Higher Education Studies; Vol. 15, No. 2; 2025
ISSN 1925-4741 E-ISSN 1925-475X
Published by Canadian Center of Science and Education

A Bibliometric Analysis of Artificial Intelligence for Multimedia in Education by Dimensions AI

Potsirin Limpinan[1], Ampawan Yindeemak[2], Rungfa Pasmala[3], Manop Nammanee[4] & Thada Jantakoon[4]

[1] Faculty of Information Technology, Rajabhat Mahasarakham University, Thailand

[2] Faculty of Technical Education, Rajamangala University of Technology Isan, Khonkhaen, Thailand

[3] Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand

[4] Faculty of Science and Technology, Rajabhat Mahasarakham University, Thailand

Correspondence: Thada Jantakoon, Faculty of Science and Technology, Rajabhat Maha Sarakham University, Maha Sarakham, Thailand. E-mail: thada.phd@gmail.com

Received: January 14, 2024 Accepted: February 15, 2024 Online Published: February 18, 2025

doi:10.5539/hes.v15n2p1 URL: https://doi.org/10.5539/hes.v15n2p1

Abstract

This study presents a comprehensive bibliometric analysis of Artificial Intelligence (AI) research for Multimedia in Education from 2020 to 2024. Using the Dimensions AI database, VOSviewer software and Scimago Graphica, we examined 45 publications to identify key trends, influential contributors, and emerging directions in this rapidly evolving field. The analysis reveals a significant publication surge from 2020 to 2021, followed by stabilization in subsequent years. China is the dominant contributor, with 19 publications and 214 citations, highlighting its leadership in AI and educational technology research. Co-authorship network analysis shows a tightly interconnected research community lacking distinct clusters. The most cited papers focus on student engagement and specific AI applications in education, indicating the field's emphasis on practical implementations. Keyword analysis reveals a consistent focus on core concepts such as artificial intelligence, education, technology, and learning, with a recent shift towards more user-centered research. The study also identifies challenges in implementing AI for multimedia in education, including data privacy concerns, ethical considerations, and the need for educator training. These findings provide valuable insights for researchers, educators, and policymakers, highlighting the need to balance technological advancements with pedagogical needs and ethical considerations. Future research directions include investigating the long-term impact of AI-enhanced multimedia education, developing ethical frameworks, conducting cross-cultural studies, and enhancing AI's capability to provide personalized learning experiences through multimedia content.

Keywords: artificial intelligence, multimedia education, bibliometric analysis, educational technology, vosviewer, dimensions, e-learning, educational innovation, ai in education

1. Introduction

The integration of artificial intelligence (AI) in multimedia educational contexts has emerged as a significant area of research and development in recent years. As educational paradigms shift towards more personalized, interactive, and technology-enhanced learning experiences, AI offers promising solutions to address the evolving needs of both learners and educators (Awad & Oueida, 2024; Flogie & Aberšek, 2022). This bibliometric analysis aims to provide a comprehensive overview of the current landscape of AI applications in multimedia education, examining publication trends, key contributing countries, highly cited articles, and emerging themes within this rapidly evolving field.

The intersection of AI, multimedia, and education presents unique opportunities to enhance learning outcomes, improve engagement, and streamline educational processes. From intelligent tutoring systems to adaptive learning platforms, AI-driven technologies are reshaping how educational content is created, delivered, and consumed (Hamal et al., 2022; Zhang, 2022). However, alongside these opportunities come challenges related to implementation, ethics, and the changing roles of educators in AI-enhanced learning environments (Gökoğlu, 2024; Sytnyk & Podlinyayeva, 2024).

The potential of AI in education extends beyond traditional classroom settings, bridging the gap between formal and informal learning environments (Barker et al., 2014; Salmi, 2012). This convergence of AI and multimedia

in education can create more immersive, tailored, and equitable learning experiences, addressing diverse learning needs and styles (Worsley, 2022; Leiker et al., 2023). However, the rapid advancement of AI technologies also raises important questions about data privacy, algorithmic bias, and the need for critical digital literacy skills among both educators and students (AlAli & Wardat, 2024; Kaswar et al., 2023).

This study systematically analyzes the scholarly literature on AI for multimedia in education published between 2020 and 2024. We aim to identify the key research foci, influential contributors, and emerging directions within this interdisciplinary domain by examining publication patterns, geographical distributions, citation impacts, and keyword trends. The insights gained from this analysis will provide a snapshot of the current state of research and help guide future investigations and practical applications of AI in multimedia educational contexts.

Through a rigorous bibliometric methodology, including the use of tools such as VOSviewer and Scimago Graphica for network analysis and visualization, this study seeks to answer several key questions:

1. What are the predominant trends in research output related to AI for multimedia in education over the examined period, and how has the volume and focus of publications evolved?

2. Which countries are at the forefront of research in AI for multimedia education, and how does their contribution impact the global research landscape in this field?

3. What are the most influential articles in AI for multimedia in education, as measured by citation count, and what key themes or innovations do these highly cited works represent?

4. How has the thematic focus of research in AI for multimedia education evolved, as evidenced by keyword analysis and co-occurrence networks?

5. What are the primary thematic clusters emerging from the literature, and how do these clusters reflect current priorities and future directions in AI for multimedia education research?

By addressing these questions, this study aims to provide valuable insights for researchers, educators, policymakers, and technology developers working at the intersection of AI, multimedia, and education. The findings will contribute to a better understanding of the field's current state, highlight areas of concentrated research activity, and identify potential gaps or underexplored areas that merit further investigation.

Moreover, this analysis seeks to contextualize the rapid advancements in AI for multimedia education within the broader landscape of educational technology and pedagogical innovation. By examining the interplay between technological capabilities and educational needs, we can better understand how AI shapes the future of learning and teaching in increasingly digital and interconnected environments (Hemachandran et al., 2022; Talan, 2021).

The bibliometric approach employed in this study builds upon recent works that have applied similar methodologies to related fields, such as AI in science education (Akhmadieva et al., 2023) and AI in e-health (Shaikh et al., 2023). By focusing specifically on the intersection of AI, multimedia, and education, this analysis aims to provide a more nuanced understanding of this emerging subdomain and its potential to transform educational practices across various contexts and levels of learning.

As we navigate the complexities of integrating AI into multimedia educational environments, it is crucial to maintain a balanced perspective that acknowledges both these technologies' transformative potential and inherent challenges. This bibliometric analysis is a foundation for informed decision-making and strategic planning in developing and implementing AI-enhanced multimedia learning experiences.

2. Literature Review

2.1 Challenges of Implementing Artificial Intelligence for Multimedia in Education

Implementing Artificial Intelligence (AI) for multimedia in education presents many challenges educators and stakeholders must navigate to harness its full potential. One of the primary challenges is ensuring data privacy and security, as educational institutions must establish stringent policies to safeguard student data and adhere to relevant laws and regulations, thereby cultivating trust among students and parents (Awad & Oueida, 2024; Ke, 2023). Ethical concerns also loom large, with issues such as algorithmic bias and the potential for AI to perpetuate existing inequities in the educational system (Salloum et al., 2024; Sytnyk & Podlinyayeva, 2024; AlAli & Wardat, 2024). Additionally, the reliability and accuracy of AI tools are critical, necessitating regular testing and evaluation to identify and rectify potential issues, which requires collaborative efforts between educational institutions and technology vendors (Ke, 2023). Another significant challenge is the need for comprehensive training and professional development for educators to effectively employ AI tools, as highlighted by the practical sessions conducted at SMP Negeri 2 Kahu (Kaswar et al., 2023). The integration of AI also raises questions about the role of human educators, emphasizing the importance of maintaining a balance

where AI serves as a teaching aid rather than supplanting human expertise (Ke, 2023; AlAli & Wardat, 2024). Furthermore, the implementation of AI in education must address socioeconomic disparities, ensuring equitable access to AI-driven educational resources to prevent widening the digital divide (Sytnyk & Podlinyayeva, 2024; de Sá et al., 2024; Nykonenko, 2023). Technical limitations, such as the need for robust infrastructure and the potential for technology access issues, pose significant hurdles (Kaswar et al., 2023; Gökoğlu, 2024). The ethical and responsible use of AI technologies is paramount, with a focus on transparency in algorithms and inclusive design principles to foster a human-centric approach to AI integration (Owoc et al., 2019; AlAli & Wardat, 2024). Additionally, the potential for plagiarism and fraud associated with AI use necessitates the development of stringent standards and policies to mitigate these risks (Nykonenko, 2023). The transformative potential of AI in education, particularly in personalizing learning experiences and optimizing administrative tasks, is undeniable, but it requires a concerted effort from educators, policymakers, technologists, and students to navigate these challenges effectively (Sytnyk & Podlinyayeva, 2024; Awad & Oueida, 2024; de Sá et al., 2024). Collaborative partnerships and ongoing dialogue among stakeholders are essential to ensure that AI integration in education prioritizes ethics, safety, and effectiveness, ultimately creating more immersive, tailored, and equitable learning environments (AlAli & Wardat, 2024). By addressing these multifaceted challenges, the educational sector can leverage AI to enhance multimedia learning experiences while safeguarding the interests and well-being of all participants involved.

