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Impacts of Artificial Intelligence on Student Learning: A Systematic Literature Review

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ABSTRACT

This research presents a systematic literature review on the impact of artificial intelligence (AI) on student learning outcomes. While previous studies have explored various aspects of AI in education, there has been a lack of comprehensive analysis specifically examining its effect on learning outcomes. The objective of this study is to provide a detailed review of the literature on the effects of AI on student learning outcomes from 2013 to 2023, employing the PRISMA methodology. From an initial pool of 1068 papers identified in the Scopus database using defined search criteria, 39 articles were selected for the final analysis. Descriptive data reveal that most of the research focuses on higher education students and aims to enhance cognitive learning outcomes. Despite being grounded primarily in empirical research, the findings suggest that AI has significant potential to enhance educational processes in both schools and universities. This study aims to elucidate how AI can improve the learning experience, identify associated challenges and risks, and underscore the importance of integrating technology into the educational system to elevate the overall quality of learning.

Keywords: Artificial Intelligence, Learning Outcomes, Systematic Literature Review

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INTRODUCTION

The COVID-19 pandemic has caused a paradigm shift in education, forcing institutions and schools to switch from offline to online instruction (Alam et al., 2022). This circumstance not only brings forth new difficulties but also sparks a surge of innovation in the field of education. To improve student learning outcomes, teachers respond to this circumstance by developing their technological abilities, adjusting to digital learning platforms, and developing teaching practices sensitive to the virtual world (Ng et al., 2023). This process has improved teachers' use of technology to promote more dynamic and connected learning.

In recent years, there has been a fast advancement in artificial intelligence due to the development of instructional technologies. This has dramatically impacted the education sector, for example, by automating teacher tasks (Sperling et al., 2022) and improving human intelligence for learning (Tuomi, 2018). Artificial intelligence (AI) has attracted much attention lately, particularly from academics (Chan & Zary, 2019; Luan et al., 2020; Toniolo et al., 2020). This phenomenon is getting more profound and complex in education because it affects student learning outcomes. With the

development of technology, AI has entered the classroom as a potential learning aid (D'Mello & Graesser, 2012; Owan et al., 2023). AI can customize learning materials to each student's needs, thus creating a more personalized and practical learning experience (Hwang et al., 2020; Kamalov et al., 2023; Seo et al., 2021). When it comes to individualized learning, it's critical to comprehend the needs and objectives of every student and design lessons accordingly.

Artificial intelligence is the science and engineering of creating intelligent machines and brilliant computer programs like humans (McCarthy, 2007). Artificial intelligence, an emerging technology, aims to build computer systems that exhibit intelligent and adaptable behaviors and can learn from their surroundings like humans (Christie & de Graaff, 2017; Luckin et al., 2016). This is in line with (Hamet & Tremblay, 2017), who states artificial intelligence (AI) is the science and engineering of creating intelligent computers that mimic the most essential aspects of human behavior. It is clear from the definitions above that some strongly emphasize using technology and computers to create artificial beings that are clever enough to behave like humans.

Learning outcomes are the main target of a learning process. After completing the learning process, an individual has acquired information, skills, and competencies known as learning outcomes (Cedefop, 2017). This is supported by (Kumpas-Lenk et al., 2018), who define learning outcomes as abilities, knowledge, or attitudes that students should acquire as a result of their learning (Bai et al., 2022). Thus, it can be concluded that learning outcomes can take various forms, depending on the objectives a teacher expects.

Studies indicate that artificial intelligence (AI) influences learning outcomes (Lasfeto & Ulfa, 2023; Salas-Pilco, 2020; Tsai et al., 2021). According to research findings from (Zheng et al., 2023), artificial intelligence can enhance students' perceptions of and performance in the classroom. Research (Slimi, 2023) said that artificial intelligence (AI) significantly impacts higher education, impacting assessment, teaching and learning methods, quality of instruction, and future career preparation.

A literature review on artificial intelligence in education using systematic analysis of literature review has been conducted by several studies (Chiu et al., 2023; Heeg & Avraamidou, 2023; Zafari et al., 2022; Zawacki-Richter et al., 2019). To the best of the researcher's knowledge, no research has ever been done on the impact of artificial intelligence on student learning outcomes that involves a comprehensive examination of the literature review. Consequently, this study aims to close the gap by conducting a systematic literature review analysis from 2013 to 2023. It can offer insight and information to educational practitioners and curriculum developers about creating and executing more successful learning strategies and making the best use of technology to benefit students.

