International Journal of Evaluation and Research in Education (IJERE)
Vol. 14, No. 6, December 2025, pp. 4567~4579
ISSN: 2252-8822, DOI: 10.11591/ijere.v14i6.34519

Mapping research trends in innovative pedagogies: a bibliometric analysis

Nurul Eeffah Awang, Hafizhah Zulkifli, Mohd Isa Hamzah
Faculty of Education, National University of Malaysia, Bangi, Malaysia

Article Info

Article history:

Received Jan 7, 2025
Revised Jul 14, 2025
Accepted Sep 30, 2025

Keywords:

Bibliometric analysis
Educational trends
Innovative pedagogy
Technology integration
VOSviewer visualization

ABSTRACT

This study examines global research trends in innovative pedagogy through a bibliometric analysis of 901 Scopus-indexed publications from 2022 to 2024. Despite the growing importance of innovative pedagogy in modern education, a systematic evaluation of its research landscape is still limited. This study bridges this gap by analyzing key trends, including influential works, authors, citation networks, and emerging themes. Using VOSviewer for data visualization, the findings reveal a growing research focus on AI-driven learning, immersive technologies, and problem-based methodologies. The analysis highlights the social sciences as the dominant field (45.3%), with increasing contributions from computer science and engineering. The United States, Australia, China, and India emerge as leading contributors, while developing regions show an increasing presence in pedagogical innovation. Research indicates a shift towards digital and experiential learning environments, yet challenges such as digital accessibility, equity, and ethical concerns persist. The study underscores the importance of interdisciplinary collaboration and policy interventions to tackle these challenges. By providing a comprehensive overview of the research landscape, this study serves as a roadmap for educators, policymakers, and researchers to promote sustainable and inclusive advancements in innovative pedagogy.

This is an open access article under the CC BY-SA license.

Corresponding Author:

Hafizhah Zulkifli
Faculty of Education, National University of Malaysia
Bangi, Malaysia
Email: hafizhah_zulkifli@ukm.edu.my

1. INTRODUCTION

Innovative pedagogy represents a significant shift in educational practices, focusing on dynamic, student-centered approaches, technology integration, and interdisciplinary strategies to meet the evolving needs of modern learners [1]–[5]. Traditional teaching methods are increasingly being replaced by active learning models such as flipped classrooms, problem-based learning (PBL), and gamification, which have demonstrated their effectiveness in improving student engagement, critical thinking, and knowledge retention. Bhuttah *et al.* [1] emphasized how inclusive leadership amplifies the impact of these pedagogical practices, while Wu *et al.* [2] highlighted gamification's role in fostering deeper student connections to learning materials. The rapid advancement of digital technologies and the growing emphasis on personalized learning experiences have further accelerated the shift toward innovative pedagogical models, making them a crucial area of academic inquiry and practical implementation.

Beyond technology integration, innovative pedagogy redefines the roles of educators and learners, fostering adaptability and inclusivity. Research has shown that technology-enhanced teaching methods, such as AI-driven personalized feedback systems, virtual learning environments, and digital storytelling,

contribute to improved learning outcomes and greater accessibility for diverse learners. Digital storytelling, as illustrated by Khoo *et al.* [3], promotes cultural competency and reflective teaching, particularly in multicultural contexts. Similarly, Han and Li [4] showcased the use of artificial intelligence (AI) tools like ChatGPT to personalize feedback and enhance teacher-student interactions. These practices exemplify the shift toward collaborative, inclusive learning environments that emphasize critical skills such as creativity, collaboration, and cultural awareness. These strategies enhance the educational experience and facilitate lifelong learning and social advancement, ensuring that learners are prepared to navigate a globalized and linked world.

