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Bibliometric Analysis of Artificial Intelligent Studies in Education and Pedagogy

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ABSTRACT

Purpose – Artificial Intelligent (AI) is a technology that is currently developing rapidly. The application of AI in Education (AIEd) is a study that is starting to be of interest to researchers in the field of AI and Education. The purpose of this research is to summarize studies on AIEd from 2018 to 2023 through bibliometric analysis and analyze current study progress, key points, and trends in AIEd related to pedagogy.

Method – This research is a bibliometric analysis method. The data were collected from the Scopus database using R Studio software with search keywords of "Artificial Intelligence, Education, and Pedagogy". A total of 94 articles were reviewed in this study.

Findings – The results of the study show that combining the more frequently researched AI and Pedagogy topics with the less researched AIED topics can produce innovative updates and make important contributions in the field of artificial intelligence and education.

Research Implications – The impact of this research can open opportunities for researchers to further explore the combination of AIED, AI, and pedagogy topics so as to enrich and expand the scope of research and encourage progress in related disciplines.

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Introduction

Artificial Intelligence (AI) has rapidly developed in the era of Industry 4.0 and provides a strategic contribution to the education world. Several studies on AI in Education (AIED) express the lack of an educational-perspective AI study (Chen et al., 2017;Chen et al., 2020;Hinojo-Lucena et al., 2019;Zawacki-Richter et al., 2019). Education studies are crucial to carry out such that artificial intelligence experts obtain suggestions from education technology experts in application development thus a system can be implemented appropriately and optimally beneficial to support education development.

This is consistent with previous studies stating that a critical gap exists between what the AIEd technology can do and how the technology can truly be implemented in the real educational setting (Bates et al., 2020;Kabudi et al., 2021). Moreover, approaching the integration of artificial intelligence with education must be from a strong pedagogical approach; not only does the algorithm have to be right, but also the emotions and values that are appropriate are needed (Vázquez-Cano, 2021).

AIED brings new hope to the advancement of education; however, it raises concerns regarding data protection, emotion, and sustainability issues. The release of Chat GPT by Open AI creates the pros and cons for numerous parties, especially educators (Devi et al., 2022; Dwivedi et al., 2023; Zhang & Aslan, 2021). Although educators and students gain a new opportunity that simplifies their study and access to learning resources, it is likely to trigger a decrease in student's critical thinking (Eke, 2023; Zhai, 2023) due to inappropriate use of AI applications (Cooper, 2023; Tlili et al., 2023). Education experts need to provide solutions for the issue. Pedagogy is vital to study if we want to help educators and students as well as AI developers so that the developed system can be effectively applied.

AI transformation in education consists of three types, namely administrative task automation, smart content, and Intelligence Tutoring Systems (Tahiru, 2021). The three types require the identification of any pedagogical research that has been conducted. Summarizing global research trends and research hotspot is imperative for future research. So far, bibliometric studies that examine AI pedagogy in Education is limited. Therefore, it is important to carry out a bibliometric analysis to identify research opportunities in the domain.

Several previous studies conducted Luckin et al., (2016), Yang (2019), Zhang & Aslan (2021), and Lim et al., (2023) only delineate AIED studies in general. Meanwhile, some previous studies conducted by Yang (2019), Bates et al., (2020), Demir (2019), and Hocky & White (2022) also studied AIED which in their discussion there is a connection between AIED and pedagogy but in their discussion only briefly discussed, so that no study of the connection between AIED and pedagogy has been carried out directly and specifically. Referring to these studies, the novelty of the current research is to examine AIED more deeply in relation to AIED directly and specifically in the pedagogical aspect using the

Bibliometric approach method. This study aims to summarize studies on AIED from 2018 to 2023 through bibliometric analysis and analyze current study progress, key points, and trends in AIED, especially pedagogy. The results of this study are expected to be useful in assisting new research to better understand the development direction of AIED topic trend opportunities in the aspect of pedagogy.

Methods

The research used a bibliometric analysis method. The data were collected from the Scopus database using R Studio software with search keywords of "Artificial Intelligence, Education, and Pedagogy". Based on the Scopus database, 94 articles were found stored in the CSV and RIS formats. The articles were then analyzed using R Studio and VOSviewer software. Network analysis was carryout to enrich mapping science using clustering and visualization (Huang et al., 2022; Oyewola & Dada, 2022)

The hierarchical grouping was used to analyze grouping, whereas visualization analysis employed network visualization, overlay visualization, and density visualization (Nandiyanto & Al Husaeni, 2022; Nordin, 2022; Wirzal & Putra, 2022). Literature state that a bibliometric analysis requires five stages (Dhamija & Bag, 2020; Nurfauzan & Faizatunnisa, 2021; Setyaningsih et al., 2018) as illustrated in Figure 1.