2.2 Artificial Intelligence for Multimedia in Education Bridge the Gap between Formal and Informal Learning Environments

Artificial Intelligence (AI) has the potential to significantly bridge the gap between formal and informal learning environments by leveraging multimedia technologies to create more engaging, personalized, and effective educational experiences. AI-driven tools and technologies can support a variety of learning experiences that are embodied, project-based, inquiry-driven, collaborative, and open-ended, thus expanding the contexts and timescales of human learning beyond traditional classrooms (Worsley, 2022). The integration of AI in education has been a research subject for over 30 years, combining interdisciplinary fields such as education, psychology, and neuroscience to develop adaptive learning environments and flexible, inclusive tools that cater to formal education and lifelong learning (Hamal et al., 2022). AI-generated synthetic videos, for instance, have shown promise in online educational settings, providing high-quality educational content as compelling as traditionally produced videos, thereby making learning more accessible and engaging (Leiker et al., 2023). Moreover, AI can enhance modern distance education by building virtual teaching environments that overcome the limitations of traditional teaching models, such as resource constraints and lack of personalization, thus improving the quality of education and stimulating students' enthusiasm for learning (Zhang, 2022). AI also plays a crucial role in out-of-school time programs that align with formal classroom content, providing hands-on, minds-on activities that inspire students and support their natural curiosity in STEM fields (Barker et al., 2014). AI in multimedia processing can narrow the semantic gap by combining machine learning and symbolic AI to map signals to objects and link objects to meanings, thus enhancing the understanding and interpretation of multimedia content in educational contexts (Moreno et al., 2019). Additionally, AI-driven personalized multimedia network teaching systems can offer intelligent recommendations based on students' learning habits, further bridging the gap between formal and informal learning by providing tailored educational experiences (Zhang, 2022). Developing user-friendly intelligent tutoring systems based on experience-based AI design approaches can also support better lessons and self-learning. However, careful design and extensive testing are necessary to avoid adverse outcomes (Flogie & Aberšek, 2022). Furthermore, AI's role in education is not limited to content delivery; it also involves the ethical considerations of data usage and the potential biases in AI models, which must be addressed to ensure equitable and compelling learning experiences (Worsley, 2022; Flogie & Aberšek, 2022). Therefore, the integration of AI in education represents a transformative approach that enhances formal education and leverages informal learning opportunities, creating a more holistic and inclusive educational landscape (Salmi, 2012; Hemachandran et al., 2022).

2.3 Bibliometric Analysis be used to Evaluate the Impact of Artificial Intelligence Applications in Multimedia Education

Bibliometric analysis is a powerful tool for evaluating the impact of artificial intelligence (AI) applications in multimedia education by systematically quantifying and analyzing the vast body of research literature. This method involves collecting and examining data from various databases, such as Scopus and Web of Science, to identify trends, influential authors, key themes, and collaborative networks within the field. For instance, a comprehensive bibliometric study on AI in education revealed a significant annual growth rate of 22.68% in published articles, highlighting the rapid expansion and increasing interest in this area (Metli, 2023). By

categorizing themes into core, niche, emerging, and declining categories, researchers can pinpoint focal points and underserved areas, thus guiding future research and policy decisions (Metli, 2023). Additionally, bibliometric analysis can identify the most productive countries and institutions, as seen in studies where China, the US, and the UK emerged as leading contributors to AI research in education (Pesántez et al., 2023; Karaca & Kılcan, 2023; Akhmadieva et al., 2023). This geographical distribution helps us understand the global landscape and the potential for international collaboration. Furthermore, the analysis of publication types and sources, such as conference proceedings and high-impact journals like Computers & Education, provides insights into the dissemination channels and academic influence of the research (Pesántez et al., 2023; Kaban, 2023; Talan, 2021). Identifying frequently occurring keywords, such as machine learning, deep learning, and intelligent tutoring systems, helps map the thematic evolution and current hot topics within the field (Triansyah et al., 2023; Talan, 2021). Moreover, bibliometric studies often highlight the most cited works and influential authors, offering a benchmark for academic impact and recognition within the community (Kaban, 2023; Talan, 2021). For example, researchers like Vanlehn and Chen have been identified as key contributors to AI in education, indicating their significant influence on the field (Talan, 2021). The analysis also extends to understanding the interdisciplinary nature of AI applications, as seen in the integration of computer science, social sciences, and engineering education (Akhmadieva et al., 2023). By examining co-authorship networks and collaboration patterns, bibliometric analysis can reveal the extent of interdisciplinary and international cooperation, which is crucial for advancing multimedia education through AI (Muraro & Göktepe-Hultén, 2023; Liu et al., 2022). In summary, bibliometric analysis provides a comprehensive and quantitative overview of the research landscape, enabling stakeholders to assess the impact, identify trends, and make informed decisions to foster the development and application of AI in multimedia education.

3. Research Method

This study employed a systematic bibliometric analysis approach to examine the research landscape of Artificial Intelligence for Multimedia in Education from 2020 to 2024. The methodology adhered to the PRISMA 2020 guidelines, ensuring transparency and reproducibility.

3.1 Data Collection

We conducted a comprehensive search of the Dimensions.ai database using the keywords "artificial intelligence," "multimedia," and "education." The initial search yielded 263 records published between 2020 and 2024.

3.2 Screening and Eligibility

The screening process involved removing duplicates and excluding non-research articles such as book chapters, edited books, preprints, and monographs. This resulted in 150 records for further evaluation. We then applied rigorous eligibility criteria, assessing content relevance, language (English only), and study design (empirical research studies only). After this process, 45 studies met all inclusion criteria.

3.3 Data Analysis

We utilized VOSviewer software and Scimago Graphica for network analysis and visualization. The analysis focused on several key aspects:

1. Publication trends: Examining the number of publications per year.
2. Geographical distribution: Analyzing contributions from different countries.
3. Co-authorship networks: Investigating collaborative relationships among researchers.
4. Citation analysis: Identifying the most influential articles and authors.
5. Keyword analysis: Exploring the evolution of research themes and focus areas.

We generated various visualizations, including co-authorship networks, keyword co-occurrence networks, and citation networks, to illustrate the relationships and trends within the field.

3.4 Data Interpretation

We interpreted the bibliometric data in the context of current developments in AI for multimedia education, considering both technological advancements and pedagogical implications. This interpretation aimed to identify key trends, challenges, and future directions in the field.

This method combined quantitative bibliometric analysis with qualitative interpretation, providing a comprehensive overview of AI's current state and future prospects in multimedia education research.

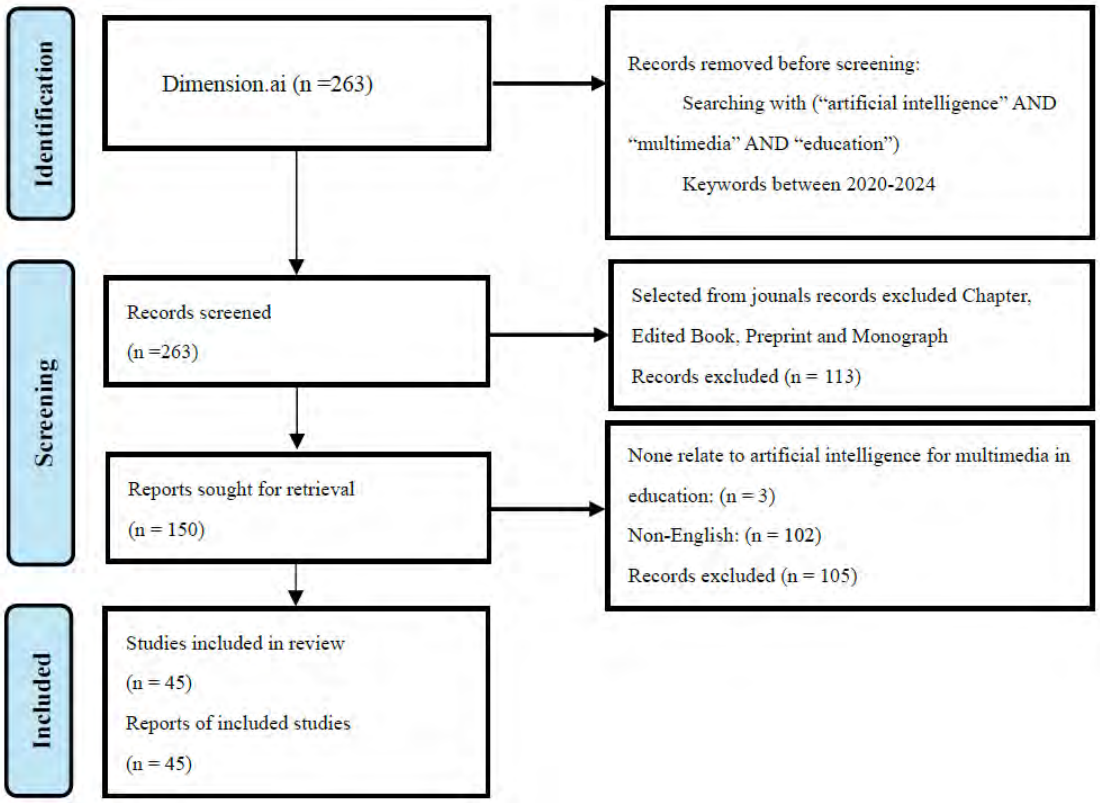

Figure 1. PRISMA 2020 guided bibliometric review procedure used for this study

Figure 1 illustrates the meticulous process of a systematic literature review on artificial intelligence (AI) for multimedia in education. Adheres to the PRISMA 2020 guidelines, a globally recognized standard for reporting systematic reviews and meta-analyses. This rigorous methodology ensures the review process's transparency, reproducibility, and comprehensiveness.

Identification: The initial phase involved a comprehensive search of the Dimension.ai database, a repository encompassing various research articles, academic publications, and patents. The search strategy employed a combination of keywords, namely "artificial intelligence," "multimedia," and "education," to identify relevant studies published within the timeframe of 2020-2024. This initial search yielded 263 records, indicating substantial literature on the topic.

Screening: The subsequent screening phase aimed to refine the initial pool of records by eliminating duplicates and excluding irrelevant publications. Duplicates were identified and removed to ensure each unique study was considered only once. Additionally, non-research articles such as book chapters, edited books, preprints, and monographs were excluded, as this review focused on original research published in peer-reviewed journals. This screening process resulted in a reduced set of 150 records for further evaluation.