Despite the promising benefits, the widespread adoption of innovative pedagogies requires systemic efforts, particularly in the areas of teacher training, curriculum development, and implementation of policy. The adoption of innovative pedagogy requires systemic efforts, particularly in teacher training, to address challenges like technological accessibility and ethical considerations. Educators must be equipped with the necessary digital competencies and pedagogical expertise to effectively integrate emerging technologies into their teaching practices. Emphasizing digital literacy, creative instructional design, and adaptability, educators can transform traditional classrooms into vibrant, student-centered environments. Kolb's experiential learning theory [5] and the use of innovative learning environments [6] are two examples of research that shows how important open, hands-on models are for improving cognitive and social growth. By embracing these strategies, education systems can empower learners to address global challenges with resilience and ingenuity, fostering sustainable, inclusive, and impactful learning experiences.

Innovative pedagogy represents a transformative shift in educational research, integrating student-centered strategies, interdisciplinary approaches, and technological advancements to enhance learning outcomes. While prior studies have explored various aspects of innovative pedagogy, a comprehensive bibliometric analysis that systematically maps global research trends remains limited. This study aims to bridge this gap by conducting an extensive bibliometric analysis of 901 Scopus-indexed publications (2022–2024), uncovering dominant research themes, influential contributions, and emerging patterns. Unlike previous works that focus on qualitative reviews or small-scale empirical studies, our approach offers a quantitative and data-driven perspective, revealing new intellectual structures in the field. Scopus was chosen as the primary database for this study due to its comprehensive coverage of peer-reviewed literature, ensuring high-quality and credible academic sources. A study by Jeroen *et al.* [7] affirmed that Scopus is a curated, high-quality bibliometric data source, specifically designed to support robust and reliable quantitative analysis in academic research. Additionally, Moed *et al.* [8] highlighted that Scopus's citation tracking features make it particularly valuable for bibliometric studies, ensuring that researchers can systematically analyze high-impact studies in their field. Scopus provides a robust platform for bibliometric analysis, enabling the identification of emerging research trends, influential authors, and key thematic areas in innovative pedagogy. Its advanced citation metrics and visualization tools, such as VOSviewer integration, allow for precise mapping of intellectual structures, collaboration networks, and keyword distributions, making it an ideal choice for this study. To determine the trend in innovative pedagogy, the following research questions are proposed:

- Q1: What is the distribution of document types per source in the field of innovative pedagogy?
- Q2: Who are the most influential authors contributing to research on innovative pedagogy?
- Q3: What are the most frequently cited documents by subject area in innovative pedagogy?
- Q4: Who are the top 10 authors based on citation metrics in the field of innovative pedagogy?
- Q5: What are the most prevalent keywords associated with research on innovative pedagogy?
- Q6: What are the dominant countries contributing to global research on innovative pedagogy?

2. LITERATURE REVIEW

The concept of innovative pedagogy reflects an ongoing transformation in educational strategies, emphasizing creativity, inclusivity, and adaptability to meet the needs of diverse learners and evolving societal demands. A significant trend in recent research involves integrating digital technologies into pedagogical practices. Scholars and educators have explored various models that challenge traditional teacher-centered approaches, favoring active learning strategies such as flipped classrooms, gamification, and PBL. These approaches emphasize student engagement, critical thinking, and the development of 21st-century skills, which are essential for preparing learners to navigate complex, technology-driven societies [9], [10]. The integration of AI, augmented reality (AR), and adaptive learning technologies into educational settings has further revolutionized instructional practices, enhancing personalization, accessibility, and knowledge retention [11].

A critical trend in innovative pedagogy is the integration of digital learning technologies, which have been widely adopted across educational institutions worldwide. The technological pedagogical content knowledge (TPACK) framework, developed by Schmid *et al.* [12] provides a foundation for understanding how technology, pedagogy, and subject content interact to create effective teaching strategies. Recent studies highlight that teachers who possess strong digital pedagogical skills can significantly enhance student learning outcomes [12]. Platforms such as Google Classroom, Edmodo, and Moodle have become essential tools for delivering blended learning experiences, enabling educators to create interactive, student-centered environments [13]. Furthermore, the adoption of learning analytics and AI-driven feedback systems allows for real-time assessment and personalized learning pathways, ensuring that students receive targeted support based on their progress [14].