A systematic literature review can provide a clear picture of what has been studied and what areas still require investigation to enhance the body of knowledge in this area. This study aims to provide an overview of empirical research on the effect of artificial intelligence on student learning outcomes

that has been published in the last ten years. A review of the literature on AI and learning outcomes is required, given the rapid advancements in recent years and the growing interest in using AI in education, particularly in learning. The following research questions were developed in light of these goals: (1) What journals, institutions, and countries/regions have provided the most highly cited works on the impact of AI on student learning outcomes?; (2) How does artificial intelligence affect learning outcomes at different levels of education?; (3) What are the learning domain measures in each article?; (4) How is AI conceptualized in learning, and what implications, challenges, and risks are considered?

METHOD

A systematic literature review (SLR) is conducted in this study to obtain a thorough grasp of the process prediction research field. We adhered to the three-phase process suggested by (Kitchenham et al., 2009) to ensure the quality of the review of the literature:

- When planning the review, we defined the research question and derived the search string to query the academic database.
- Conducted the review using a set of inclusion and exclusion criteria to screen out irrelevant studies.
- Reporting the results of the review requires a discussion of the results to identify relevant papers that do not match the search string.

Search Identification

We developed keywords related to the research issue using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to create the search strategy. There are 4 stages in the review process, consist of identification, screening, eligibility, and inclusion (see Fig. 1 for the PRISMA steps in this study). The identification phase of this study was the determination of keywords to be used in the search for the required research articles. The best articles that fit the research objectives will be selected from databases considered highly reputable, taking into account a certain range of years and considering the PICO (Population, Intervention, Comparison, Outcome) principle, which stands for Participants, Intervention, Comparison, and Outcome, as applied by (da Costa Santos et al., 2007). Quality journals were the basis for selecting publications (Xia et al., 2018). This review examined literature published in the last ten years (2013-2023) from the Scopus database on December 10, 2023. Scopus was chosen due to its wide range of journals and reputation as a trusted source of information, allowing access to a diverse array of quality journals across various disciplines, including social sciences, humanities, engineering, and technology (Bartol et al., 2014). The next step is assigning PICOs to identify keywords for systematic review in the database. Table 1 shows the keywords selected for each PICO Component. The keywords were used to search for the desired research articles (an example of a search in Scopus can be seen in Figure 2). At this stage, there were 1,068 articles from the database.

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TITLE-ABS-KEY ( "Ai" OR "Artificial Intelligence" AND "Learning Outcomes" OR "Learning Result" AND "students" OR "College Students" OR "Undergraduate" )
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Figure 1. Search Strategy

Table 1. Keywords Based on PICO Principles

PICO Aspects	Keywords
Participants	"students", "College Students", "Undergraduate"
Intervention	"AI", "Artificial Intelligence", "Learning Outcomes", "Learning Result" AND
Comparison	Learner Context
Outcome	Cognitive, Affective

Article Screening

This stage involves the publication of research articles, not the desired type of publication type. As a result, the list has several articles of the kind that are removed, including book chapters, review articles and proceedings. Proceeding-type publications are not included because they have a lower relative scientific effect, lose relevance more quickly than the scientific literature, and have a smaller relative impact (Lisée et al., 2008). Moreover, reviews are not included because they do not present the findings of empirical studies (Short, 2009).

The language used is another criterion for exclusion, in addition to the article type. As of right now, only English-language articles are chosen for this research. Because English is an international language, it facilitates analysis and synthesis for scholars. The final requirement is to omit articles that are duplicates. There may be duplication since this study makes use of two worldwide databases. After applying this, 712 articles were excluded leaving 356 articles.

Article Eligibility and Inclusion

The eligibility phase is conducted by selecting articles based on abstracts and titles. The authors scrutinized the titles, abstracts, and keywords of all 356 papers to weed out duplicates and unconnected research that concurrently examined the impact of AI on student learning outcomes. 325 papers were deleted in this process. Consequently, 31 papers were kept for content analysis. The main steps are visualized in Figure 2.

