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Research Article

A Systematic Literature Study on AI in Education

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ABSTRACT

Artificial intelligence in education has developed into a significant corpus of literature encompassing various viewpoints. This review study aims to address three fundamental questions: What are the main categories of AI applications examined in the education sector? What are the primary research subjects and their significant conclusions? What is the state of key research design components, including foundational ideas, methodologies, and research contexts? A bibliometric study of 2,223 research articles, accompanied by a content analysis of 125 selected papers, elucidates a thorough conceptual framework of the current literature. The existing AIED research covers a broad range of applications, including adaptive learning and individualized tutoring, intelligent evaluation and management, profiling and prediction, and innovative products. Research themes explore the technical design of educational systems as well as the analysis of the acceptance, effects, and issues related to AIED. This analysis emphasizes the variety of ideas utilized in AIED literature, the multidisciplinary characteristics of publication sites, and the inadequately studied research domains. This research provides significant insights for scholars to understand the existing landscape of AIED research and pinpoint future research opportunities in this evolving domain.

Keywords: Artificial intelligence, Education, Bibliometric analysis, Literature review, Content analysis

Introduction

Information technologies, especially artificial intelligence (AI), are transforming contemporary education. Artificial intelligence algorithms and educational robots have become essential components of learning management and training systems, facilitating a diverse range of teaching and learning activities (Costa et al., 2017; García et al., 2007). A plethora of uses of artificial intelligence in education (AIED) has emerged. Khan Academy provides Khanmigo, an AI tutor utilizing GPT-4 technology, which delivers tailored educational assistance and insightful feedback in multiple disciplines, such as mathematics, programming, and language acquisition. Likewise, Duolingo, a language acquisition platform, employs advanced AI technologies to enhance student experiences (Bicknell et al., 2023). iFlyTek provides intelligent assessment systems designed for several grading scenarios, including China's national college entrance test (iFlyTek, 2024). AI-driven learning management systems (LMS), including Absorb LMS and Docebo, offer many AI functionalities to enhance educational processes, such as intelligent content generation, automation of administrative tasks, and customized learning experiences (Leh, 2022). SoftBank Robotics has developed the Nao and Pepper robots as social robots for language instruction (Belpaeme & Tanaka, 2022).

The applications of AIED are swiftly advancing, transforming the entire educational scene (Popenici & Kerr, 2017). The emergence of generative AI technology has created further opportunities, drawing investment into and fostering the development of the AIED business. The global AIED market, valued at USD 1.82 billion in 2021, is anticipated to expand at a compound annual growth rate of 36% from 2022 to 2030 (Grand-View Research, 2021). Students, educators, and educational organizations are rapidly adopting AIED. Recent studies reveal that 43% of college students in the US utilize AI technologies such as ChatGPT, while half of instructors incorporate AI in class development (Businessolution.org, 2023).

Furthermore, AIED exhibits its efficacy and effectiveness. Adaptive learning facilitated by AIED has demonstrated a 62% improvement in student test outcomes, whereas the overall application of AI boosts student performance by 30% and diminishes anxiety by 20% (Businessolution.org, 2023).

Research on AIED has significantly increased in recent years, resulting in a considerable body of work examining many facets of these applications, including as design, effectiveness, and consequences (Chiu et al., 2023). This emerging research domain has prompted review studies that provide insights into the broader AIED research field (Chassignol et al., 2018; Goksel & Bozkurt, 2019; Guan et al., 2020; Hwang et al., 2020; Srinivasan, 2022), as well as specific subjects such as learning analytics (Charitopoulos et al., 2020), machine learning and precision education (Luan & Chin-Chung, 2021), and educational AI in particular disciplines like mathematics (Hwang & Tu, 2021) or STEM (Xu & Ouyang, 2022). However, limited research has rigorously outlined the conceptual framework of the AIED study domain and its theoretical foundations, which are essential for comprehending its present condition and future developments.

This review seeks to elucidate the conceptual framework of current AIED research. It specifically addresses the subsequent research inquiries:

- What are the main categories of AI applications examined in the education sector?
- What are the primary research subjects and their significant conclusions?
- What is the current status of key research design components in the AIED domain, encompassing research methodologies, foundational ideas, and research environments?

This research utilizes a mixed methodology, integrating bibliometric analysis (Donthu et al., 2021) with a systematic literature review (Snyder, 2019). Bibliometric analysis entails the quantitative summarizing of metadata from large research papers, encompassing publication year, title, abstract, citations, authors, and institutions. This method effectively captures the status of a study domain, especially when the review scope is big and the dataset is too large for manual analysis (Donthu et al., 2021). A comprehensive literature review, utilizing content analysis of research publications, can explore study nuances pertinent to scholars (Snyder, 2019). Collectively, these two complimentary methodologies can offer an exhaustive perspective on the conceptual framework and evolving patterns within the research domain (Donthu et al., 2021).