Eligibility: The remaining 150 records were subjected to a rigorous eligibility assessment to determine their alignment with the pre-defined inclusion criteria. These criteria encompassed various aspects, including:

Content relevance: Studies were assessed for their direct relevance to AI for multimedia in education. This involved examining the research objectives, methodology, and findings to ensure that the studies specifically addressed the application of AI technologies in multimedia-based educational contexts.

Language: Only studies published in English were considered, ensuring the research findings' accessibility and comprehensibility for the intended audience.

Study design: The review focused on empirical research studies, which involved collecting and analyzing original data to investigate the research question. This excluded theoretical papers, reviews, and opinion pieces, as the aim was to synthesize evidence from primary research studies.

During the eligibility assessment, 115 records were excluded for various reasons. Three records were deemed

irrelevant to the topic, as they did not specifically address the use of AI for multimedia in education. Additionally, 102 records were excluded because they were not published in English, hindering the comprehensive analysis and synthesis of the findings.

Included: After the rigorous screening and eligibility assessment, 45 studies met all inclusion criteria and were deemed suitable for the systematic review. These studies represent the most relevant and high-quality research on AI for multimedia in education, published within the specified timeframe.

In conclusion, Figure 1 visually represents the systematic and comprehensive process of identifying and selecting relevant studies for this review. The meticulous application of the PRISMA 2020 guidelines ensures the rigor and transparency of the review process, enhancing the credibility and reliability of the findings. The final set of 45 included studies serves as a solid foundation for the subsequent bibliometric analysis using Vosviewer, which will delve deeper into the patterns, trends, and relationships within the research landscape of AI for multimedia in education.

4. Results

4.1 Publication Trend

Figure 2. and Table 1. present data on the number of publications per year from 2020 to 2024, utilizing distinct visual representations. The line graph in Figure 2. illustrates a sharp increase in publications in 2021, followed by a gradual decline in subsequent years. Specifically, a single publication was recorded in 2020, which surged to 12 publications in 2021, marking the peak. The number then plateaued at 11 publications in 2022 and 2023 before slightly decreasing to 10 in 2024.

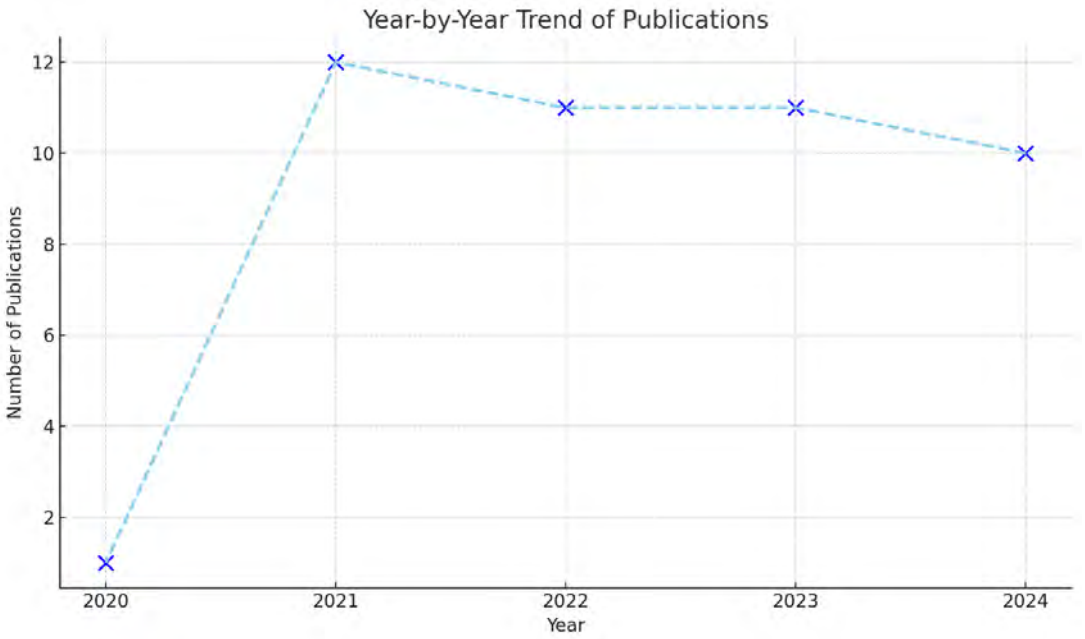

Figure 2. The visualization shows the number of publications published in each year

Table 1. Annual scientific production

Year	Publication
2020	1
2021	12
2022	11
2023	11
2024	10
Total	45

Table 1. complements Figure 2 by providing the same data in tabular format, detailing the exact number of publications for each year and the cumulative total of 45 publications. This allows for a clearer understanding of

the overall research output within the field. While a slight decline is observed post-2021, the overall publication volume remains substantial, indicating sustained activity and research within the field. The combined presentation of data in both graphical and tabular formats facilitates a comprehensive understanding of this domain's publication trends and research output.

4.2 Analysis of the Author

The co-authorship network presented visually depicts the collaborative relationships among eight authors within a specific research context. Each node within the network symbolizes an individual author, while the edges connecting these nodes signify instances of co-authorship on at least one publication.

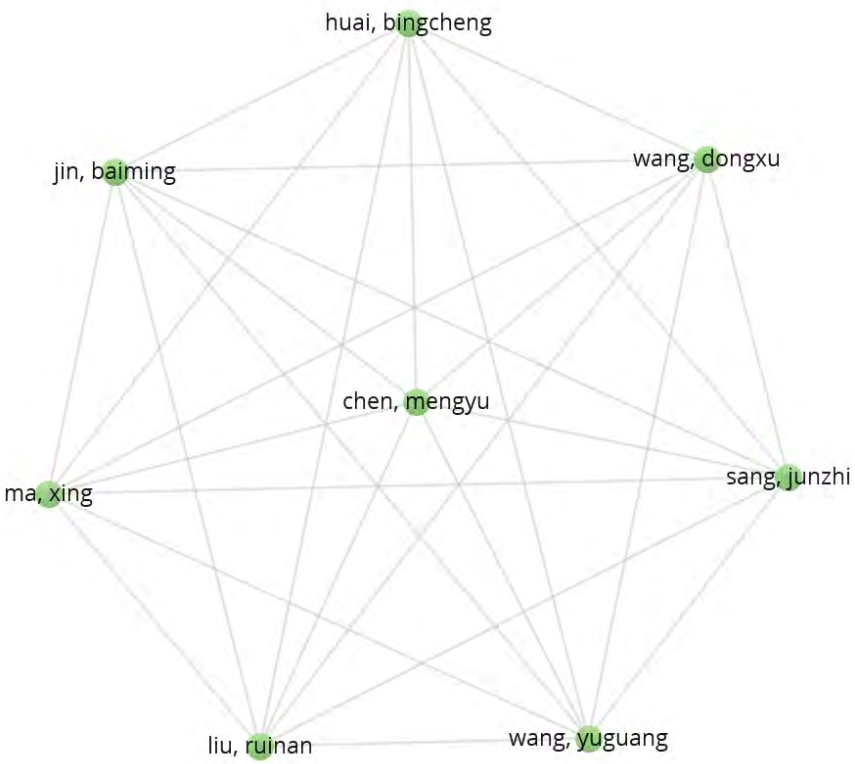

Figure 2. Co-authorship Network Analysis

A comprehensive analysis of this co-authorship network reveals several key insights. Notably, authors "huai" and "bingcheng" emerge as central figures within the network, exhibiting connections to all other authors. This centrality underscores their pivotal role in fostering collaboration and potentially influencing the research direction within the group. The network's high density, characterized by the interconnectedness of all authors through co-authorship, further emphasizes the strong collaborative nature of this research community.

Interestingly, the absence of distinct clusters within the network suggests a lack of clear subgroupings based on shared research interests or specialization. This could be attributed to the authors' diverse research interests, which lead to cross-disciplinary collaborations. Alternatively, the relatively small size of the network might not be conducive to forming distinct clusters.

Table 2. Co-authorship of author analysis

author	documents	total link strength
chen, mengyu	1	7
huai, bingcheng	1	7
jin, baiming	1	7
liu, ruinan	1	7
ma, xing	1	7
sang, junzhi	1	7
wang, dongxu	1	7
wang, yuguang	1	7