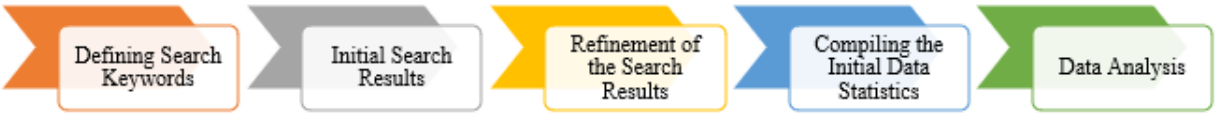

Figure 1. Five Stages of Bibliometric Analysis Method

Result

1. Defining Search Keyword

Keywords of "Artificial Intelligence, Education, and Pedagogy" were used to search literature in the Scopus database. The keyword selection was written on the sub-part of a document, which is a search document. The format of "article title, abstract, keywords" in the Scopus database was selected to identify more high-quality literature.

2. Initial Search Result & Refinement of the Search Result

In the initial search of the literature, the researchers determined that the range of the article publishing years was from 2019 to 2023. The initial search found 188 articles relevant to the keywords. Next, a screening process was carried out for articles that did not meet the criteria. The results of the data screening are presented in Table 1.

Table 1. Criteria of Screening

Search Screening	Number of Articles
Unidentified/citation link only/rejected website	27
Less than four pages	3
Not in English	2
Not open access	62
Total	94

The screening results indicate that of the 188 articles, 94 articles did not meet the criteria. Therefore, the 94 remaining articles that met the criteria were analyzed. The comparison of the data matrix before and after the screening is shown in Table 2.

Table 2. Comparison of Matrix Data

Matrix Data	Initial Search	Refinement Search
Source	Artificial Intelligence, Education, Pedagogy	Artificial Intelligence, Education, Pedagogy
Publication year	2019-2023	2019-2023
Paper	188	94
Citation	820	690
Cite/year	205.00	172.50
Author/paper	3.12	3.30
h-index	16	16
g-index	74	23
hI,norm	23	8
hI,annual	2.25	2.00
hA-index	12	11

Next, of the 94 articles it was identified that 10 articles had the most citations as indicated in Table 3.

Table 3. Top 10 Articles

Year	Author	Title	Publication	Cites
2022	Holmes, Wayne; Porayska-Pomsta, Kaska; Holstein, Ken; Sutherland, Emma; Baker, Toby; Shum, Simon Buckingham; Santos, Olga C; Rodrigo, Mercedes T.; Cukurova, Mutlu; Bittencourt, Ig Ibert; Koedinger, Kenneth R.	Ethics of AI in Education: Towards a Community-Wide Framework	International Journal of Artificial Intelligence in Education	48
2021	Cope, Bill; Kalantzis, Mary; Searsmith, Duane	Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies	Educational Philosophy and Theory	41

Year	Author	Title	Publication	Cites
2019	Vazhayil, Anu; Shetty, Radhika; Bhavani, Rao R.; Akshay, Nagarajan	Focusing on Teacher Education to Introduce AI in Schools: Perspectives and Illustrative Findings	Proceedings-IEEE 10th International Conference on Technology for Education, T4E 2019	32
2019	Lavrentieva, Olena O.; Rybalko, Lina M.; Tsys, Oleh O.	Theoretical and methodical aspects of the organization of students' independent study activities together with the use of ICT and tools	CEUR Workshop Proceedings	31
2022	Yang, Weipeng	Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation	Computers and Education: Artificial Intelligence	30
2021	Tedre, Matti; Toivonen, Tapani; Kahila, Juho; Vartiainen, Henriikka; Valtonen, Teemu; Jormanainen, Ilkka; Pears, Arnold	Teaching machine learning in K-12 Classroom: Pedagogical and technological trajectories for artificial intelligence education	IEEE Access	30
2021	Raji, Inioluwa Deborah; Scheuerman, Morgan Klaus; Amironesei, Razvan	"you can't sit with us": Exclusionary pedagogy in AI ethics education	FAccT 2021 - Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency	29
2019	du Boulay, Benedict	Escape from the Skinner Box: The case for contemporary intelligent learning environments	British Journal of Educational Technology	29
2019	Al Hashimi, Sama'a; Al Muwali, Ameena; Zaki, Yasmina; Mahdi, Nasser	The effectiveness of social media and multimedia-based pedagogy in enhancing creativity among art, design, and digital media students	International Journal of Emerging Technologies in Learning	27
2021	Nazari, Nabi; Shabbir, Muhammad Salman; Setiawan, Roy	Application of Artificial Intelligence powered digital writing assistant in higher education: a randomized controlled trial	Heliyon	24

3. Compiling the Initial Data Statistics

The initial data statistic from 94 articles stored in the CSV format was compiled and then analyzed using R Studio software. The results of the Biblioshyne analysis with R

Studio obtained a statistical result in the form of annual scientific production, most relevant sources, and most cited countries.