This study commences with a bibliometric analysis of 2,223 publications pertaining to the overarching subject of AIED. The analytical examination of bibliometric metadata provides insights into publication trends, prominent journal sources, and significant publications. To provide a thorough understanding of new research concepts, we present the co-occurrence networks of two categories of keywords related to articles: keywords plus and author keywords. Subsequently, we identified and categorized 125 empirical study papers for a comprehensive literature evaluation, encompassing AIED applications, research themes, and further research design specifics, including techniques, theoretical frameworks, and contextual settings.

The coding results reveal four main categories of AI applications in the AIED literature: adaptive learning and personalized tutoring, intelligent assessment and management, profiling and prediction, and emerging products, with adaptive learning and personalized tutoring receiving the most attention in research. The research subjects encompass system design and implementation, adoption and usage, implications of AIED, and associated difficulties, with system design and implementation being the predominant focus. The analysis indicates that experiments are the predominant research methodology, with various learning theories, such as constructivist learning theory, learning style theory, cognitive theories of learning, and item response theory, being the most utilized frameworks guiding the research design. Higher education constitutes the predominant research context.

This research enhances the AIED literature in several respects. Initially, it provides an extensive comprehension of the conceptual framework of AIED research, addressing a deficiency in current literature. This study offers a critical and current overview of the growing research landscape in AIED, reflecting the recent significant increase in AIED research papers and reviews on specific domains, while incorporating the latest publications. The analysis of the present state of AIED research has revealed neglected study domains and emphasized critical future research trajectories. This encompasses the incorporation of novel AI technologies, the advancement of theoretical contributions in research, and the augmentation of scientific rigor via theory-driven study design. These findings may provide crucial support in shaping the advancement of the AIED research domain.

This study is organized as follows. Initially, we present a literature review of current review studies within the AIED study domain. Secondly, we elucidate the methodology and findings of the bibliometric analysis. We then provide a thorough literature analysis of a curated collection of empirical studies on AIED, elucidating types of AIED applications, principal study themes, and prevalent research design components. This study concludes with an examination of the principal outcomes and its contributions.

Literature Review

Artificial Intelligence is a branch of computer science focused on comprehending human cognitive processes and emulating their outcomes via information systems. The principal objective of AI is to develop intelligent systems (i.e., computer programs or machines) that can exhibit intelligent behaviors (Rainer et al., 2016), encompassing learning, reasoning, problem- solving, perception, and creation. Common instances of AI technologies encompass expert systems, neural networks (comprising machine learning and deep learning methodologies), fuzzy logic, genetic algorithms, and intelligent agents (Rainer et al., 2016). Academics

frequently differentiate between strong and weak AI (Wells, 2023). Strong AI, or artificial general intelligence, encompasses a wide range of human abilities, such as communication, reasoning, and emotional responses, and is proficient in doing various jobs. Conversely, weak AI, or narrow AI, lacks the comprehensive range of human abilities but employs algorithms to address problems or reason within certain activities, such as fraud detection and chess playing. Currently developed and commercially utilized AI applications are classified as weak AI.

The domain of education is particularly conducive to AI technologies, as educational activities, encompassing both learning and teaching, are knowledge-intensive cognitive processes. AI applications, designed for cognition and problem-solving through algorithms and knowledge bases, can effectively enhance the capabilities of educators and learners in the teaching and learning process. Since the emergence of AI in the mid-1950s, AI technologies have progressively been utilized to enhance education and training across several disciplines, including language, STEM, and medicine (Perrotta & Selwyn, 2020). Currently, AIED apps are designed to facilitate teaching and learning activities, including material preparation and dissemination, interactions and collaboration, and performance assessment (Chassignol et al., 2018; Perrotta & Selwyn, 2020). A significant number of studies have investigated AIED applications, resulting in review articles within the discipline. Table 1 presents a compilation of current review articles. Numerous reviews address the overarching domain of AIED (Chassignol et al., 2018; Chen, Xie, & Hwang, 2020; Chen, Xie, Zou, et al., 2020; Chiu et al., 2023; Goksel & Bozkurt, 2019; Guan et al., 2020), while the majority concentrate on specific application areas such as chatbots (Okonkwo & Ade-Ibijola, 2021), precision education (Luan & Chin-Chung, 2021), mathematics education (Hwang & Tu, 2021), STEM (Xu & Ouyang, 2022), or student assessment (González-Calatayud et al., 2021). Researchers have employed bibliometric, systematic, or narrative reviews in their examination of the discipline. Chassignol et al. (2018) conducted a narrative review that synthesized their principal literature findings within a framework comprising four elements of the educational process: content, teaching technique, assessment, and communication. Goksel and Bozkurt (2019) performed a co-word analysis of the keywords in 393 publications from 1970 to 2018, identifying three principal themes in the AIED literature: adaptive learning, personalization and learning styles, and expert systems and intelligent tutoring systems. Xu and Ouyang (2022) performed a systematic evaluation of 63 empirical studies on AI in STEM from 2011 to 2021, detailing AI applications in STEM education, their attributes, and impacts.

