughtful strategy that values ethical considerations, inclusivity, and long-term sustainability to ensure it delivers meaningful and equitable benefits.

## Conclusion

### Researcher's Personal Opinion and Commentary:

Integrating artificial intelligence (AI) into education represents a significant step toward enhancing the learning environment and making it more interactive and tailored to the diverse needs of students. In my opinion, AI has the potential to make a profound positive impact on educational experiences, but it must be approached with caution and careful planning.

From the study of the future challenges and opportunities discussed, I believe there is an urgent need to strike a balance between the benefits of AI and its impact on the human aspects of education. While AI can contribute to personalized learning and support, over-reliance on it could diminish students' critical thinking and creative abilities. Therefore, AI should be used as a complementary tool to the learning process rather than a complete replacement for human interaction. Human touch and personalized guidance remain essential components of the educational journey.

Additionally, the ethical issues surrounding the use of AI, such as privacy protection and ensuring fairness in decisions made by AI systems, must be urgently addressed. We must ensure that these technologies do not reinforce biases or exacerbate social and economic disparities in education.

In the future, research must focus on developing strategies for professional training for educators to empower them to use these technologies effectively and efficiently, ensuring that all students benefit equally from the opportunities AI provides. Research

into AI should also explore ways to enhance the emotional experience of students in a manner that supports their motivation and mental well-being.

Based on these considerations, the use of AI in education should be backed by a strategic and ethical vision to ensure that it adds genuine value for all stakeholders involved and enhances the learning experience in a balanced and integrated way.

This study makes several contributions to the AIED literature. First, it closes a vacuum in the literature by providing a thorough grasp of the conceptual framework of the AIED study. Furthermore, this study offers a critical, current assessment of the changing research environment, encompassing the most recent papers, given the recent trend of a significant increase in AIED research articles and the review works on certain AIED themes. Furthermore, the analysis of the state of AIED research has revealed uncharted territory and indicated crucial avenues for further investigation. These include improving scientific rigor, elevating theoretical contributions in research, and incorporating emerging AI technology. These insightful observations might be helpful in guiding the direction of the AIED research area.

### Proposed Areas for Future Research

Based on the findings of this study, the following areas are proposed for future research in the integration of AI in education:

1. **AI for Diverse Learners:** Future research should explore how AI can be adapted to meet the needs of a diverse range of learners, including those with special educational needs, older students, and those from underprivileged backgrounds. Ensuring inclusivity through personalized learning is essential.
2. **Long-Term Impact of AI:** While AI shows promising short-term improvements, it is crucial to investigate its long-term effects on students' cognitive development, emotional well-being, and academic performance. Longitudinal studies could offer valuable insights into the sustained impact of AI on learning outcomes.
3. **Ethical Guidelines for AI in Education:** As ethical concerns regarding data privacy, algorithmic bias, and fairness continue to arise, research should focus on developing frameworks to guide the responsible implementation of AI in education. This includes ensuring transparency and protecting student data.
4. **Bridging the Digital Divide:** Given the growing digital divide, future research should explore how AI can be leveraged to bridge the gap in access to quality education. Special focus should be placed on providing equitable access to AI tools, particularly for students in low-resource settings.
5. **Teacher Training for AI Integration:** Research should focus on the development of professional training programs to equip educators with the skills necessary for effectively integrating AI tools into their teaching practices. This includes both technical skills and pedagogical strategies.
6. **AI and Emotional Intelligence in Learning:** Future studies should explore how AI can enhance emotional intelligence within learning environments. AI tools that recognize and respond to students' emotional states could improve engagement and motivation while supporting overall well-being.
7. **AI in Lifelong Learning:** Research should investigate the potential of AI in facilitating lifelong learning, helping individuals of all ages to continuously develop new skills >

### Limitations

Our use of only one research technique is a constraint, as prospects for producing high-caliber research are highlighted by the examination of research procedures. Notably, the area underutilizes mixed research approaches, which have the potential to greatly improve research quality and, in turn, result robustness. Furthermore, theoretical frameworks are not included into the research development of more than half of the empirical investigations in the AIED sector. To further improve the general caliber of research in the field, future studies might aim for more exacting study designs and procedures.

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