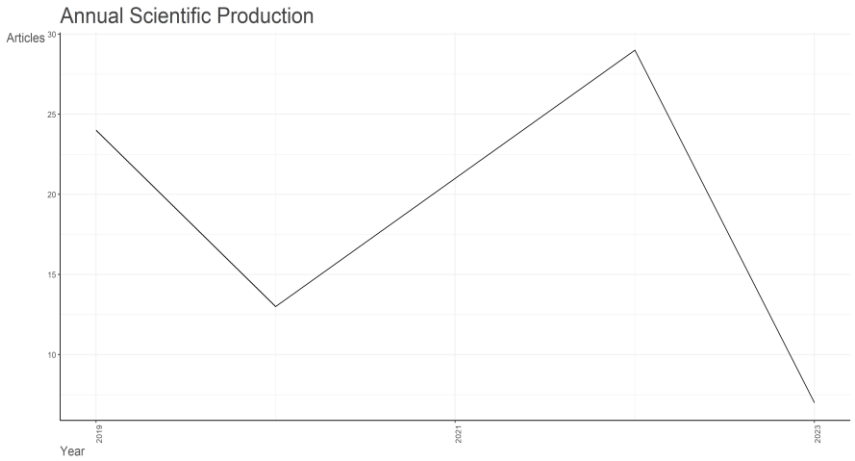

Figure 2. Annual Scientific Production

Fugure 2 shows that the publication trend related to AI and pedagogy fluctuated for the last 5 years and experienced an increase from the period of 2020 to 2022. In 2019, the number of article publications was 24 and it decreased to 13 articles in 2020. In 2021 the publication increased to 21 articles and 29 articles in 2022. In 2023, only 7 articles published so far. The result suggests that researches on AI and pedagogy have an opportunity to develop.

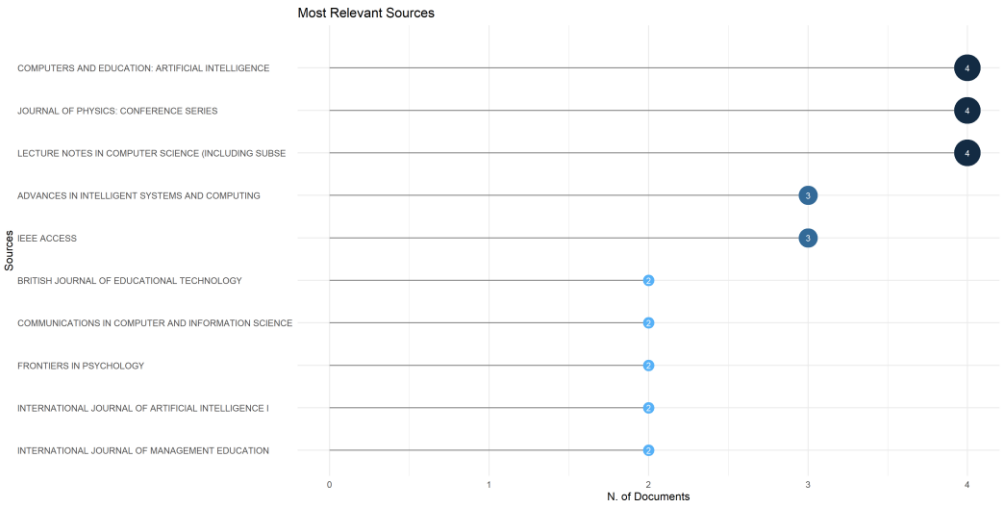

Figure 3. Most Relevant Sources

Figure 3 shows the 10 most relevant sources and the number of their published articles. The data indicates that Computer and Education Artificial Intelligence, Journal of Physics Conference Series, and Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) published 4 articles; Advances in Intelligent Systems and Computing and IEEE Access published 3 articles; British Journal of Educational Technology, Communications in Computer and

Information Science, Frontiers in Psychology, International Journal of Artificial Intelligence in Education, and International Journal of Management Education published 2 articles.