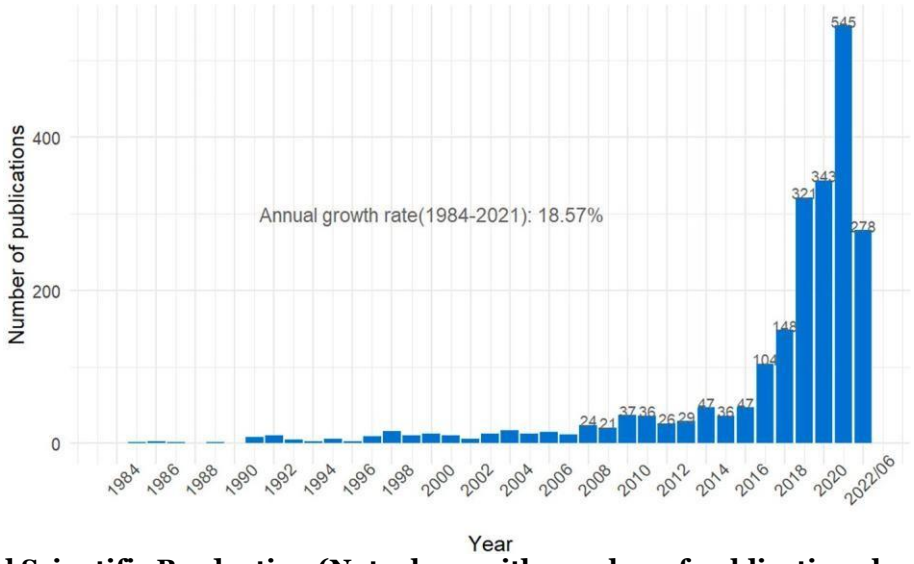


Fig. 1. Annual Scientific Production (Note: bars with number of publications less than 20 are not labelled).

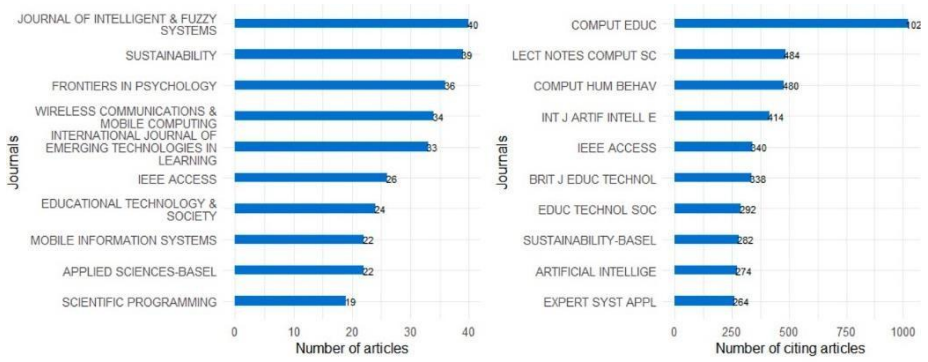
Notwithstanding the presence of prior review studies on AIED research, a thorough examination of the current literature is necessary to elucidate the conceptual framework of the domain. The predominant focus of the current review is on AIED applications and their attributes (Chassignol et al., 2018; Chiu et al., 2023; Xu & Ouyang, 2022), neglecting a broader, thorough examination of research themes and methodologies, which is essential for academic engagement. Secondly, current review studies in the overall AIED domain predominantly rely on works published prior to 2019. Nonetheless, the COVID-19 pandemic accelerates the acceptance of artificial intelligence and the investigation of artificial intelligence in education. This current sample requires examination and aggregation of thoughts. Ultimately, there is an absence of scrutiny regarding the underlying theories that are frequently utilized in and guiding AIED study, which are essential for understanding the existing body of studies and directing future research advancements.

Analysis of AI in Educational Research

Collection of Data

This study employs the Web of Science (WoS) database to assemble a preliminary collection of articles. The

WoS database is frequently utilized for performing systematic literature reviews. In accordance with the methods established by Goksel and Bozkurt (2019), we executed a search in WoS in June 2022 to obtain English publications that include the phrases “artificial intelligence” and “education” in their title, abstract, or keywords. The preliminary search produced a total of 3,690 items. Subsequently, we conducted a manual review to evaluate the pertinence of these articles to our emphasis on AIED. All papers considered irrelevant or deficient in substantial content about AIED were excluded from our dataset.
Furthermore, we included solely scholarly publications with full-text availability, comprising journal articles and conference papers. The final collection consisted of 2,223 articles published from 1984 to June 2022. We conducted a bibliometric study of the 2,223 articles using the R program "bibliometrix" and its interactive online version "biblioshiny," as created by Aria and Cuccurullo (2017).