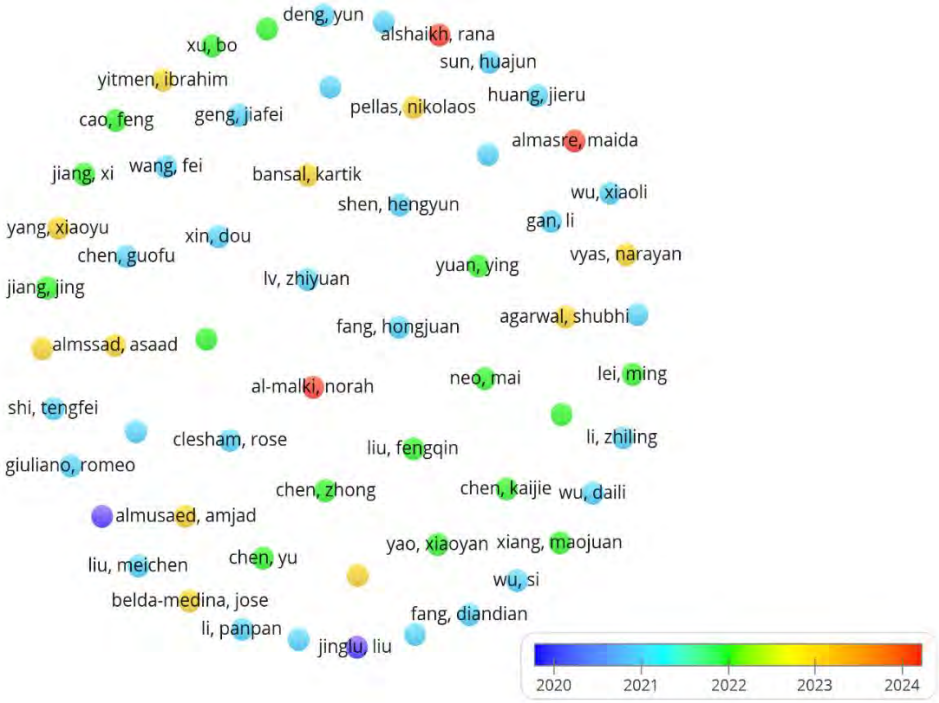

Figure 3. The clustering of citations from contributor

Table 3. Citation by Authors

id	author	documents	citations
1	agarwal, shubhi	1	3
2	al-malki, norah	1	5
3	almasre, maida	1	5
4	almssad, asaad	1	47
5	almusaed, amjad	1	47
6	alshaikh, rana	1	5
10	bansal, kartik	1	3
11	belda-medina, jose	1	10
12	cao, feng	1	5
14	chen, guofu	1	26
15	chen, kaijie	1	5
19	chen, yu	1	2
20	chen, zhong	1	2
21	clesham, rose	1	16
24	deng, yun	1	3
26	fang, diandian	1	26
27	fang, hongjuan	1	38
29	gan, li	1	2
30	geng, jiafei	1	9
31	giuliano, romeo	1	8
32	homod, raad z.	1	47
34	huang, jieru	1	45
35	jiang, jing	1	3
36	jiang, xi	1	2
38	jinglu, liu	1	27
39	kokošková, vendula	1	10
40	lei, ming	1	5
41	li, moyan	1	26

id	author	documents	citations
42	li, panpan	1	38
44	li, zhiling	1	2
45	liu, fengqin	1	3
46	liu, meichen	1	45
50	lv, zhiyuan	1	24
52	neo, mai	1	16
53	ni, yujia	1	2
54	ning, yuwen	1	38
56	pellas, nikolaos	1	7
59	ran, wang	1	27
60	richardson, mary	1	16
64	shen, hengyun	1	24
65	shi, tengfei	1	26
68	su, yawen	1	26
69	sun, huajun	1	2
73	vyas, narayan	1	3
75	wang, fei	1	24
79	wu, daili	1	24
82	wu, si	1	24
83	wu, xiaoli	1	9
84	xiang, maojuan	1	5
85	xin, dou	1	7
87	xu, bo	1	3
88	yang, xiaodong	1	2
89	yang, xiaoyu	1	1
90	yao, xiaoyan	1	5
91	yitmen, ibrahim	1	47
92	yuan, ying	1	13
93	zhang, aiyun	1	1
95	zhang, yezi	1	9
97	zhao, ying	1	1
98	zheng, huan	1	2

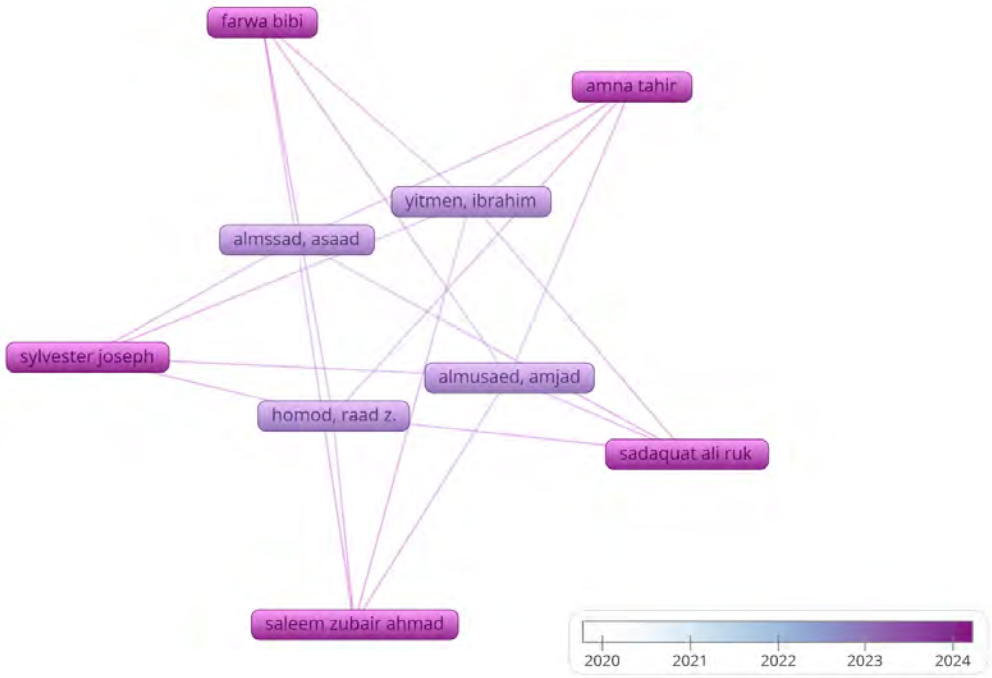

Figure 4. The trend of Most Cited Authors (Co-Citation Analysis)

Figure 4 and Table 4 illustrate a co-citation network, a bibliometric analysis tool that reveals relationships between authors frequently cited in the same documents. The network highlights a cluster of authors, including Almssad, Assad, Almusaed, Amjad, Homod, Raad Z., and Yitmen, Ibrahim, who are highly interconnected, suggesting their research is closely related and often cited together. This observation is further supported by Table 4, which indicates these authors have the highest number of citations (47), emphasizing their significant influence and contribution to the field.

Table 4. Citation by Authors (Taltal link straengh)

author	citations	total link strength
almssad, asaad	47	5
almusaed, amjad	47	5
homod, raad z.	47	5
yitmen, ibrahim	47	5
amna tahir	0	4
farwa bibi	0	4
sadaquat ali ruk	0	4
saleem zubair ahmad	0	4
sylvester joseph	0	4

4.3 Analysis of Countries

Figure 5. and Table 5. provide a visual and numerical representation of the distribution of publications and citations across different countries. Figure 5, a world map with varying circle sizes, illustrates the concentration of publications, with China prominently leading with 19 publications. Saudi Arabia follows with a modest contribution of 2 publications, while several other countries contribute a single publication each.

Figure 5. Countries published

Table 5. List of the countries based on the number of publications

Country	Document	Citations
China	19	214
Saudi Arabia	2	5
Czechia	1	10
Ghana	1	0
Greece	1	7
India	1	3
Iraq	1	47
Italy	1	8
Malaysia	1	16
Netherlands	1	0
South Korea	1	9
Spain	1	10
Sweden	1	47
Thailand	1	1
United Kingdom	1	16
United States	1	0
Unknow countries	10	0

Figure 6. and Table 6 delve deeper into the specifics, listing each country alongside its publication and citation count. China's dominance is further emphasized with its 19 publications garnering a substantial 214 citations. While contributing fewer publications, other countries exhibit varying citation counts, reflecting their research's diverse impact and reach. Notably, Ghana, the Netherlands, and the United States, despite having publications, have not received any citations within the dataset presented.

Figure 6. Citations of country

Table 6. Most cited research papers

Rank	Country	Citations
1	China	214
2	Iraq	47
2	Sweden	47
3	Malaysia	16
3	United Kingdom	16
4	Czechia	10
4	Spain	10

Table 6. shows the provided table summarizing the top research citation counts by country. China stands out with the highest number of citations at 214. This highlights the significant role and global recognition of Chinese research contributions. Iraq, Sweden, Malaysia, the United Kingdom, Czechia, and Spain follow suit, ranking second and third with 47, 16, and 10 citations, respectively, demonstrating the strength of these countries' research on the international stage.

4.4 Analysis of the Cited Articles

The top 5 papers are ranked based on the total quotes from the time of publication until the time this study was conducted (July 2024). Of the 45 papers published on the theme of artificial intelligence in multimedia for education in the last 5 years, from 2020 to 2024. Data show that Table 2.

Table 7. Most cited research papers

Rank	Top 5 Publication Based on Times Cited Article	Year	Authors	Country	Citations
1	Enhancing Student Engagement: Harnessing "AIED"'s Power in Hybrid Education—A Review Analysis	2023	Amjad Almusaed, Asaad Almssad, Ibrahim Yitmen, Raad Z. Homod	Sweden	47
2	Piano playing teaching system based on artificial intelligence – design and research	2021	Meichen Liu, Jieru Huang	China	45
3	Artificial intelligence translation under the influence of multimedia teaching to study English learning mode	2021	Panpan Li, Yuwen Ning, Hongjuan Fang	China	33
4	The Design and Development of Digital Books for E-learning	2020	Ran, Wang; Jinglu, Liu	China	27
5	Design and Implementation of Web Multimedia Teaching Evaluation System Based on Artificial Intelligence and jQuery	2021	Yawen Su, Guofu Chen, Moyan Li, Tengfei Shi, Diandian Fang	China	26

Figure 7 and Table 7 show the time of publication of the top 5 articles with citations from the time of publication to the time of the study (July 2024), based on 45 papers published on the topic of multimedia artificial intelligence for study over the past 5 years, from 2020 to 2024. The top-ranked article with 47 citations is Enhancing Student Engagement: Harnessing the Power of "AIED" in Education Blended—Review Analysis by Amjad Almusaed, Asaad Almssad, Ibrahim Yitmen, Raad Z. Homod (2023). The second-ranked article with 45 citations is 'Piano Playing Teaching System Based on Artificial Intelligence Design and Research' by Meichen Liu and Jieru Huang (2021). The third-ranked article with 33 citations is 'AIDI Translation under the Influence of Multimedia Teaching to Study English Learning Styles' by Panpan Li, Yuwen Ning, and Hongjuan Fang (2021). The fourth-ranked article with 27 citations is The Design and Development of Digital Books for E-learning by Ran, Wang; Jinglu, Liu (2020). The fifth-ranked article with 26 citations is Design and Implementation of Web Multimedia Teaching Evaluation System Based on Artificial Intelligence and jQuery by Yawen Su, Guofu Chen, Moyan Li, Tengfei Shi, Diandian Fang (2021). This presentation concluded that the literature referring to artificial intelligence in multimedia for education has started to be widely discussed since 2020, and the 2024 results have been cited in recent studies. This is in line with the development of artificial intelligence in multimedia for education topics in more depth.