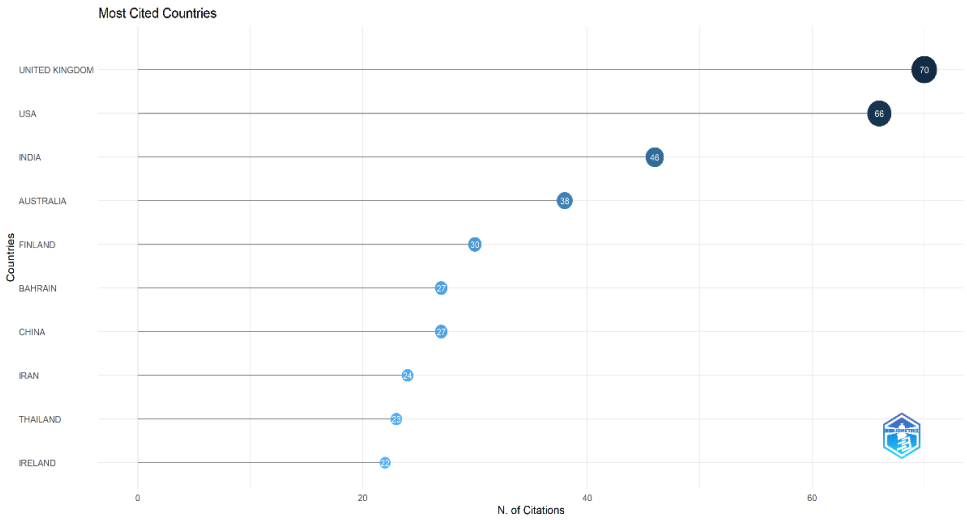

Figure 4. Most Cited Countries

Referring to Figure 4, the 10 countries with the most cited articles were the United Kingdom with 70 citations, the United States with 66 citations, India with 46 citations, Australia with 38 citations, Finland with 30 citations, Bahrain and China with 27 citations, Iran with 24 citations, Thailand with 23 citations, and Ireland with 22 citations. The data indicate that AI and pedagogy-related publications were mostly from these 10 countries.

3. Data Analysis

94 articles generated from the screening process were stored in the RIS format and analyzed using VOSviewer software. The software output can be seen in the display of the network visualization, overlay visualization, and density visualization.

Discussion

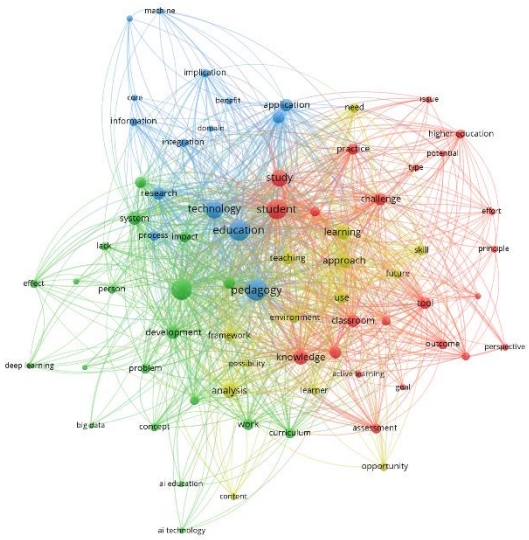

Figure 5. Network Visualization

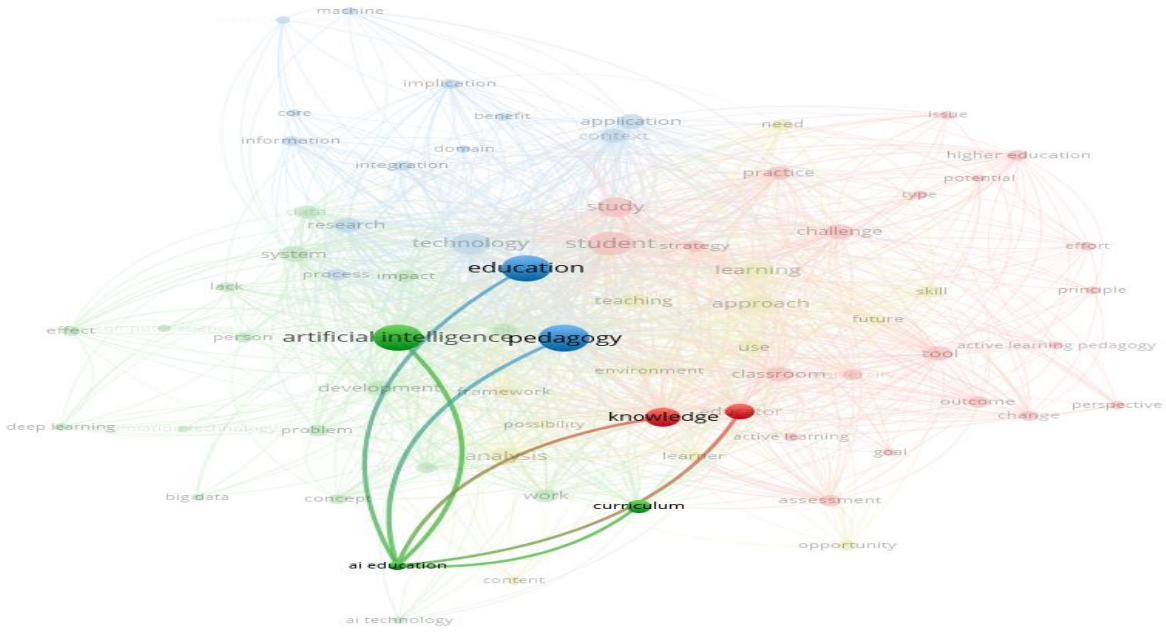

Figure 6. Network Visualization

Figure 5 presents 4 color clusters connected to 72 items. A keyword representing each cluster is presented in Table 4. Figure 6 illustrates the existence of a network of the AI education keyword against the Artificial Intelligence and Pedagogy keywords.