(a) Top Journals Publishing AIED Research **(b) Top Local Cited Journals**

Fig. 2. Important Journal Sources

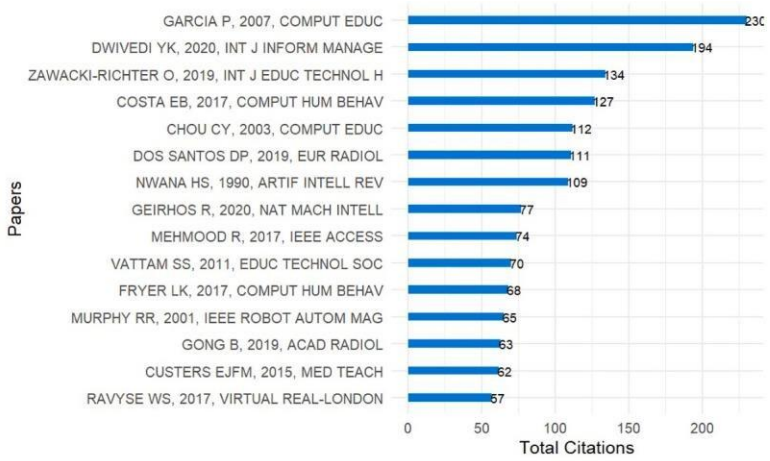
Descriptive Analysis of Data

Table 2 encapsulates the fundamental details of the articles inside our dataset. The publishing dates of the 2,223 articles range from 1984 to June 2022. These publications were disseminated in 1,247 journals and altogether reference 60,764 citations. As of June 2022, the mean age of these articles was 5.62 years, signifying that more than half of the AIED research publications were published post-2016. Figure 1 depicts the expansion of the AIED domain to provide a deeper examination of publishing trends. Significantly, AIED did not become a major study domain until 2017. From 1984 to 2016, the annual publication totals never surpassed 50 articles. Since 2017, this topic has attracted substantial research interest, with a notable increase occurring between 2019 and 2021. This expansion can be ascribed to the swift progression of AI capabilities in recent years (Roser, 2022) and the shift to online education during the COVID-19 epidemic (Du et al., 2022).

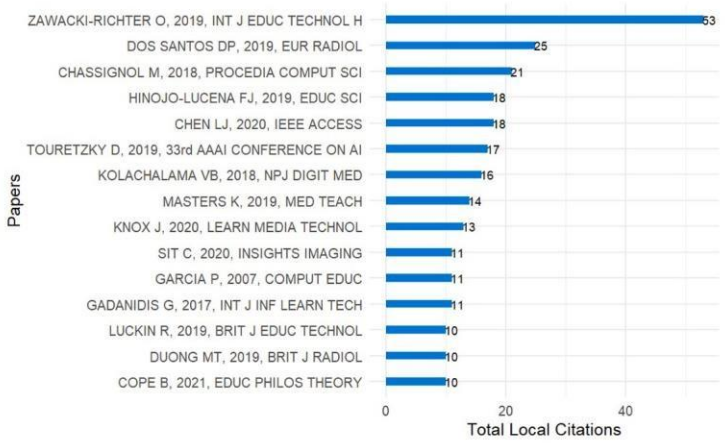
Table 2 Article Information in the Sample.

Description	Results
Timespan	1984:2022(June)
Journals included	1,247
Articles included	2,223
Average years from publication	5.62
Average citations per documents	4.09
Cited references	60,764
Keywords plus (ID)	1,336
Author keywords (DE)	5,076

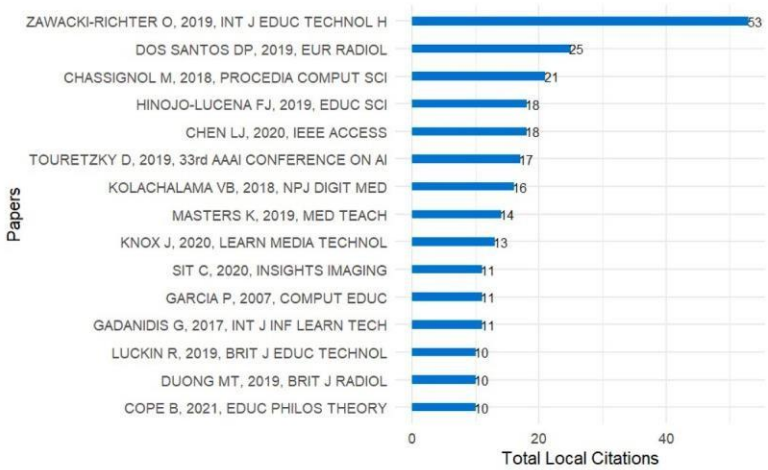
An analysis of the most-cited journals and papers uncovers further information. Figure 2a enumerates the ten journals that publish the highest volume of articles in our sample, whereas Figure 2b displays the ten most frequently cited local sources (i.e., journals referenced by the articles in our sample). The two journal lists indicate that AIED is an interdisciplinary domain.