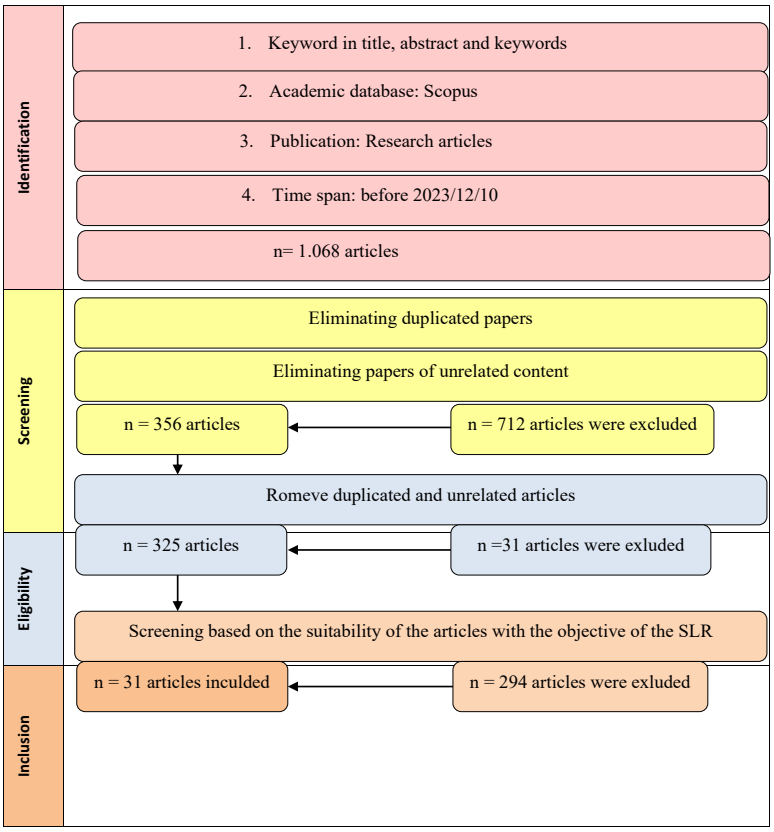

Figure 2. Flow Chart with the Result of Study Selection Process

Quality Assessment

In Systematic Literature Review research, the question criteria for quality assessment will be used to guide the examination of the data discovered. The questions that are used to evaluate articles are listed below:

Table 2. Quality Assessment Used in the Review

ID	Quality Assessment (QA)
QA1	Were journal papers published in 2013-2023?
QA2	Does the article's research report include information about how artificial intelligence (AI) impacts student learning outcomes?
QA3	Does the article provide a list of the several kinds of AI tools that enhance student learning outcomes?

RESULTS & DISCUSSION

Result

The outcomes of the analysis of the research questions are explained in this section. Table 3 displays the 31 papers obtained based on the PRISMA protocol results.

Table 3. Summary of the 31 Influential Effects of AI on Students' Learning Outcomes Studies.