Table 4. Keywords that Represent Each Cluster

No	Cluster	Element
1	Cluster 1 (23 items)	Active learning, active learning pedagogy, assessment, challenge, classroom, educator, effort, goal, higher education, issue, knowledge, outcome, perspective, potential, practice, strategy, student, study, tool, type, university
2	Cluster 2 (20 items)	AI education, AI technology, artificial intelligence, big data, computer science, concept, curriculum, data, deep learning, development, effect, impact, implementation, information technology, lack, person, problem, role, system, work
3	Cluster 3 (15 items)	Application, benefit, context, core, domain, education. Implication, integration, machine, machine learning, pedagogy, process, research, technology
4	Cluster 4 (14 items)	Analysis, approach, content, environment, framework, future, learner, learning, need, opportunity, possibility, skill, teaching, use

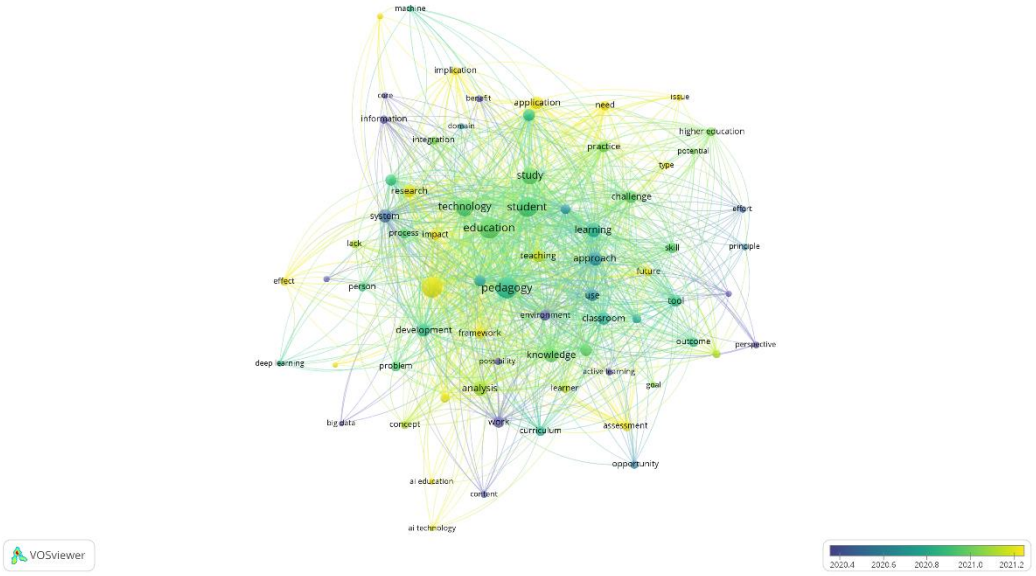

Figure 7. Overlay Visualization

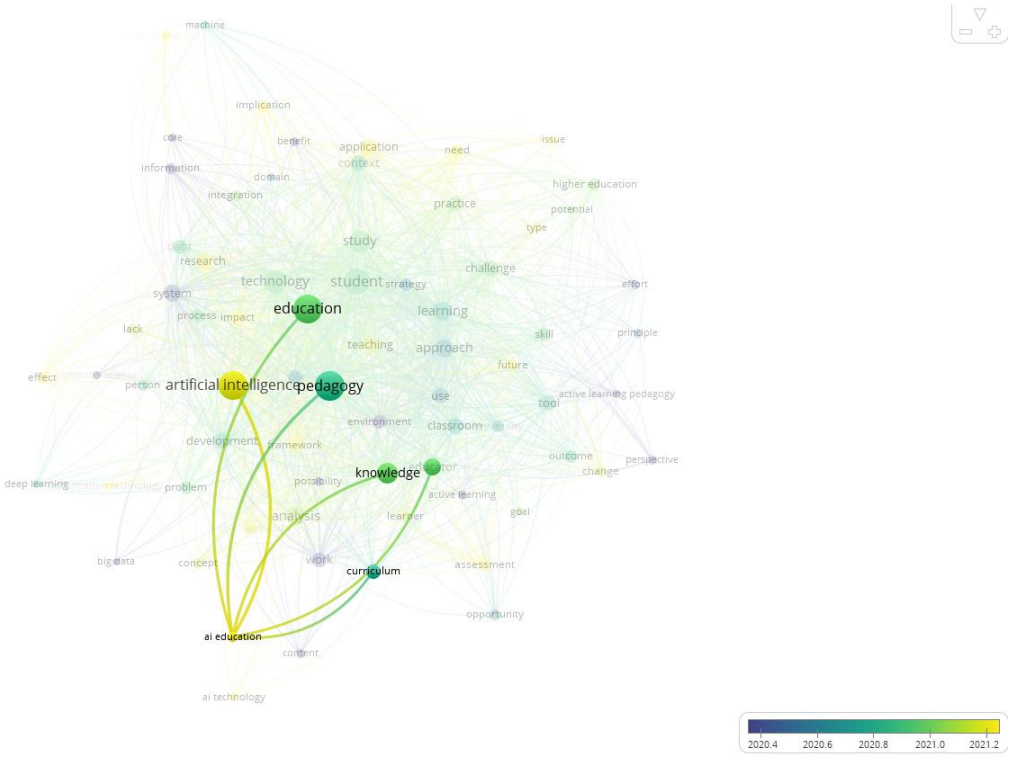

Figure 8. Overlay Visualization AI Education and Pedagogy

Figure 7 indicates several old and current research topics in artificial intelligence research. The results of VOSveiwer analysis suggest that when connecting artificial intelligence research to several topics it showed that it recently gained attention for research. This illustrates in figure 8 which indicates a trend for research when connecting AI Education topic to Artificial Intelligence and Pedagogical topics. Therefore, AI Education and Artificial Intelligence topics had yellow color suggesting article publication on the topics in 2021 quarter 1, whereas pedagogical topic has a bright green color suggesting