(a) Most Globally Cited Papers



(b) Most Locally Cited Papers

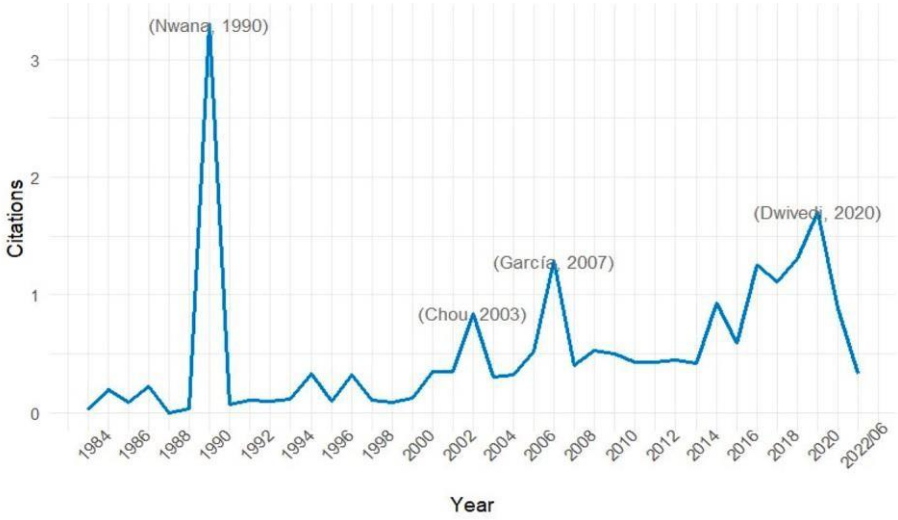


(c) Most Cited References

Fig. 3. Most Cited Papers and References

Research is disseminated in Computer Science journals (e.g., Journal of Intelligent and Fuzzy Systems, Wireless Communications and Mobile Computing, IEEE Access), Education journals (e.g., International Journal of Emerging Technologies in Learning, Computer and Education), and Management Information Systems (MIS) journals (e.g., Computers in Human Behavior). Analysis of Fig. 2a and 2b reveals that open-access journals constitute a significant platform for AIED research, with 9 of the 10 journals depicted in Fig. 2a being open-access (excluding

the Journal of Intelligent and Fuzzy Systems). In contrast, traditional, established journals like Computers and Education and Computers in Human Behaviour exhibit greater impact based on citation metrics. Both open-access publications and traditional journals facilitate the dissemination of knowledge regarding AIED.



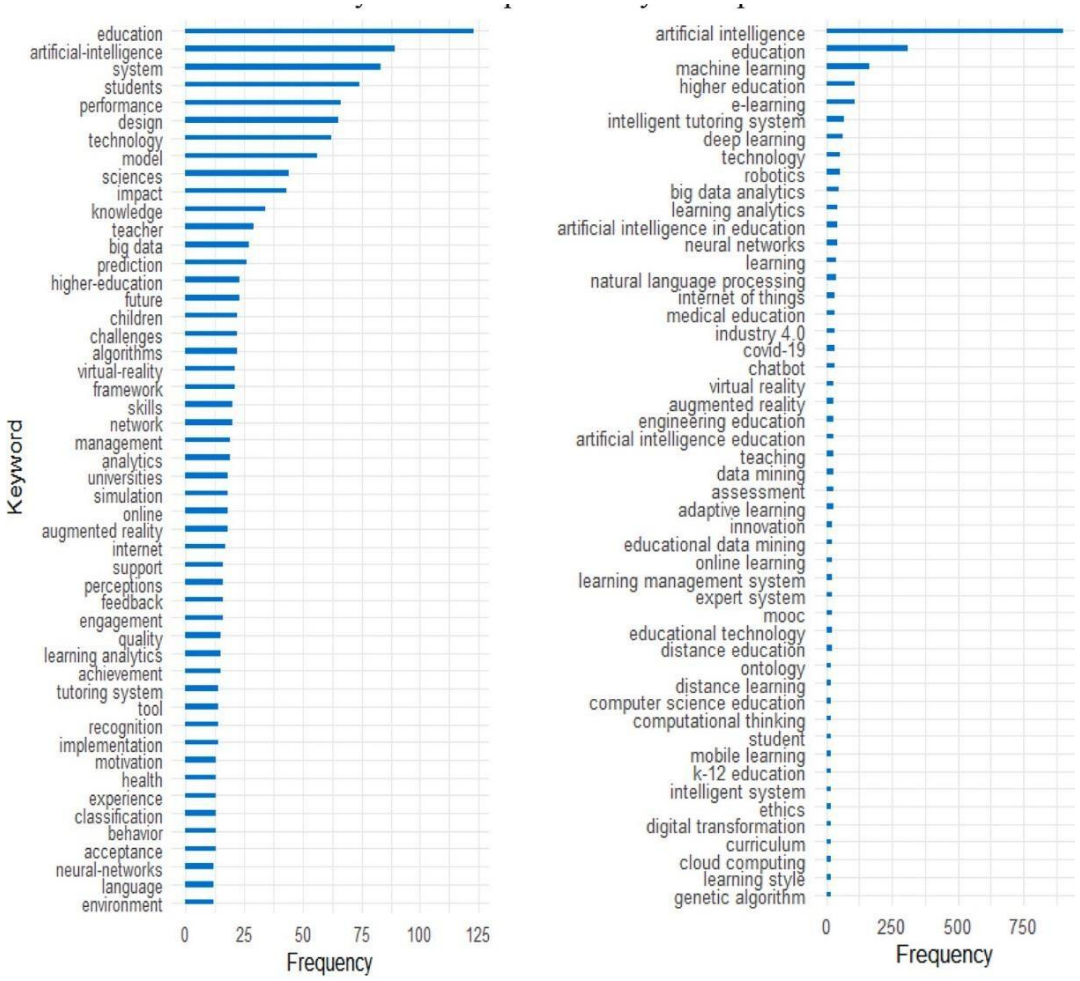
Note: Papers noted at the peaks are the most significant contributors to the AACPY of that particular year.