The flipped classroom model has gained traction as a highly effective student-centered approach, where traditional lecture-based instruction is replaced by pre-class video lectures and in-class active learning activities. Research by Mokhele-Ramulumo *et al.* [6] found that flipped classrooms in secondary physical science education resulted in higher student engagement and improved conceptual understanding. However, implementation challenges remain, particularly in regions with limited technological access and socio-economic disparities [15]. Studies also suggest that while flipped learning fosters independent learning habits, it requires significant preparation from educators and a structured support system to ensure equitable access to learning materials [16]. The role of the digital divide in flipped learning implementation is a critical factor that must be addressed through institutional support and policy interventions [17].

Gamification and AI applications in education have also gained prominence, offering engaging, interactive learning experiences that promote student motivation and knowledge retention. Research by Freeman *et al.* [18] demonstrated that gamified nursing simulations significantly improved students' confidence, clinical reasoning skills, and engagement. Similarly, Zhang [19] compared cooperative and competitive gamification models in language learning, finding that collaborative gamification strategies foster a more inclusive and enjoyable learning environment. The growing use of AI-driven adaptive learning systems, such as ChatGPT and intelligent tutoring systems, has further transformed education by enabling personalized feedback, automated assessment, and predictive analytics for student performance [4]. However, concerns regarding data privacy, bias in AI algorithms, and the ethical implications of AI-driven assessments require careful consideration and regulation [20].

The role of PBL and experiential learning has also been extensively studied, particularly in medical and engineering education. Research by Papakostas *et al.* [21] highlights that AR and virtual simulations provide immersive learning experiences, allowing students to develop practical skills in a risk-free environment. Anatomy education, for instance, has benefitted from interactive 3D modeling tools, which enhance spatial understanding and diagnostic reasoning [22]. Similarly, AR-based welding simulators in engineering training have demonstrated higher user engagement and skill acquisition compared to traditional instructional methods [23]. These findings suggest that experiential learning, when integrated with innovative pedagogies, significantly enhances knowledge application and skill mastery across various disciplines.

Previous studies have extensively documented pedagogical innovations, including flipped classrooms [24], gamification [25], and AI [26]. However, literature lacks systematic evaluation of research trends, citation networks, and global research collaborations in this field. This study contributes to filling this gap by providing a bibliometric perspective that quantitatively assesses research impact. Unlike traditional systematic reviews that synthesize findings qualitatively, our approach reveals underlying research structures through co-citation analysis and keyword mapping. Moreover, prior works have primarily focused on case studies within specific geographical or disciplinary contexts (e.g., North America, Europe). Our findings highlight a growing global engagement in pedagogical innovation, particularly in developing regions such as India, China, and Malaysia. This trend underscores the increasing democratization of educational research, which previous studies have not adequately addressed.

3. METHOD

This study adopts bibliometrics as a powerful tool for collecting, organizing, and analyzing bibliographic data from scientific publications [7], [27]. The methodology incorporates both basic descriptive metrics—such as publishing journals, publication years, and primary author classifications—and advanced techniques like document co-citation analysis [28]. Relevant keywords were systematically identified, and a comprehensive literature search was performed, emphasizing high-impact publications to uncover theoretical frameworks shaping the field [29].

Data collection was conducted using the Scopus database, chosen for its extensive and reliable coverage of peer-reviewed academic journal articles published between January 2022 and December 2024 [30]–[32]. Non-journal sources such as books and lecture notes were excluded to maintain quality standards [33]. Quantitative bibliometric indicators and network analysis methods underpinned the study, including

tracking publication trends, citation and co-citation analyses, keyword co-occurrence analysis, and collaboration network analysis to explore international research patterns.