article publication on the topic in 2021 quarter 2. The brighter the year color in the overlay visualization, the more recent the research publication is (Finandhita et al., 2022; Indriyanti et al., 2023; Komarudin et al., 2023; Luckyardi et al., 2022; Soegoto et al., 2022). It affirms that the popularity of AI Education, Artificial Intelligence, and Pedagogical topics is an opportunity for researchers to study the topics in the future.

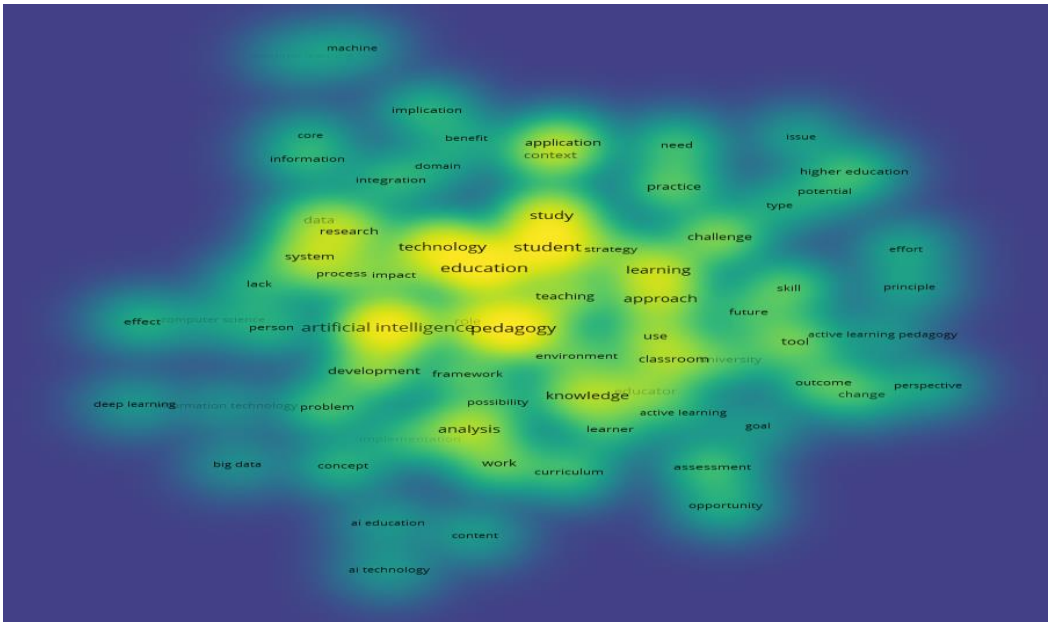

Figure 9. Density Visualization

Figure 9 shows that the dimmer the color, the less frequently the topics are researched (Al Husaeni & Nandiyanto, 2021; Sarman & Soebagyo, 2022; Ginting, 2023; Lesmana & Rifaldi, 2023; Nurfaiziya et al., 2023; Ria & Susilowati, 2023). AI Education topic has a dim color, whereas Artificial Intelligent and Pedagogical topics have a bright color. Therefore, topics that are rarely researched can be correlated with topics that have been widely researched to obtain updates in the research, which means an opportunity for updated research by taking on these topics.

Referring to the discussion on the output of network visualization, overlay visualization and density visualization, this study identified the popularity of AIED, AI and Pedagogy topics as significant opportunities for researchers to further explore these three topics in the future. Based on the visualization analysis of research trends, the findings of this study suggest that although AI and Pedagogy topics are more frequently researched, incorporating AIED topics that are less frequently researched can result in innovative updates in research. Therefore, these under-researched AIED topics can become the foundation for renewed research and have great potential to make important contributions to the field of artificial intelligence and education. Thus, the combination of AIED, AI, and pedagogy topics can be an opportunity for researchers to conduct renewed research by further examining all three topics.