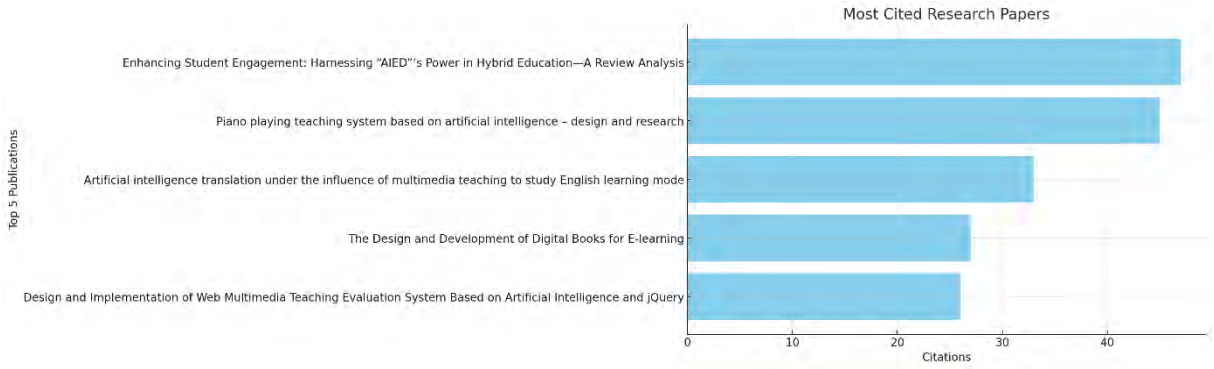

Figure 7. Most cited research papers

4.5 Analysis of Keywords

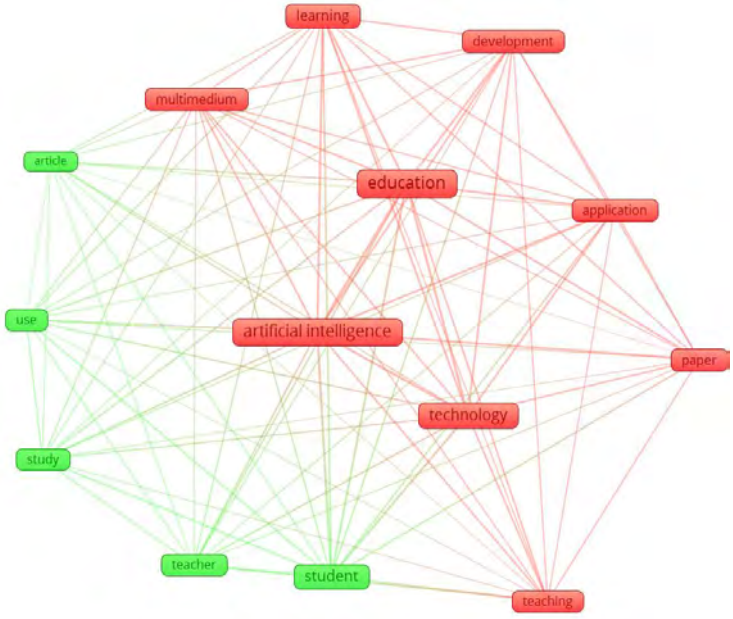

Figure 8. A Visualization of keywords' networks

Figure 8 visually represents the network of keywords related to "Artificial Intelligence for Multimedia in Education." The network is divided into two distinct clusters, with the red cluster being the primary one.

The red cluster, centered around "artificial intelligence," indicates a strong focus on the technological aspects of AI. It highlights the interconnectedness of AI with "education," "technology," "learning," and "teaching," underscoring the integration of AI in various educational domains. The presence of "application," "development," and "paper" suggests a research-oriented approach, emphasizing the practical applications and ongoing advancements in AI within the educational context.

The secondary green cluster, while less extensive, revolves around "student" and "teacher." This cluster indicates a focus on the human element within AI in education, highlighting the impact of AI on both learners and educators. The connections to "learning," "teaching," and "multimedia" suggest that AI is being used to enhance the learning experience and improve teaching methods.

Figure 9. illustrates the network of keywords associated with "Artificial Intelligence for Multimedia in Education," along with the evolution of their usage trends from 2020 to 2024. The color gradient indicates the timeframe, with blue representing 2020 and orange representing 2024.

The term "research" has been consistently prevalent since 2020, signifying the significance of research in this field. Conversely, the term "experience" has gained prominence in 2024, potentially reflecting a growing interest

in the practical implementation of artificial intelligence in educational multimedia.

Several other keywords, including "artificial intelligence," "education," "technology," "learning," and "teaching," have maintained consistent usage throughout the period, highlighting the importance of artificial intelligence technology in education and the interconnectedness of these concepts.