Fig. 4. Average Article Citation Per Year (AACPY).

To obtain more insights into the significant contributions in AIED, we present a summary of the top 15 globally cited papers, the top 15 locally cited papers, and the top 15 cited references in our sample, as seen in Figures 3a, 3b, and 3c, respectively. The complete details of these papers are included in the Appendix. The most cited papers, both globally and locally, encompass various themes in AIED, which can be categorized into three main groups: (1) general opinion pieces (Dwivedi et al., 2020; Gadanidis, 2017) and literature reviews (Chen et al., 2020; Hinojo-Lucena et al., 2019; Zawacki-Richter et al., 2019); (2) studies on prevalent AIED applications, such as machine learning and precision education (Costa et al., 2017; Duong et al., 2019), intelligent tutoring (Nwana, 1990), learning companion agents (Chou et al., 2003), chatbots (Fryer et al., 2017), and educational robotics (Murphy, 2001); (3) investigations into perceptions and attitudes towards AI systems (Sit et al., 2020). An analysis of the 15 most referenced references in our sample (refer to Appendix 1c) uncovers the disciplinary underpinnings of AIED research. In addition to the aforementioned AIED topics, seminal works in the domains of computer science and AI, management information systems, and education are referenced, including Turing's (1950) influential research on machine intelligence, Russell and Norvig's (2002) renowned textbook on AI, David's (1989 seminal paper on user adoption and behavior regarding information systems, and Felder's (1988) extensively cited article on teaching and learning styles. The referenced sources indicate three essential fields underpinning AIED research: Computer Science and AI, Management Information Systems, and Education.

To further ascertain the effects of the papers in our sample, Fig. 4 depicts the average article citation per year (AACPR). AACPR denotes the aggregate citations garnered by papers released in a certain year, adjusted for citable years (i.e., the duration since publication). This normalization considers that older articles generally accrue more citations as time progresses. Standardizing citations in this manner can alleviate the age effect when evaluating article quality based on citations. Figure 4 illustrates that AACPR exhibits an increasing trend in publications since 2014. This suggests that recent articles generally garner more citations than older ones, indicating an increasing influence of contemporary research in the subject.

Furthermore, Fig. 4 identifies particular studies that significantly influence the pronounced fluctuations in the AACPR trend line. The most significant peak occurred in 1990. In our collection, only one work, specifically Nwana's (1990) review article on intelligent tutoring systems, originates from that year. This study has received several citations, highlighting its quality and the sustained interest in intelligent tutoring systems over the last 28 years. Other extensively referenced studies encompass Chou et al.'s (2003) investigation of learning companions and educational agents, García et al.'s (2007) analysis of students' learning styles identification, and Dwivedi et al.'s (2020) discourse on the effects of COVID-19 on education. These works have substantially enhanced the academic dialogue in AIED.



(a) Keyword Plus **(b) Author Keywords**

Fig. 5. Most Frequent Keywords

Analysis of Co-occurrence

To comprehend the conceptual framework of the literature, we do keyword co-occurrence analysis, commonly referred to as co-word analysis. This study constructs a co-word network, with nodes representing keywords, edges denoting co-occurrence associations, and edge weights reflecting the frequency of co-occurrences throughout the corpus of literature. Keywords offer succinct summaries of research studies and are ideal for co-occurrence analysis, enabling the identification of structural trends among fundamental themes in the literature. Our research employs both Keywords Plus and author keywords from WoS: Keywords Plus are standardized terms supplied by WoS, while author keywords are designated by the authors in their publications. Before the analysis, we preprocess and sanitize the keywords, implementing alterations such as substituting “AI” with “artificial intelligence” and standardizing “student” and “students” to “students”.

Figure 5 depicts the distributions of the top 50 keywords plus and author keywords in panels a and b, respectively. Significantly, "artificial intelligence" and "education" rank first and second in both panels, as these were the principal search terms employed to delineate the body of literature. Aside from these two keywords, the lists of keywords plus and author keywords demonstrate notable disparities, with author keywords being more varied and closely aligned with the articles' content. Keywords plus are more generically descriptive, whereas author keywords are more relevant to the content of the post. The primary keywords in Keywords Plus, outside the top two, are broad terms such as "system," "students," "performance," "design," "technology," "models," and "sciences." Conversely, author keywords explore specific specialty domains within AIED, encompassing concepts such as “machine learning,” “higher education,” “e-learning,” “intelligent tutoring system,” and “robotics.” The distribution of author keywords exhibits more skewness compared to that of keywords plus. The allocation of author keywords is significantly skewed in favor of the two search terms, "artificial intelligence" and "education". This skewness is likely attributable to the increased variability and less standardization of author keywords in comparison to keywords plus.