No	Paper (s)	Journal	Cited	Institution (s)	Region (s)
1	(Crawford et al., 2023)	Journal of University Teaching and Learning Practice	65	Univ of Tasmania; Central Queensland Univ; Monash Univ	Australia
2	(Seo et al., 2021)	International Journal of Educational Technology in Higher Education	57	Seoul National Univ et al.	South Korea; Canada; Israel
3	(Bonneton-Botté et al., 2020)	Computers and Education	40	Univ of Rennes; Arts et Metiers; Univ of Geneva; Univ Brest	France; Switzerland
4	(Huang et al., 2023)	Computers and Education	34	National Central Univ; National Chengchi Univ	Taiwan
5	(Salas-Pilco, 2020)	Educational Technology and Society	28	National Tsing Hua Univ	Taiwan
6	(C.-A. Lee et al., 2021)	British Journal of Educational Technology	28	Central China Normal Univ	China
7	(Hooda et al., 2022)	Mathematical Problems in Engineering	28	Maharshi Dayanand Univ et al.	India; Saudi Arabia; Bangladesh
8	(Xu & Babaian, 2021)	International Journal of Management Education	24	Bentley Univ	USA
9	(Wei et al., 2022)	Computers and Electrical Engineering	24	Huaihua Univ; SRM Institute; Vel Tech Rangarajan	China; India
10	(Yang et al., 2021)	Educational Technology and Society	23	Kyoto Univ; National Changhua Univ of Educ	Japan
11	(Lim et al., 2023)	Computers in Human Behavior	20	Technical Univ of Munich et al.	Germany
12	(C. K. Y. Chan & Hu, 2023)	International Journal of Educational Technology in Higher Education	20	Univ of Hong Kong	Hong Kong
13	(Ng et al., 2023)	Educational Technology Research and Development	19	Univ of Hong Kong Instituto Univ de Lisboa et al.	Hong Kong
14	(Sousa et al., 2021)	TEM Journal	16	Al Ain Univ; Portland State Univ	Portugal
15	(Chaudhry et al., 2023)	Cogent Education	14		United Arab Emirates; USA
16	(C. K. Y. Chan, 2023)	International Journal of Educational Technology in Higher Education	14	Univ of Hong Kong	Hong Kong
17	(Shu & Gu, 2023)	Systems	13	Zhejiang Open Univ; East China Normal Univ	China
18	(Tsai et al., 2021)	British Journal of Educational Technology	12	Univ of Oulu; Carnegie Mellon Univ	Finland; USA
19	(Nguyen et al., 2023)	Education Sciences	12	National Kaohsiung Normal Univ; National Pingtung Univ of Sci & Tech	Taiwan
20	(How, 2019)	Journal of University Teaching and Learning Practice	10	Univ of Tasmania	Australia
21	(Liang et al., 2021)	Journal of Intelligent and Fuzzy Systems	10	Cangzhou Normal Univ	China
22	(Eager & Brunton, 2023)	Big Data and Cognitive Computing	10		Singapore

No	Paper (s)	Journal	Cited	Institution (s)	Region (s)
23	(Chien et al., 2022)	Frontiers in Psychology	9	Nanyang Technological Univ	Taiwan
24	(Hu, 2022)	Australasian Journal of Educational Technology	8	Singapore National Cheng Kung Univ; National Yunlin	Taiwan
25	(Hsu et al., 2023)	Education and Information Technologies	8	Univ of Sci & Tech Soochow Univ; National Yunlin Univ of Sci & Tech National Yunlin Univ of Sci & Tech	Taiwan
26	(Thinh et al., 2020)	International Journal of Mechanical Engineering and Robotics Research	4	HCMC Univ of Technology and Education National Pingtung	Vietnam
27	(Wu & Yang, 2022)	Frontiers in Psychology	3	Univ of Sci & Tech State Polytechnic of	Taiwan
28	(Lin et al., 2022)	Journal of Educational Computing Research	3	Kupang; State Univ of Malang	Indonesia
29	(Su, 2022)	IET Cyber-systems and Robotics	3	The Chinese Univ of Hong Kong	China
30	(Lasfeto & Ulfa, 2023)	Journal of Baltic Science Education	3	Hungkuo Delin Univ of Technology et al.	Taiwan
31	(Alshahrani, 2023)	International Journal of Data and Network Science	2	Arab Open Univ	Saudi Arabia

Discussion

RQ1: What journals, institutions, and countries/regions have provided the most highly cited works on the impact of AI on student learning outcomes?

Articles per year

Figure 3 charts the evolution of articles on the impact of AI on student learning outcomes from 2013 to 2023. The number of papers published increased significantly between 2020 and 2023. In 2023, there were thirteen articles, up from three in 2020. During 2013-2023, research by How (2019) was the first study to address artificial intelligence, whose findings indicated that using AI technology can enhance the efficacy of learning through artificial intelligence-supported adaptive learning systems. Thus, research on how AI affects learning outcomes is relatively recent.

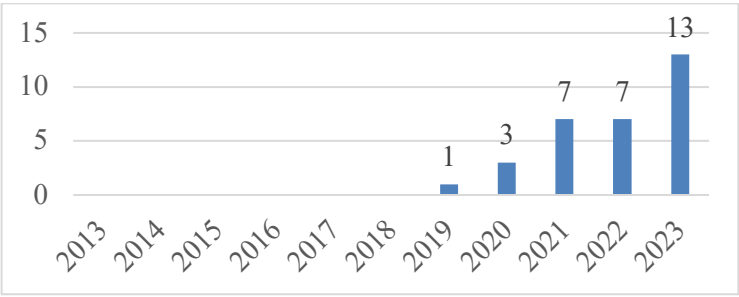

Figure 3. Number of Papers Published Yearly from 2013 to 2023

As shown in Table 3, the paper with the most citations was published in 2023 by Crawford et al. (2023). Furthermore, the ranking position of the most cited article was recently contributed by Seo et al. (2021). This demonstrates how, since it was published, the subject of AI and learning outcomes has been rapidly evolving and drawing scholarly interest. The study's results demonstrate a discernible increase in citations, indicating the growing impact of highly cited articles on the relationship between AI and learning outcomes.