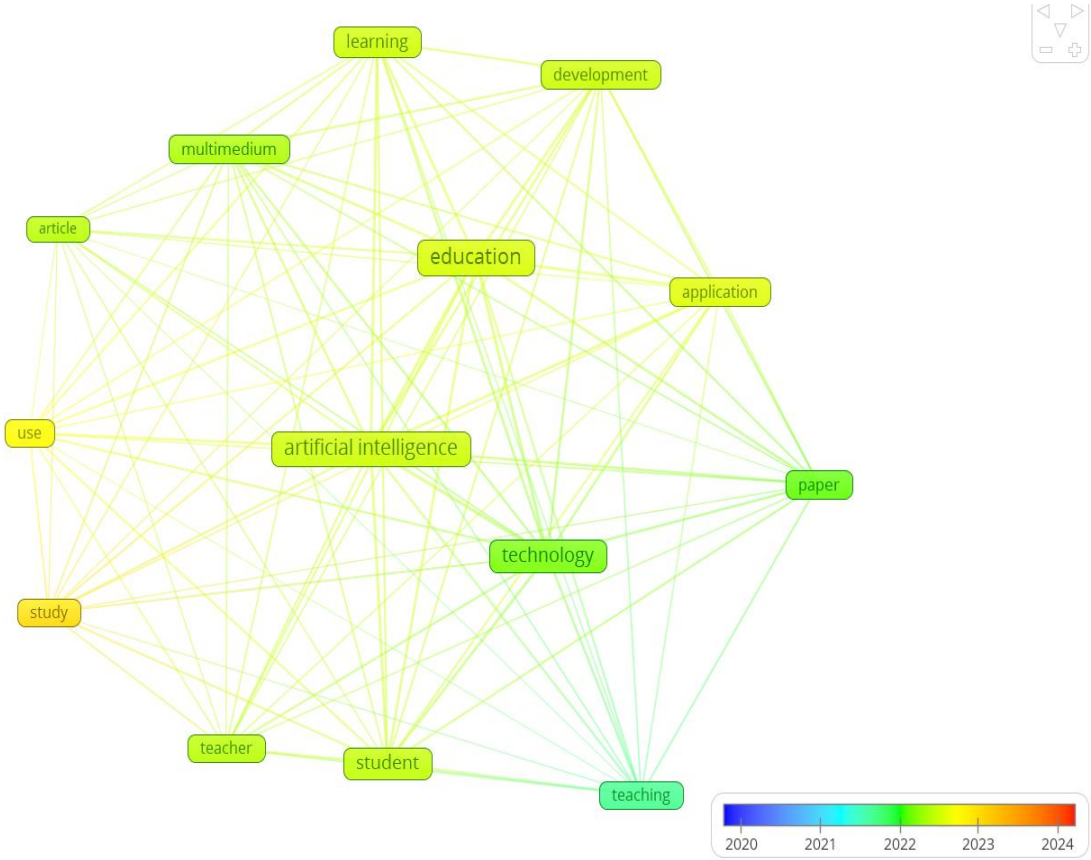

Figure 9. Bibliometric Keywords

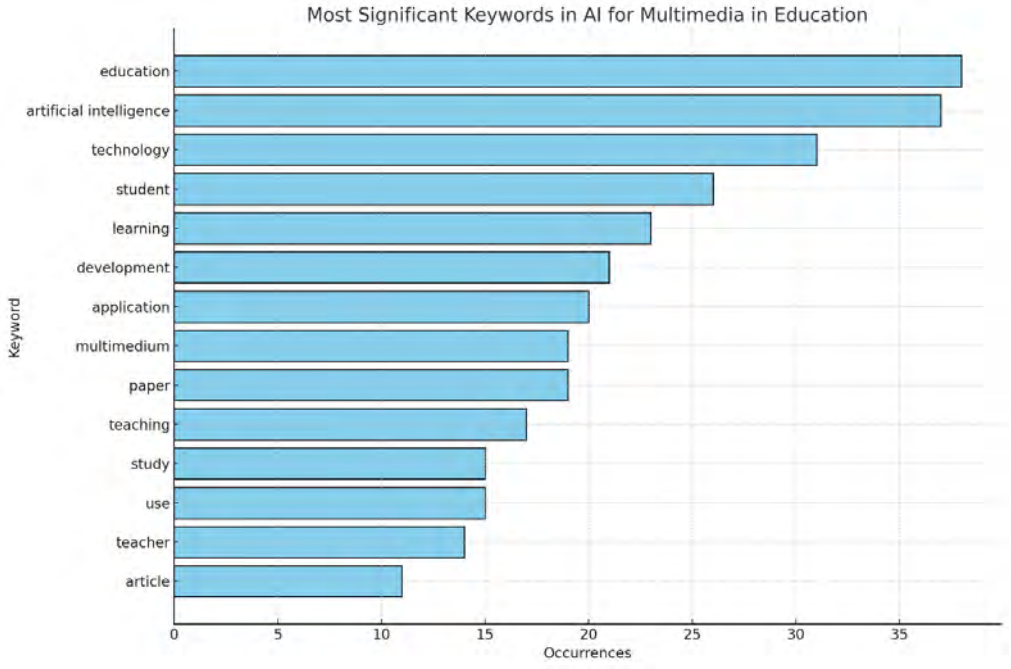

Figure 10. Most Significant Keywords of AI For Multimedia in Education

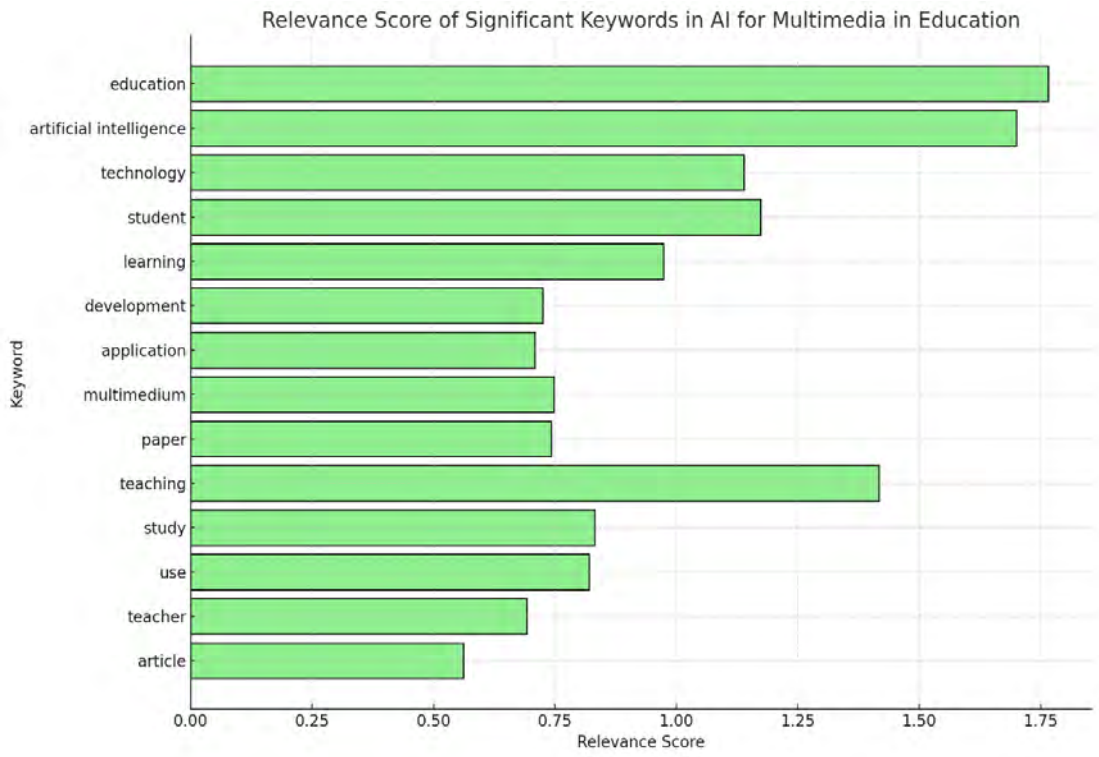

Figure 11. Relevance Score of Significant Keywords of AI For Multimedia in Education

Figure 10 presents the frequency of the top 14 most prevalent keywords. "Education" emerges as the most frequently occurring term (38 occurrences), followed by "artificial intelligence" (37 occurrences) and "technology" (31 occurrences), respectively. This frequency distribution reflects the primary areas of interest among researchers, highlighting a focus on the application of AI and technology within educational contexts.

Concurrently, Figure 11 depicts the relevance scores of these keywords, offering a different perspective. "Education" maintains the highest score (1.7659), followed by "artificial intelligence" (1.7003). Interestingly, "teaching" (1.4171) ranks third in relevance, despite not appearing among the most frequent terms.

When considering both figures in conjunction, it can be inferred that research in this domain places significant emphasis on the integration of AI in education and teaching, with a focus on developing technologies to support learning processes. Additionally, the terms "student" and "learning" demonstrate both high frequency and relevance scores, indicating that the majority of research prioritizes the impact of AI on learners and the learning process.

This data suggests that while research is oriented towards AI technology development, it maintains a strong focus on educational applications and learner impact. This reflects a research trend that seeks to balance technological innovation with educational advancement.

The analysis reveals a nuanced landscape of AI research in educational multimedia, where technological advancements are consistently contextualized within educational paradigms. This approach underscores the interdisciplinary nature of the field, bridging computer science, education, and cognitive psychology. Future research directions may continue to explore the synergies between AI capabilities and pedagogical needs, potentially leading to more personalized and effective learning experiences.

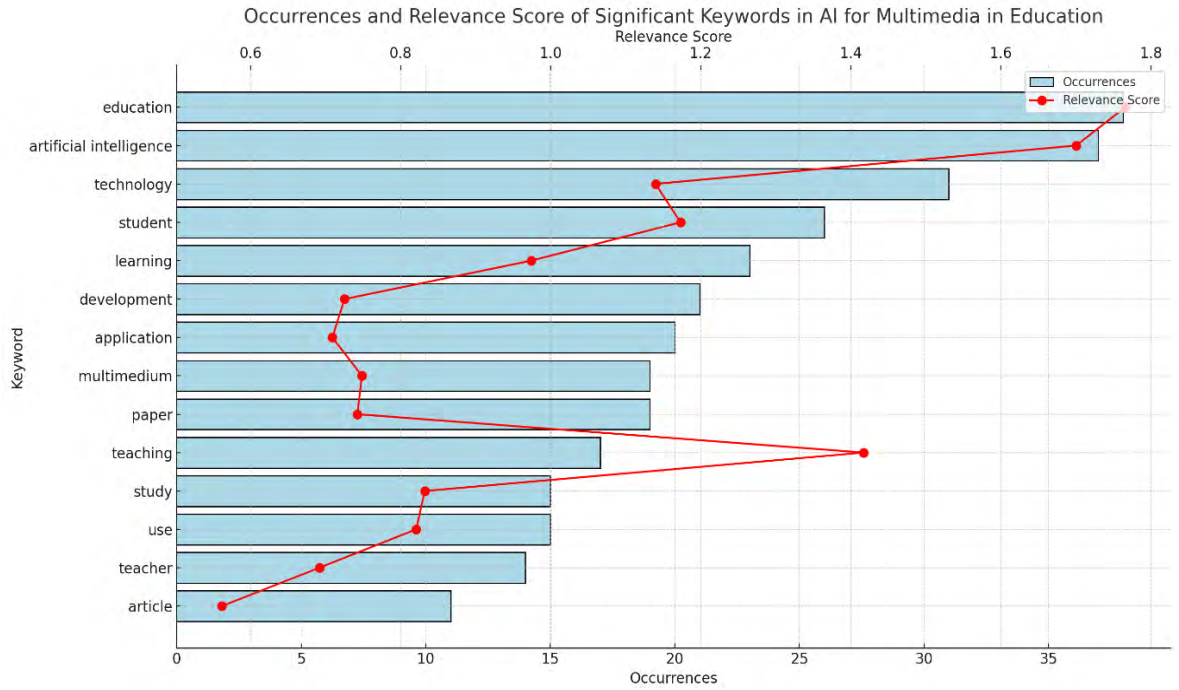

Figure 12. Matplotlib Chart

The combined graph effectively highlights the relationship between the frequency (occurrences) and importance (relevance score) of various keywords. Keywords like "education" and "artificial intelligence" are both highly frequent and highly relevant, making them central themes in AI for multimedia in education. Other keywords such as "technology" and "student" are important but secondary. This visualization helps identify key focus areas and themes within the field.

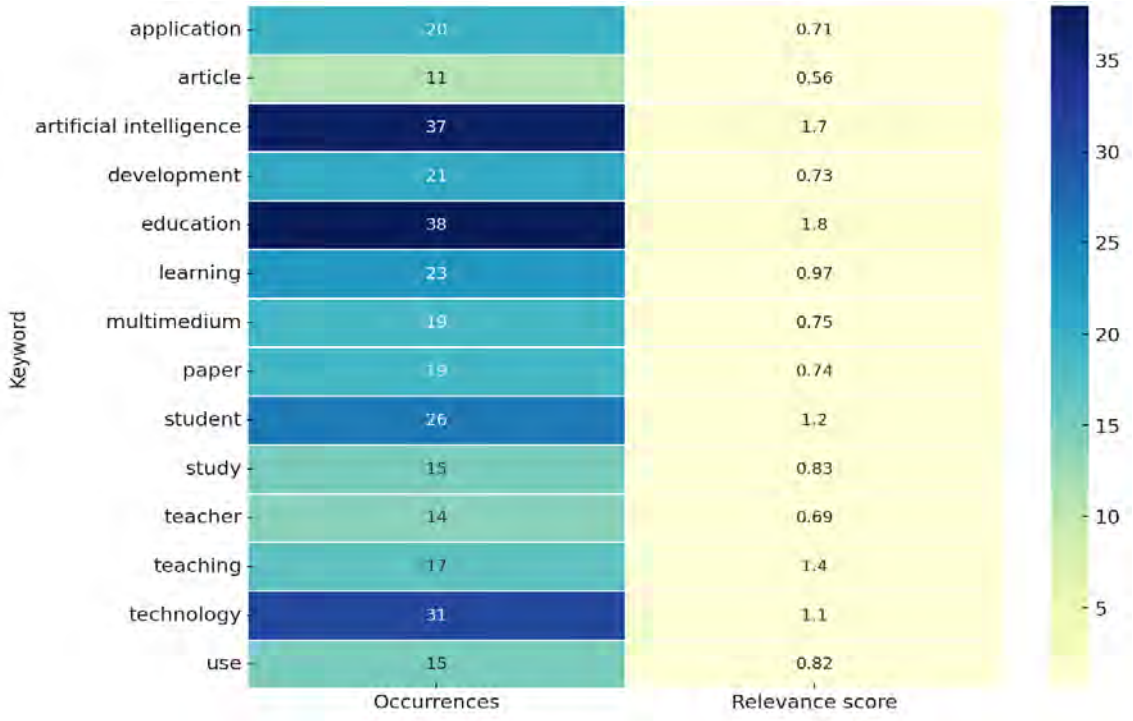

Figure 13. Heatmap of Significant Keywords

The heatmap effectively highlights the relationship between the frequency and relevance of various keywords. Keywords like "education" and "artificial intelligence" are widespread and highly relevant, indicating their central role in AI for multimedia education. Other keywords, such as "technology" and "student," are important but secondary. This visualization helps identify key themes and areas of focus within the field.