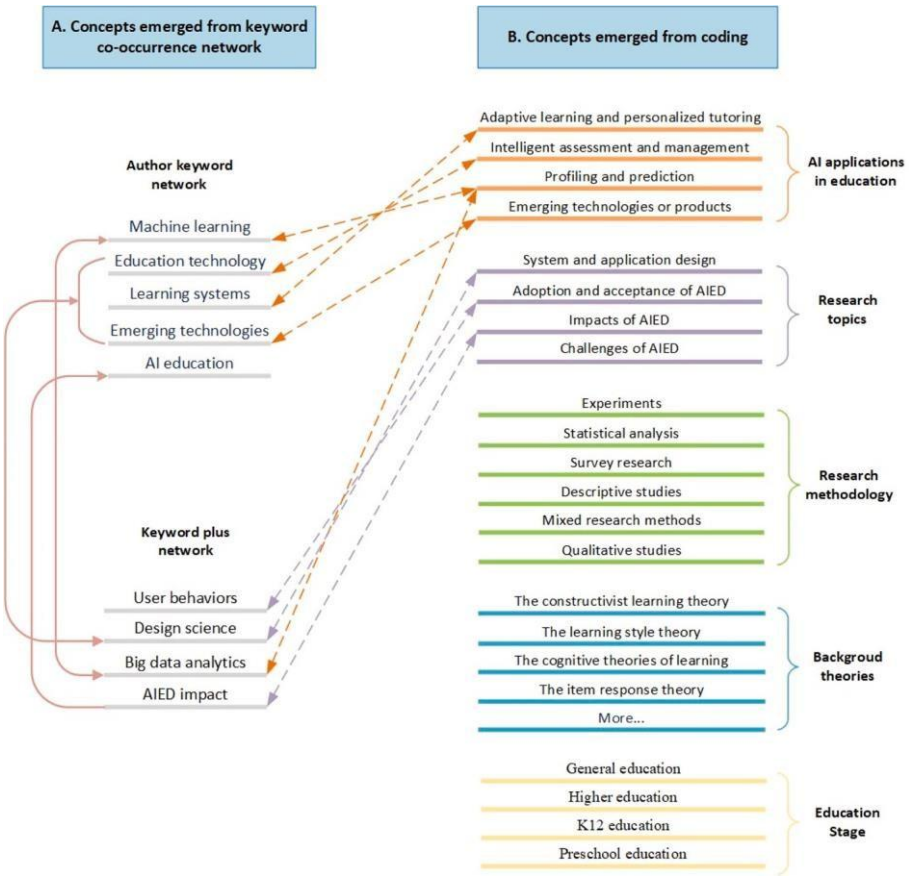


Fig. 7. Conceptual Mapping between Co-occurrence Networks and Systematic Review.

Content Analysis

Bibliometric analysis is fundamentally data-driven and does not examine the content specifics of research papers. Thus, we augment the bibliometric analysis with a systematic literature review that entails manual content analysis of a reduced sample of articles. The outcomes derived from the co-occurrence network analysis provide a basis for coding the chosen publications in the systematic review. The findings related to study designs from the content analysis are encapsulated on the right side of Fig. 7. Figure 7 further depicts a correlation between concepts obtained from the co-occurrence network analysis and those extracted from the systematic examination of the chosen papers.

Discussion

This study utilizes bibliometric analysis and content analysis for a systematic review of the AIED literature. The bibliometric study indicates that the co-occurrence of keywords uncovers two distinct clusters of concepts examined in the literature. The keywords plus co-occurrence network identifies four conceptual clusters: user behaviors, design science, big data analytics, and AIED impacts. In contrast, the co-occurrence network of author keywords demonstrates clusters of concepts pertaining to machine learning, educational technology, intelligent systems, emerging technologies, and AI education. A thorough analysis reveals both similarities and differences between these two groupings. The clusters generated from author keywords provide a more nuanced perspective than those recognized in the keywords plus network. The clusters of educational technology, learning systems, and emerging technologies inside the author keywords network align with the design science cluster in the keywords plus network. It is significant that the AIED user behavior cluster recognized in the keywords plus network is absent from the author keywords network.