Journals

Many journals published the papers that made up the research sample. According to Table 4, between 2013 and 2023, at least two studies on the impact of AI on learning outcomes were published in six out of twenty-four journals. The International Journal of Educational Technology in Higher Education published the most papers (3 articles), followed by the Journal of University Teaching and Learning Practice with two articles.

Table 4. Journals that Publish at Least Two Articles

Journal	Articles	TC
International Journal of Educational Technology in Higher Education	3	73
Journal of University Teaching and Learning Practice	2	75
Computers and Education	2	74
Educational Technology and Society	2	51
British Journal of Educational Technology	2	40
Frontiers in Psychology	2	11

Top institutions and countries/regions

As indicated on the left side of Table 4, 94 institutions and 23 countries/regions have collectively contributed to the publication of 31 articles (at least two articles) on the impact of AI on learning outcomes. Taiwan supplied eight articles, followed by China with four articles, and Hong Kong with 3. Hong Kong was third in terms of citations, although the United States and Hong Kong submitted three articles each. Although Australia only provided two articles, they offered significant influence and impact with a citation index of 38. The top 5 universities that published the 31 most cited (at least two articles) studies of the effects of AI on learning outcomes are shown in Table 5, right section. With three papers each, the University of Hong Kong and the National Yunlin University of Science and Technology hold the record for most articles.

Table 5. Top Countries/Regions and Institutions in Publishing Highly Cited Relate to the Effect of AI and Learning Outcomes

C	A	TC	Institutions	A	TC
Taiwan	8	105	University of Hong Kong	3	53
China	4	78	National Yunlin University of Science and Technology	3	25
Hong Kong	3	53			
United States	3	50	University of Tasmania	2	75
Australia	2	75			
India	2	52	National Pingtung University of Science and Technology	2	15
Saudi Arabia	2	30			

Note: C: Countries/regions; A: article count; TC: total citation

RQ2. How does artificial intelligence affect learning outcomes at different levels of education?

The studies that have been reviewed are grouped based on the learning outcomes of students at various levels of education. Table 6 summarizes 31 articles about types of AI techniques, learner context, and student outcomes. Most studies applied AI at the higher education level, with 23 studies or about 74%. The use of AI technologies at the secondary education level was also a significant focus, with five studies accounting for about 16% of the total studies. At the elementary school level, research applying AI is slightly more limited, consisting of two studies or about 7%. In contrast, there is only one study at the kindergarten level, accounting for about 3%.

Table 6. Summary Of 31 Articles About Types of AI Techniques, Learner Context and Outcomes Students'

No	Paper (s)	Journal	Cited	Institution (s)
1	(Crawford et al., 2023)	ChatGPT AI	Higher Education	Affective
2	(Seo et al., 2021)	Personalized Learning	Higher Education	Affective (perception) Cognitive
3	(Bonneton-Botté et al., 2020)	Tablet Apps	Kindergarten	Affective (motivation)
4	(Huang et al., 2023)	Personalized learning	Higher Education	Cognitive; Affective;
5	(Salas-Pilco, 2020)	Artificial Narrow Intelligence (ANI)	Elementary School	
6	(C.-A. Lee et al., 2021)	Pedagogical Agents	Higher Education	Affective Cognitive
7	(Hooda et al., 2022)	Machine learning algorithms	Higher Education	Cognitive; Affective; Skill
8	(Xu & Babaian, 2021)	Pedagogical Agents	Higher Education	Cognitive Affective(perception)
9	(Wei et al., 2022)	MET-AI	Higher Education	Cognitive
10	(Yang et al., 2021)	EDM and LA	Higher Education	
11	(Lim et al., 2023)	Scaffolds	Higher Education	Cognitive
12	(C. K. Y. Chan, 2023)	AI Policy Framework	Higher Education	Cognitive Cognitive
13	(Ng et al., 2023)	Chatbots	Higher Education	Cognitive
14	(Sousa et al., 2021)	Machine Learning	Higher Education	Cognitive
15	(Chaudhry et al., 2023)	ChatGPT	Higher Education	
16	(C. K. Y. Chan & Hu, 2023)	GenAI	Higher Education	Affective (perception)