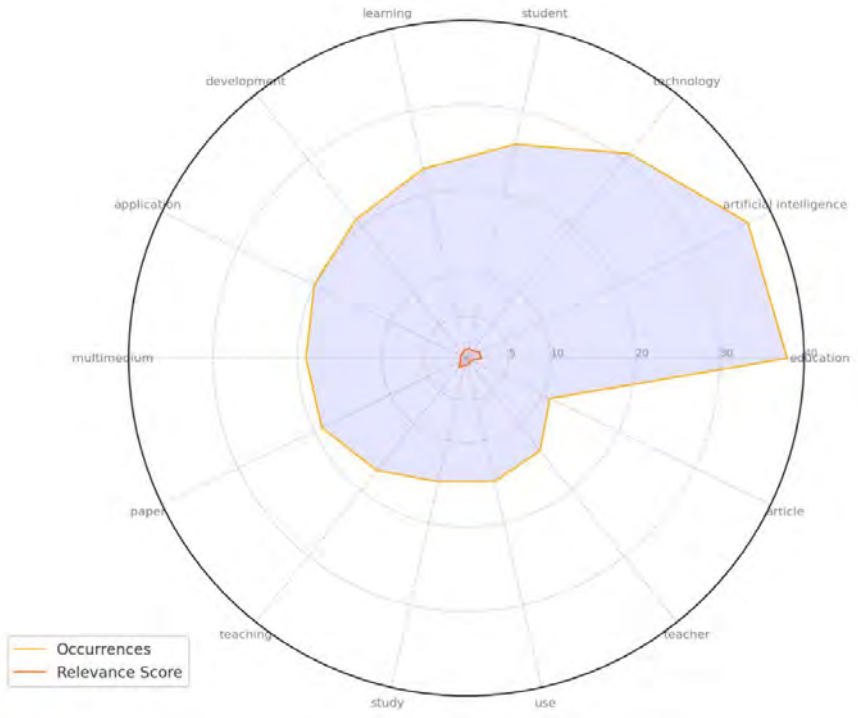

Figure 14. The radar chart effectively highlights the relationship

The radar chart effectively highlights the relationship between the frequency and relevance of various keywords. It shows that "education" and "artificial intelligence" are the most significant keywords regarding occurrences and relevance in this context. Other keywords like "technology" and "student" are also important but to a lesser degree. This visualization helps identify key themes and areas of focus within the field of AI for multimedia in education.

The keywords containing 14 keywords from the clustered data show some research focuses that can be generated, as shown in Table 8.

Table 8. The most significant keywords in AI for multimedia in education

Keyword	Occurrences	Relevance score
education	38	1.7659
artificial intelligence	37	1.7003
technology	31	1.1396
student	26	1.173
learning	23	0.974
development	21	0.7251
application	20	0.7088
multimedium	19	0.7483
paper	19	0.7422
teaching	17	1.4171
study	15	0.8321
use	15	0.8205
teacher	14	0.6916
article	11	0.5615

Table 6 presents the most frequently occurring keywords in studies on Artificial Intelligence for Mixed Media in Education, ranked by frequency of occurrence and relevance score. The top three keywords with the highest frequency of occurrence are "education" (38 occurrences), "artificial intelligence" (37 occurrences), and "technology" (31 occurrences), indicating that the majority of research focuses on the application of artificial intelligence and technology in education. The high frequency of the keywords "student" (26 occurrences) and "learning" (23 occurrences) also suggests that research emphasizes the impact of artificial intelligence on learners and the learning process.

In terms of relevance score, the keywords "artificial intelligence" and "education" have the highest scores (1.7003 and 1.7659, respectively), highlighting the significance of these two concepts in research. Other keywords with high relevance scores include "technology" (1.1396), "student" (1.173), and "teaching" (1.4171), indicating that research focuses on using artificial intelligence technology to improve teaching and learning.

Overall, Table 6 provides an overview of research trends in Artificial Intelligence for Mixed Media in Education, emphasizing the importance of artificial intelligence and technology and their impact on learners and the learning process. Future research may focus on exploring specific applications of Artificial Intelligence for Mixed Media in Education and evaluating its impact on student learning outcomes.

5. Discussion

The bibliometric analysis of research on Artificial Intelligence (AI) for Multimedia in Education from 2020 to 2024 reveals several key trends and insights into this rapidly evolving field.

5.1 Publication Trends

The data shows a significant surge in publications on this topic from 2020 to 2021, with the number of publications increasing from 1 to 12. This sharp rise likely reflects the growing interest and recognition of AI's potential in educational multimedia applications. The subsequent plateau in 2022 and 2023 (11 publications each year) and a slight decrease in 2024 (10 publications) may indicate a stabilization of research output or a shift towards more focused, in-depth studies rather than a decline in interest.

5.2 Geographical Distribution

China is the dominant contributor to this field, with 19 publications and 214 citations. This leadership position underscores China's significant investment in AI and educational technology research. While smaller in number, the contributions from other countries demonstrate the global interest in this topic. The diverse geographical spread, including contributions from Saudi Arabia, European countries, and others, suggests a growing international recognition of AI's importance in multimedia education.

5.3 Collaborative Networks

The co-authorship network analysis reveals a tightly interconnected group of researchers, particularly highlighting the central roles of authors like "huai" and "benching." This interconnectedness suggests a collaborative research environment crucial for advancing complex, interdisciplinary fields like AI in education. However, the absence of distinct clusters might indicate a need for more diverse collaboration across different research groups or specializations.

5.4 Citation Impact

The most cited papers, such as "Enhancing Student Engagement: Harnessing 'AIED"s Power in Hybrid Education—A Review Analysis" (47 citations) and "Piano Playing Teaching System based on Artificial Intelligence -- Design and Research" (45 citations), highlight the areas of significant interest within the field. These highly cited works focus on student engagement and specific AI applications in education, suggesting that the research community particularly values practical implementations and reviews of AI's educational impact.

5.5 Thematic Focus

The keyword analysis reveals a strong focus on core concepts such as "artificial intelligence," "education," "technology," and "learning." The prominence of these terms across the studied period indicates a consistent research emphasis on the technological aspects of AI in education and their impact on learning processes. The emergence of "experience" as a prominent keyword in recent years suggests a shift towards more user-centered research, focusing on the practical implications of AI in educational settings.

5.6 Challenges and Opportunities

While not explicitly discussed in the results, the literature review section highlights several challenges in implementing AI for multimedia in education, including data privacy concerns, ethical considerations, and

educator training. These challenges present opportunities for future research to address these issues and develop more robust, ethical AI systems for educational use.

5.7 Interdisciplinary Nature

The diversity of keywords and research themes indicates the highly interdisciplinary nature of AI in multimedia education. This field bridges technology, pedagogy, and cognitive science, necessitating collaboration across various domains to fully realize AI's potential in educational settings.

5.8 Future Directions

The analysis suggests several potential directions for future research:

1. More in-depth studies on the long-term impact of AI-enhanced multimedia education on learning outcomes.

2. Development of ethical frameworks and best practices for AI implementation in educational settings.

3. Cross-cultural studies to understand how AI in education can be adapted to different educational systems and cultural contexts.

4. Research enhancing AI's capability to provide personalized learning experiences through multimedia content.

In conclusion, this bibliometric analysis reveals a dynamic and rapidly evolving field of research. The integration of AI in multimedia education is gaining significant attention globally, with China leading the charge. As the field matures, there is a clear trend towards more practical, experience-focused research, aiming to leverage AI's capabilities to enhance learning experiences and outcomes. However, challenges remain, particularly in ethical implementation and adapting AI to diverse educational contexts. Future research in this field will likely need to balance technological advancements with pedagogical needs and ethical considerations to realize the full potential of AI in multimedia education.

6. Conclusion

This comprehensive bibliometric analysis of research on Artificial Intelligence (AI) for Multimedia in Education from 2020 to 2024 provides valuable insights into this rapidly evolving field's current state and future directions. The study reveals several key findings that have significant implications for researchers, educators, and policymakers.

First, the sharp increase in publications from 2020 to 2021, followed by a stabilization in subsequent years, indicates a growing recognition of AI's potential in educational multimedia applications. This trend suggests that the field has moved beyond initial exploratory stages and focuses on more targeted, in-depth research.

Second, the geographical distribution of research output highlights China's dominant position in this field, with significant contributions from other countries worldwide. This global interest underscores the universal recognition of AI's importance in advancing multimedia education and suggests international collaboration and knowledge exchange opportunities.

Third, analyzing collaborative networks reveals a tightly interconnected research community, which is crucial for advancing this interdisciplinary field. However, the lack of distinct clusters suggests a need for more diverse collaborations across different specializations and research groups to foster innovation and address complex challenges.