The ensuing content analysis offers insights into several research components, encompassing research objects (i.e., AIED applications), research objectives and subjects, research methodologies, guiding theories, and research contexts (i.e., educational stages). The research examined four principal categories of AIED applications: adaptive learning and tailored tutoring, profiling and prediction, intelligent assessment and management, and new products, with adaptive learning and personalized tutoring receiving the most comprehensive analysis. Of the four specified research topics—system and application design, adoption and acceptance of AIED, impacts of AIED, and problems of AIED—system and application design was the most extensively examined. Experiments are the primary research method among the five classified methods, which consist of mixed research methods, qualitative studies, experiments, statistical analysis of secondary data, survey research, and descriptive studies. Of the 45 theories identified in the literature, constructivist learning theory, learning style theory, and cognitive theories of learning are the most often utilized frameworks that

inform or underpin the theoretical advancement of research. Higher education and K-12 education are the primary research contexts that garner substantial focus in the AIED literature.

This study enhances the AIED literature in multiple aspects. Initially, it contributes to the corpus of AIED reviews by providing a thorough examination of the literature's conceptual framework. Although previous reviews have investigated the overarching AIED research domain or particular AIED applications (Chassignol et al., 2018; Goksel & Bozkurt, 2019; Guan et al., 2020; Hwang et al., 2020; Srinivasan, 2022), there is a scarcity of systematic examinations of the conceptual foundations within the literature. This study utilizes bibliometric analysis and text analysis to elucidate the concepts related to research elements of primary importance to researchers. This methodology provides an extensive comprehension of the literature, extending beyond the examination of study subjects and AIED implementations to encompass theoretical frameworks, research themes, and methodological approaches. The distribution of their occurrences, as described in Fig. 9, elucidates the present condition of the research design elements.

Secondly, the study enhances our understanding of the AIED research environment and highlights various areas for further investigation. There are evident potential for study on the incorporation of recent breakthroughs in AI technologies. Although our study covers a wide range of AIED applications, many recent advancements, such as generative AI, are not included in our selected articles. Generative AI relies heavily on significant human engagement for optimal outcomes, rendering it a potential field for academic investigation. Recent studies in AIED have progressively highlighted the significance of human involvement in AI application design, focusing on paradigms that prioritize learner cooperation and leadership (Andersen et al., 2022; Ouyang & Jiao, 2021; Xu & Ouyang, 2022). The development of AI systems for individuals in leadership positions is a complex and continuous endeavor (Ouyang & Jiao, 2021), and generative AI has the capacity to aid and involve users, whether as leaders or collaborators, in accomplishing tasks.

Another domain warranting consideration is AI in preschool education, which is inadequately represented in our sample. AI uses in preschool education may require more captivating design and increased parental involvement. Creating applications that engage both parents and children offers a valuable opportunity for investigation. The study of user emotions presents significant prospects for more research. Although emotions are essential for learning in IT- driven environments (Li et al., 2023), current AIED apps predominantly utilize weak AI, which possesses a restricted capacity for emotional engagement with users. As a result, our sample exhibits a deficiency in research regarding user mood. Future research can methodically examine user emotions and their functions inside the AI-enhanced learning environment. Flow theory (Csikszentmihalyi, 1990) serves as a compelling theoretical framework to inform future research on AIED applications in preschool education. Flow denotes a condition of intensified focus, concentration, and pleasure. AIED system designs that induce a flow state can have a lasting effect on learning.

Moreover, ethical considerations represent a significant area for future research. In our review, AIED ethical studies did not appear as a prominent study issue in the keyword co-occurrence analysis and content analysis. Nevertheless, several ethical considerations have been broadly addressed under the "challenges of AIED." The escalating incorporation of AI technology in education has resulted in heightened ethical hazards and concerns, encompassing matters of personal data privacy, algorithmic biases, and the autonomy of learners and educators (Akgun & Greenhow, 2022; Boulay, 2023; Wells, 2023). For instance, learning analytics might promote the extensive gathering of personal and surveillance data, students could acquire biased information from ChatGPT or other AI models, and educators may become dependent on analytical outcomes to make decisions regarding students facing challenges and needing further support (Boulay, 2023). Biased algorithms can reinforce detrimental societal ideals. AI-driven language translation technologies are known to frequently perpetuate gender stereotypes when translating from gender-neutral languages, therefore affecting language learners' social perceptions of gender (Miller et al., 2018). Consequently, it is essential to create AIED applications that comply with ethical criteria for the welfare of humanity. Future study may encompass subjects such as the implications of ethical risks, users' perceptions of AIED ethical risks, and the influence of these beliefs on their behaviors concerning the adoption and utilization of AIED apps. Design science researchers may integrate ethical criteria as a performance indicator in their experimental design—criteria for assessing AIED applications include not only learning efficacy and algorithm precision but also fairness, algorithm transparency, and trustworthiness.

Conclusion

This study utilizes a mixed-methods approach, integrating bibliometric analysis and content analysis, to identify and understand the fundamental concepts in the domain of AIED. The results from both methods align, offering a thorough comprehension of AIED ideas. This study enhances the AIED literature evaluations by highlighting the significance of understanding the conceptual framework of the discipline. The research indicates several future directions, including the incorporation of advanced AI technologies, the enhancement of AIED research within preschool education, the improvement of research quality through mixed methods, the prioritization of theoretical contributions, and the strengthening of collaboration among computer scientists, psychologists, educators, and MIS experts.

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