No	Paper (s)	Journal	Cited	Institution (s)
17	(Shu & Gu, 2023)	Edu-Metaverse	Higher Education	Cognitive; Affective (perception and motivation)
18	(Tsai et al., 2021)	AIOT	High School	Cognitive; Affective (perception and motivation)
19	(Nguyen et al., 2023)	CNN	High School	Cognitive
20	(How, 2019)	AI-ALS	Higher Education	Cognitive
21	(Liang et al., 2021)	Cloud computing	Higher Education	Cognitive
22	(Eager & Brunton, 2023)	ChatGPT	Higher Education	Cognitive Affective (motivation)
23	(Chien et al., 2022)	LINE ChatBot	High School	Cognitive
24	(Hu, 2022)	LAD	Higher Education	Cognitive Affective (motivation)
25	(Hsu et al., 2023)	Termbot	Higher Education	
26	(Thinh et al., 2020)	Fuzzy neural network (FNN)	High School	Affective (motivation)
27	(Wu & Yang, 2022)	AI Science	Elementary School	Cognitive Cognitive
28	(Lin et al., 2022)	STAr	High School	Affective (motivation)
29	(Su, 2022)	AI- PBL	Higher Education	Cognitive
30	(Lasfeto & Ulfa, 2023)	Fuzzy Expert Systems (AI)	Higher Education	Affective (motivation)
31	(Alshahrani, 2023)	ChatGPT	Higher Education	Affective (motivation)

Much of the research in higher education is concerned with the implications and impact of using artificial intelligence on student learning and learning outcomes in academic environments. Research undertaken by (Chaudhry et al., 2023; Hsu et al., 2023) has demonstrated the potential to improve both the quantity and quality of instruction through AI technologies such as ChatGPT and ChatBot. Furthermore, AI has been found to influence student behavior, particularly in addressing issues of academic dishonesty and plagiarism, as highlighted in research by (Crawford et al., 2023; Eager & Brunton, 2023). Additionally, AI plays a crucial role in supporting the digitization of pedagogy, as demonstrated by (Alshahrani, 2023). Moreover, AI technologies contribute to addressing challenges in online learning, such as social isolation and motivation, as indicated by research from (Ng et al., 2023). Overall, the integration of AI in higher education holds immense potential to enhance teaching and learning practices, foster academic integrity, support pedagogical innovation, and address the evolving needs of learners in the digital age.

Pedagogical Agents and Personalized Learning are complementary concepts to enhance students' learning experience. Pedagogical agents are virtual agents or entities designed to interact with students in a learning context. Research from (M. C. M. Lee et al., 2023; Xu & Babaian, 2021) states Pedagogical Agents can effectively improve student learning outcomes. Pedagogical agents can help make sense of raw educational data to enrich the learning process for students and instructors. Meanwhile, Personalized Learning is a learning approach that focuses on students' individual needs, interests, and learning styles. Huang et al. (2023) and Seo et al. (2021) state that Personalized Learning has the potential to provide personalized and real-time support to students in online learning. This suggests that AI can improve student performance and engagement in learning.

AI technology, primarily through machine learning, EDM LA, and AI Policy Framework, has significantly improved student learning outcomes. Research (Hooda et al., 2022; Sousa et al., 2021) highlights that AI helps improve student learning outcomes and enables educators to monitor student performance and support students experiencing difficulties systematically. Other studies, such as those conducted by (Chan & Hu, 2023; Ng et al., 2023), show that AI significantly influences student learning outcomes in higher education. Furthermore, examining how college students use eBook systems for learning (Yang et al., 2021) allows teachers to forecast students' learning outcomes by analyzing their online learning habits. This can enhance comprehension of the efficacy of various learning strategies.