Conclusion

Based on the results and discussion, this study successfully summarized and analyzed the development, key points, and trends of AIED research from 2018 to 2023 through bibliometric analysis. The finding of this research is that combining more frequently researched AI and pedagogy topics with less researched AIED topics can produce innovative updates and make important contributions in the field of artificial intelligence and education. The implication of this research is that it helps new research to better understand the direction of development of AIED topic trend opportunities in the aspect of pedagogy. In addition, the impact of this research can open opportunities for researchers to further explore the combination of AIED, AI, and pedagogy topics so as to enrich and expand the scope of research and encourage progress in related disciplines. Moreover, research related to the collaboration of AI topics in education and pedagogy is still limited. This leads to the need to increase the focus of research on AI in education that pays attention to pedagogical aspects. Therefore, the suggestion for future researchers is to conduct research on the application of AI in the pedagogical aspect in the scope of education.

References

Al Husaeni, D. F., & Nandiyanto, A. B. D. (2021). Bibliometric Using Vosviewer with Publish or Perish (using Google Scholar data): From Step-by-step Processing for Users to the Practical Examples in the Analysis of Digital Learning Articles in Pre and Post Covid-19 Pandemic. *ASEAN Journal of Science and Engineering*, *2*(1), 19–46. https://doi.org/10.17509/ajse.v2i1.37368

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education? *International Journal of Educational Technology in Higher Education*, *17*(1). https://doi.org/10.1186/s41239-020-00218-x

Chen, P., Liu, X., Cheng, W., & Huang, R. (2017). A review of using Augmented Reality in Education from 2011 to 2016. *Innovations in Smart Learning*. https://doi.org/DOI 10.1007/978-981-10-2419-1_2

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *1*, 100002. https://doi.org/10.1016/j.caeai.2020.100002

Cooper, G. (2023). Examining Science Education in ChatGPT: An Exploratory Study of Generative Artificial Intelligence. *Journal of Science Education and Technology*, *32*(3), 444–452. https://doi.org/10.1007/s10956-023-10039-y

Demir, Ü. (2019). The effect of using negative knowledge based intelligent tutoring system evaluator software to the academic success in English language education. *Pedagogies: An International Journal*.

Devi, J. S., Sreedhar, B., Arulprakash, P., Kazi, K., & Radhakrishnan, R. (2022). A Path

Towards Child-Centric Artificial Intelligence based Education. *International Journal of Early Childhood Special Education (INT-JECS)*, *14*(03).

Dhamija, P., & Bag, S. (2020). Role of artificial intelligence in operations environment: a review and bibliometric analysis. *The TQM Journal*, *32*(4), 869–896. https://doi.org/10.1108/TQM-10-2019-0243

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., & Kar, A. K. (2023). So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, *71*.

Eke, D. O. (2023). ChatGPT and the rise of generative AI: Threat to academic integrity? *Journal of Responsible Technology*, *13*.

Finandhita, A., Mega, R. U., Jumansyah, R., Rafdhi, A. A., & Oktafiani, D. (2022). VOSviewer Application Analysis: Computational Physical Chemistry Case Study. *Moroccan Journal of Chemistry*, *10*(1), 91–101. https://doi.org/10.48317/IMIST.PRSM/morjchem-v10i1.31756

Ginting, S. L. B. (2023). A Computational Bibliometric Analysis of Esport Management using VOSviewer. *International Journal of Informatics , Information System and Computer Engineering*, *4*(1), 31–48.

Hinojo-Lucena, F. J., Aznar-Díaz, I., Cáceres-Reche, M. P., & Romero-Rodríguez, J. M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. *Education Sciences*, *9*(51), 1–9. https://doi.org/10.3390/educsci9010051

Hocky, G. M., & White, A. D. (2022). Natural language processing models that automate programming will transform chemistry research and teaching. *Digital Discovery*, *1*(2), 79–83. https://doi.org/10.1039/d1dd00009h

Huang, Y. J., Cheng, S., Yang, F. Q., & Chen, C. (2022). Analysis and Visualization of Research on Resilient Cities and Communities Based on VOSviewer. *International Journal of Environmental Research and Public Health*, *19*(7068). https://doi.org/10.3390/ijerph19127068

Indriyanti, F., Fauziah, T. N., & Nuryadin, A. (2023). Analisis bibliometrik penggunaan video pembelajaran di sekolah dasar tahun 2013-2022 menggunakan aplikasi vosviewer. *Jurnal Educatio*, *9*(1), 23–31. https://doi.org/10.31949/educatio.v9i1.3906

Kabudi, T., Pappas, I., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: A systematic mapping of the literature. *Computers and Education: Artificial Intelligence*, *2*, 100017. https://doi.org/10.1016/j.caeai.2021.100017

Komarudin, P., Sodiki, M., Toyyibah, I. A., Syahrani, S., & Zakiyah, Z. (2023). Bibliometric Mapping of Research Developments Using Qardh Financing Topics On Google Scholar Using Vosviewer. *Islamic Banking: Jurnal Pemikiran Dan Pengembangan Perbankan Syariah*, *8*(2), 275–302. https://doi.org/10.36908/isbank.v8i2.716

Lesmana, R., & Rifaldi, M. I. (2023). A Computational Bibliometric Analysis of E-Groceries

Analysis Using VOSviewer. *International Journal of Informatics, Information System and Computer Engineering*, *4*(1), 75–88.