Fourth, the research's thematic focus, as revealed by keyword analysis, emphasizes core concepts such as artificial intelligence, education, technology, and learning. The emergence of "experience" as a prominent keyword in recent years indicates a shift towards more user-centered research, focusing on the practical implications of AI in educational settings.

Fifth, the most cited papers in the field highlight the research community's interest in practical implementations of AI in education and comprehensive reviews of its impact. This suggests a growing emphasis on evidence-based approaches to integrating AI in multimedia education.

However, the study also reveals several challenges that need to be addressed. These include ethical considerations, data privacy concerns, and the need for educator training in AI technologies. Future research should focus on developing robust ethical frameworks, enhancing AI's capability to provide personalized learning experiences, and conducting long-term studies on the impact of AI-enhanced multimedia education on learning outcomes.

In conclusion, this bibliometric analysis demonstrates that AI for Multimedia in Education is a dynamic and rapidly evolving field with significant potential to transform educational practices. As the field matures, it is crucial to balance technological advancements with pedagogical needs and ethical considerations. Future research should bridge the gap between theoretical advancements and practical implementations, ensuring that AI technologies are effectively harnessed to enhance learning experiences and outcomes across diverse educational contexts.

The findings of this study provide a solid foundation for researchers, educators, and policymakers to make informed decisions about the direction of future research and the implementation of AI in multimedia education. As we progress, continued interdisciplinary collaboration and a focus on user-centered, ethical AI applications will be key to realizing AI's full potential in transforming educational multimedia experiences.

Authors contributions

The project administrator, Assistant Professor Potsirin Limpinan, prepares the original draft and subsequent revision and editing to produce the published work. In addition, Ampawan Yindeemakconceptualized the methodology, while Assistant Professor Dr. Thada Jantakoon supervised the conceptualization, methodology, validation, investigation, writing review, and editing preparation. Rungfa Pasmala and Manop Nammanee conducted the formal analysis. All authors reviewed and endorsed the final manuscript.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

References

Akhmadieva, R. S., Udina, N. N., Kosheleva, Y. P., Zhdanov, S. P., Timofeeva, M. O., & Budkevich, R. L. (2023). Artificial Intelligence in Science Education: A Bibliometric Review. *Contemporary Educational Technology, 15*(4). https://doi.org/10.30935/cedtech/13587

AlAli, R., & Wardat, Y. (2024). Opportunities and Challenges of Integrating Generative Artificial Intelligence in Education. *International Journal of Religion, 5*(7), 784-793. https://doi.org/10.61707/8y29gv34

Awad, P., & Oueida, S. (2024). *The Potential Impact of Artificial Intelligence on Education: Opportunities and Challenges.* In Future of Information and Communication Conference (pp. 566-575). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-53963-3_39

Barker, B. S., Larson, K., & Krehbiel, M. (2014). Bridging formal and informal learning environments. *The Journal of Extension, 52*(5), 26. https://doi.org/10.34068/joe.52.05.26

de Sá, G. B., Pereira, A. L., Pinto, A. C. P., dos Santos Filho, E. B., & Oliveira, J. K. V. (2024). INTEGRAÇÃO DA INTELIGÊNCIA ARTIFICIAL NA EDUCAÇÃO A DISTÂNCIA: DESAFIOS E POTENCIAIS. *RCMOS-Revista Científica Multidisciplinar O Saber, 1*(1). https://doi.org/10.51473/rcmos.v1i1.2024.489

Fatimah, S., Sarwi, S., & Haryani, S. (2024). Artificial Intelligence in STEM Education: A Bibliometric Analysis. *International Journal of Multicultural and Multireligious Understanding, 11*(1), 186-200.

Flogie, A., & Aberšek, B. (2022). *Artificial intelligence in education. Active Learning-Theory and Practice.* https://doi.org/10.5772/intechopen.96498

ökoğlu, S. (2024). Challenges and limitations of generative AI in education. *Transforming Education With Generative AI: Prompt Engineering and Synthetic Content Creation*, 158-181. https://doi.org/10.4018/979-8-3693-1351-0.ch008

Hamal, O., El Faddouli, N. E., Harouni, M. H. A., & Lu, J. (2022). Artificial intelligent in education. *Sustainability, 14*(5), 2862. https://doi.org/10.3390/su14052862

Hemachandran, K., Verma, P., Pareek, P., Arora, N., Rajesh Kumar, K. V., Ahanger, T. A., ... Ratna, R. (2022). Artificial intelligence: A universal virtual tool to augment tutoring in higher education. *Computational Intelligence and Neuroscience, 2022*(1), 1410448. https://doi.org/10.1155/2022/1410448

Kaban, A. (2023). Artificial intelligence in education: A science mapping approach. *International Journal of Education in Mathematics, Science and Technology, 11*(4), 844-861. https://doi.org/10.46328/ijemst.3368

Karaca, A., & Kılcan, B. (2023). The Adventure of Artificial Intelligence Technology in Education: Comprehensive Scientific Mapping Analysis. *Participatory Educational Research, 10*(4), 144-165. https://doi.org/10.17275/per.23.64.10.4

Kaswar, A. B., Arsyad, M., & Surianto, D. F. (2023). Membangun Keterampilan Pendidik Melalui Pelatihan Pembuatan Media Pembelajaran Berbasis Artificial Intelligence. *Vokatek: Jurnal Pengabdian Masyarakat,* 293-297. https://doi.org/10.61255/vokatekjpm.v1i3.248

Ke, M. F. (2023). Applications and Challenges of Artificial Intelligence in the Future of Art Education. *Pacific International Journal, 6*(3), 61-65. https://doi.org/10.55014/pij.v6i3.405

Leiker, D., Gyllen, A. R., Eldesouky, I., & Cukurova, M. (2023). *Generative AI for learning: Investigating the potential of synthetic learning videos.* arXiv preprint arXiv:2304.03784. https://doi.org/10.1007/978-3-031-36336-8_81

Liu, Y. X., Zhu, C., Wu, Z. X., Lu, L. J., & Yu, Y. T. (2022). A bibliometric analysis of the application of artificial intelligence to advance individualized diagnosis and treatment of critical illness. *Annals of Translational Medicine, 10*(16). https://doi.org/10.21037/atm-22-913

Metli, A. (2023). Articles on education and artificial intelligence: A bibliometric analysis. *Journal of Social Sciences and Education, 6*(Education Special Issue), 279-312. https://doi.org/10.53047/josse.1352197

Moreno, M. F., Lima, G., Santos, R., Azevedo, R., & Endler, M. (2019, December). *Bridging the Gap between Semantics and Multimedia Processing.* In 2019 IEEE International Symposium on Multimedia (ISM) (pp. 315-3153). IEEE. https://doi.org/10.1109/ISM46123.2019.00070

Muraro, V., & Göktepe-Hultén, D. (2023, April). *Assessment of academic work in AI using Bibliometrics: The Case of Lund University*. In 27th International Conference on Science, Technology and Innovation Indicators (STI 2023). International Conference on Science, Technology and Innovation Indicators. https://doi.org/10.55835/6442a2612e5bbccb9a78fe1e

Nykonenko, A. (2023). The impact of artificial intelligence on modern education: prospects and challenges. *Artificial Intelligence, 2*, 10-15. https://doi.org/10.15407/jai2023.02.010

Owoc, M. L., Sawicka, A., & Weichbroth, P. (2019, August). *Artificial intelligence technologies in education: benefits, challenges and strategies of implementation*. In IFIP International Workshop on Artificial Intelligence for Knowledge Management (pp. 37-58). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-85001-2_4

Pesántez, C. V. B., Moncayo, L. N. A., Paca, E. G. C., Chango, R. J. C., & Pérez, M. Á. A. (2023). IMPACT OF ARTIFICIAL INTELLIGENCE ON VIRTUAL CLASSROOMS FOR HIGHER EDUCATION. *Russian Law Journal, 11*(9S), 52-60. https://doi.org/10.52783/rlj.v11i10s.1640

Salloum, S. A., Salloum, A., & Alfaisal, R. (2024). Objectives and Obstacles of Artificial Intelligence in

Education. *Artificial Intelligence in Education: The Power and Dangers of ChatGPT in the Classroom,* 605-614. https://doi.org/10.1007/978-3-031-52280-2_38

Salmi, H. (2012). Evidence of bridging the gap between formal education and informal learning through teacher education. *Reflecting Education, 8*(2), 45-61.

Shaikh, A. K., Alhashmi, S. M., Khalique, N., Khedr, A. M., Raahemifar, K., & Bukhari, S. (2023). Bibliometric analysis on the adoption of artificial intelligence applications in the e-health sector. *Digital Health, 9*, 20552076221149296. https://doi.org/10.1177/20552076221149296

Sytnyk, L., & Podlinyayeva, O. (2024). AI in education: main possibilities and challenges. Scientific Collection. *InterConf+, 45*(201), 569-579. https://doi.org/10.51582/interconf.19-20.05.2024.058

Talan, T. (2021). Artificial intelligence in education: A bibliometric study. *International Journal of Research in Education and Science, 7*(3), 822-837. https://doi.org/10.46328/ijres.2409

Triansyah, F. A., Muhammad, I., Rabuandika, A., Siregar, K. D. P., Teapon, N., & Assabana, M. S. (2023). Bibliometric Analysis: Artificial Intelligence (AI) in High School Education. *Jurnal Ilmiah Pendidikan Dan Pembelajaran, 7*(1), 112-123. https://doi.org/10.23887/jipp.v7i1.59718

Worsley, M. (2022). *Artificial Intelligence Innovations for Multimodal Learning, Interfaces, and Analytics*. In AI in Learning: Designing the Future (pp. 19-35). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-09687-7_2

Zhang, Y. (2022). Development and application of artificial intelligence multimedia technology based on big data. *Mobile Information Systems, 2022*(1), 2073091. https://doi.org/10.1155/2022/2073091