Implementing AI-ALS (Artificial Intelligence-Adaptive Learning Systems) can improve student learning outcomes by providing personalized support that meets individual needs (How, 2019). Understanding student learning behavior and streamlining the learning process can be achieved using LAD (Hu, 2022). The study (Hsu et al., 2023) states that while the use of AI-PBL (Artificial Intelligence - Problem-Based Learning) enables students to take on real problems and develop understanding through exploration and problem-solving to improve student learning outcomes, Thermbots assist students in understanding technical terms and improve their knowledge in learning (Su, 2022). These findings conclude that AI enhances student learning outcomes by encouraging inquiry and problem-solving, systematically tracking student performance, offering tailored support, and improving comprehension of technical terms. As a result, there is a lot of promise for using artificial intelligence in education to raise student achievement levels and learning quality.

In addition, several studies using deep learning in higher education have highlighted the various benefits of the technology in an educational context. Research by (Wei et al., 2022) using MET-AI showed a positive and significant effect on student learning outcomes. In addition, GenAI, as studied by (C. K. Y. Chan & Hu, 2023), has demonstrated the ability to offer a more individualized and engaging learning experience. The implementation of Edu-Metaverse, as proposed by (Shu & Gu, 2023), provides an intelligent education model that is enhanced by highly immersive experiences, multimodal interaction, and the freedom to share and create resources. These features can aid students in gaining a more profound understanding of the material, honing higher-order thinking abilities, and developing into intelligent people in the online learning environment. The use of cloud computing, as researched by (Liang et al., 2021), also has a positive impact by increasing the efficiency and accessibility of learning. Through flexible data storage, easier collaboration, and efficient access to learning resources, cloud computing enables a more dynamic learning experience. Lastly, Fuzzy Expert Systems, studied by (Lasfeto & Ulfa, 2023), help identify students' learning patterns and provide suitable recommendations to improve their learning outcomes. The use of deep learning in the classroom presents chances to raise student achievement, enhance the quality of instruction, and establish a more flexible and productive

learning environment. As a result, utilizing deep learning technology and associated breakthroughs can significantly improve the efficacy and quality of learning across various educational contexts.

Results of a study conducted in high schools discussed the implications of the level of interactivity, such as the interaction between robots and AI-based applications (Chien et al., 2022; Lin et al., 2022; Nguyen et al., 2023; Thinh et al., 2020; Tsai et al., 2021). (Chien et al., 2022) investigated the effects of interaction on learning, emphasizing increasing student engagement. Meanwhile, the focus of (Lin et al., 2022) is applying more profound learning principles and building critical abilities. Research by (Thinh et al., 2020) offers insight into how to enhance the efficacy of learning in a high school setting. The use of robots and AI applications for developing collaborative and communication abilities is examined in research by (Tsai et al., 2021). Lastly, (Nguyen et al., 2023) offer more information or additions to the growing body of knowledge regarding incorporating AI technologies into high school instruction. These studies provide comprehensive insights into the advantages of students interacting with cutting-edge technologies in the classroom.

Research conducted by (Salas-Pilco, 2020; Wu & Yang, 2022) at elementary schools found that AI can impact learning outcomes even in a short period. However, more time is needed to improve skills and encourage students' creativity. Research conducted by (Bonneton-Botté et al., 2020) on kindergarten students found that using a digital notebook application designed for stylus-based tablets positively impacted student learning outcomes. The application was used to analyze students' handwriting characteristics. This suggests tablet apps can be an alternative or even better than traditional learning methods. This implication can help teachers choose and integrate technology into learning effectively.

RQ3. What are learning domain measures in each article?

Each reviewed paper was assessed based on its outcome measures. This category was created under the research of (Morrison et al., 2021), who divide learning outcomes into two categories: affective (such as motivation and perceptions) and cognitive (such as knowledge acquisition and assessment results).

Table 7. Mostly Learning Domains Measures

Outcomes	Paper
Affective	(Alshahrani, 2023; C. K. Y. Chan & Hu, 2023; Chien et al., 2022; Crawford et al., 2023; Huang et al., 2023; M. C. M. Lee et al., 2023; Seo et al., 2021b; Su, 2022; Thinh et al., 2020)
Cognitive	(Bonneton-Botté et al., 2020; C. K. Y. Chan, 2023); Chaudhry et al., 2023; Eager & Brunton, 2023; Hooda et al., 2022; How, 2019; Hu, 2022; Liang et al., 2021; Lim et al., 2023; Lin et al., 2022; Ng et al., 2023; Nguyen et al., 2023; Sousa et al., 2021; Wu & Yang, 2022; Yang et al., 2021)
Affective & Cognitive	(Hsu et al., 2023; Lasfeto & Ulfa, 2023; Salas-Pilco, 2020; Shu & Gu, 2023; Tsai et al., 2021; Wei et al., 2022; Xu & Babaian, 2021)

According to Table 7 analyzed, the majority were in the cognitive (n=15, 48%), affective (n=9, 29%), and 23% (n=7) combined affective and cognitive domains. The researchers evaluated how learning altered students' attitudes or perceptions in the affective outcome category. As for cognitive, the research measured overall knowledge acquisition or the development of specific AI skills using assessment methods.