Lim, W. M., Gunasekara, A., Pallant, J. L., Pallant, J. I., & Pechenkina, E. (2023). Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators. *International Journal of Management Education*, *21*(2), 100790. https://doi.org/10.1016/j.ijme.2023.100790

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence Unleashed: An argument for AI in education. In *Pearson Education*. https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/about-pearson/innovation/Intelligence-Unleashed-Publication.pdf

Luckyardi, S., Hurriyati, R., Disman, D., & Dirgantari, P. D. (2022). The Influence of Applying Green Marketing Mix by Chemical Industries; VOSviewer Analysis. *Moroccan Journal of Chemistry*, *10*(1), 73–90. https://doi.org/10.48317/IMIST.PRSM/morjchem-v10i1.31754

Nandiyanto, A. B. D., & Al Husaeni, D. F. (2022). Bibliometric Analysis of Engineering Research Using Vosviewer Indexed By Google Scholar. *Journal of Engineering Science and Technology*, *17*(2), 883–894.

Nordin, N. A. H. M. (2022). A Bibliometric Analysis of Computational Mapping on Publishing Teaching Science Engineering Using VOSviewer Application and Correlation. *Indonesian Journal of Teaching in Science*, *2*(2), 127–138.

Nurfaiziya, S., Munajat, E., & Nurasa, H. (2023). Study literature review (SLR) artikel kebijakan ketahanan air di database scopus dalam matriks analisis dan visulisasi vosviewer. *Jurnal Ilmu Sosial Dan Pendidikan (JISIP)*, *7*(1). https://doi.org/10.58258/jisip.v7i1.4471/http

Nurfauzan, M. iqbal, & Faizatunnisa, H. (2021). Analisis Bibliometrik Trend Penelitian Covid-19 di Indonesia Pada Bidang Bisnis dan Manajemen. *Jurnal Bisnis Strategi*, *30*(2), 90–100. https://doi.org/10.14710/jbs.30.2.90-100

Oyewola, D. O., & Dada, E. G. (2022). Exploring machine learning: a scientometrics approach using bibliometrix and VOSviewer. *SN Applied Sciences*, *4*(143). https://doi.org/10.1007/s42452-022-05027-7

Ria, R. R. P., & Susilowati, D. (2023). Local wisdom-based computational thinking diagnostic test: A bibliometric analysis mapping state-of-the-art and research gaps. *Nusantara: Jurnal Pendidikan Indonesia*, *3*(3), 371–394. https://doi.org/10.14421/njpi.2023.v3i3-2

Sarman, S. N., & Soebagyo, J. (2022). Analisis bibliometrik terhadap kemampuan berpikir kritis matematika berdasarkan pemecahan masalah berbasis vosviewer. *Vygotsky: Jurnal Pendidikan Matematika Dan Matematika*, *4*(2), 117–128.

Setyaningsih, I., Indarti, N., & Jie, F. (2018). Bibliometric analysis of the term "green manufacturing." *International Journal of Management Concepts and Philosophy*, *11*(3), 315–339. https://doi.org/10.1504/ijmcp.2018.093500

Soegoto, E. S., Luckyardi, S., Rafdhi, A. A., & Oktafiani, D. (2022). Computational Analysis of Waste Management and Entrepreneur using VosViewer application. *Moroccan Journal of Chemistry*, *10*(3), 542–552. https://doi.org/10.48317/IMIST.PRSM/morjchem-v10i3.33142

Tahiru, F. (2021). AI in Education: A Systematic Literature Review. *Journal of Cases on Information Technology*, *23*(1).

Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00237-x

Vázquez-Cano, E. (2021). Artificial intelligence and education: A pedagogical challenge for the 21st century. *Educational Process: International Journal*, *10*(3), 7–12. https://doi.org/10.22521/EDUPIJ.2021.103.1

Wirzal, M. D. H., & Putra, Z. A. (2022). What is the correlation between chemical engineering and special needs education from the perspective of bibliometric analysis using vosviewer indexed by google scholar? . *Indonesian Journal of Community and Special Needs Education*, *2*(2), 103–110.

Yang, X. (2019). Accelerated Move for AI Education in China. *ECNU Review of Education*, *2*(3), 347–352. https://doi.org/10.1177/2096531119878590

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(39), 1–27. https://doi.org/10.1186/s41239-019-0171-0

Zhai, X. (2023). ChatGPT and AI: The Game Changer for Education. *AI4STEM Education Center*, 1–5. https://ssrn.com/abstract=4389098

Zhang, K., & Aslan, A. B. (2021). AI technologies for education: Recent research & future directions. *Computers and Education: Artificial Intelligence*, *2*, 100025. https://doi.org/10.1016/j.caeai.2021.100025