Affective outcome research typically focuses on how students interact with AI applications; for example, using AI in education can encourage students to engage more actively in learning. Additionally, how students engage with AI tools and resources (e.g., using robots to enhance the learning process makes students more passionate and interested). Students' perceptions of learning have shifted as a result. Cognitive outcomes research typically focuses on problem-solving and idea understanding. Furthermore, research has demonstrated that one benefit of artificial intelligence is the ability to personalize learning, enhancing concept understanding and problem-solving skills while increasing learning efficacy (Bonneton-Botté et al., 2020; Huang et al., 2023). Thus, artificial intelligence can be used in education to enhance the affective and cognitive aspects, perhaps creating the potential for a more holistic and practical learning experience.

RQ4. How is AI in learning conceptualized, and what are the implications, challenges, and risks considered?

According to Table 6 results, artificial intelligence (AI) is envisioned in learning through various applications, including pedagogical agents, machine learning, chatbots, and ChatGPT, as well as through AI technologies. AI in education has implications for individualized learning from the viewpoint of the teacher (Huang et al., 2023; Seo et al., 2021), enhancing the efficiency and effectiveness of learning (C. K. Y. Chan & Hu, 2023; How, 2019; Liang et al., 2021; Tran et al., 2022), as well as the capacity to accommodate different learning styles and offer more focused instruction (C.-A. Lee et al., 2021), learners' ability and interest level (Tsai et al., 2021). Although AI can potentially enhance student learning outcomes, there are worries that it could yield inaccurate results and harm grades (Seo et al., 2021). Students often use AI to finish their assignments, mainly when they are under a lot of academic pressure (Crawford et al., 2023). Some of the challenges and risks to be considered are concerns about the use of artificial intelligence technology in student performance evaluation, such as privacy and data security issues, as well as concerns about the reliability and accuracy of the system (C. K. Y. Chan & Hu, 2023; Sousa et al., 2021). While AI might help teachers keep a methodical eye on students' performance, it's crucial to remember that decisions based on algorithms need to be trustworthy (Hooda et al., 2022). Thus, explicit norms and ethics must be followed to guarantee that the employment of artificial intelligence technology in the classroom serves both teachers and pupils.

CONCLUSION

This study provides a systematic review of research on the effect of artificial intelligence (AI) on student learning outcomes. The review covers 31 studies published over approximately ten years (2013-2023). The research overviews the many potential AI learning applications that could enhance student learning results. The results show that research in this area is a new field of study, and interest has grown over the past decade. From a slow beginning, the trajectory has been exponential after 2020, with 2021-2023 being the most productive. The field has received research contributions from as many as 23 countries. It was further found that Taiwan contributed the most to global publications.

Further, several high-impact journals have also contributed to the growth of research on the effect of artificial intelligence on students learning outcomes. International Journal of Educational Technology in Higher Education was the top-ranked journal, publishing three articles. The most productive institutions are the University of Hong Kong and the National Yunlin University of Science & Technology.

The main research subjects focus on higher education, particularly in the cognitive domain. While the potential for artificial intelligence to improve student learning outcomes is enormous, its implementation in student performance evaluation raises several concerns, including data privacy and security issues and system accuracy and reliability challenges. It is crucial to establish clear ethical rules and guidelines to ensure that the use of artificial intelligence technologies in educational settings provides benefits. These findings have positive implications for artificial intelligence academics and practitioners. First, it helps beginners identify the most significant studies in this discipline. Secondly, to stimulate further scientific collaboration, this research allows academics to identify critical organizations and countries/regions that have made significant contributions. Finally, this study contributes to understanding future directions and essential topics of artificial intelligence research and its impact on student learning outcomes.

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