These analyses were conducted using VOSviewer software, which enabled the visualization of bibliometric networks for a comprehensive examination of the data. Although offering an in-depth overview, the study acknowledges limitations, such as reliance on a single database and exclusion of non-journal publications. Ethical considerations were addressed by exclusively using publicly available bibliometric data. To guide the research flow—from identification to source selection and screening—we applied the preferred reporting items for systematic reviews and meta-analyses (PRISMA) model [34], [35]. Through this rigorous bibliometric approach, the study aims to deliver a data-driven understanding of current trends, highlight influential contributions and scholars, and suggest future research directions in the rapidly evolving field of innovative pedagogy.

3.1. Data search strategy

The study utilized an iterative screening process to refine search terms for retrieving relevant articles. Initially, a query was performed on the Scopus database using the search string "innovative" AND "pedagogy," which yielded 5,029 articles. The search was further refined using additional criteria, including publication years 2022–2024, resulting in a reduced set of 1,612 articles. These papers underwent detailed examination, with reviews excluded and only English-language research articles considered. Following this refinement, 901 articles were selected for bibliometric analysis. By December 2024, all pertinent articles on innovative pedagogy had been collected from the Scopus database for inclusion in the study. The search was limited to 2022–2024, ensuring relevance to contemporary research. Only English-language articles were considered, and peer-reviewed journal articles were included, excluding books, conference proceedings, and non-academic sources to maintain quality standards. This process is illustrated in Figure 1.

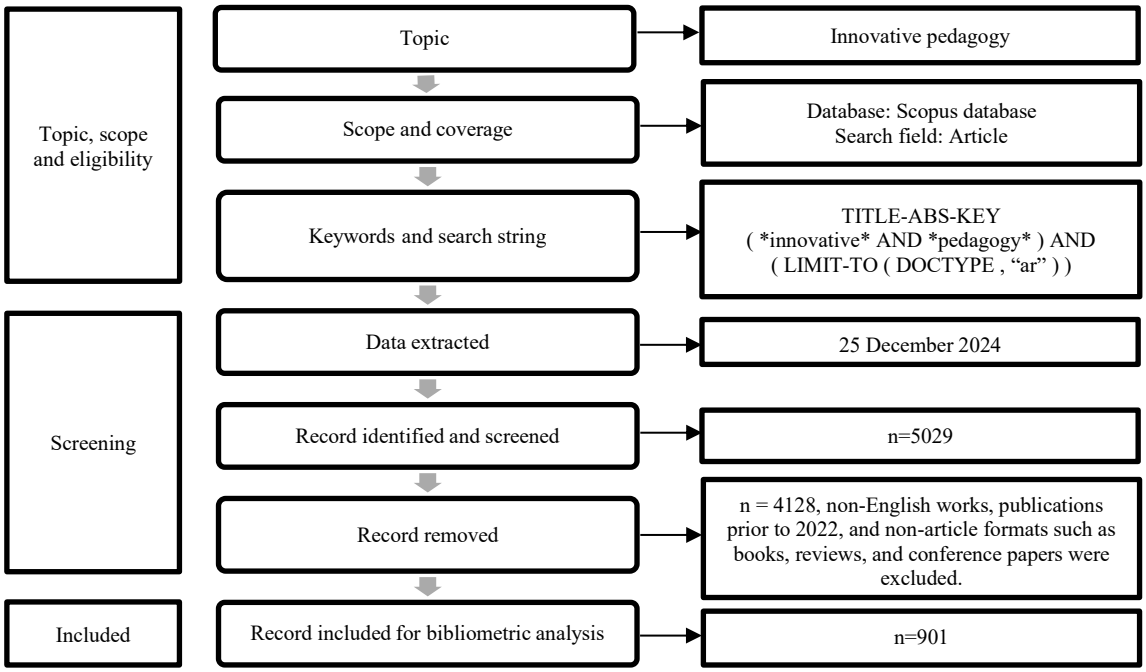

Figure 1. PRISMA diagram

3.2. Data analysis

VOSviewer is an intuitive bibliometric software developed at Leiden University [36], [37]. Renowned for its application in visualizing and analyzing scientific literature, the software specializes in generating network visualizations, clustering related entities, and creating density maps. It supports the exploration of co-authorship, co-citation, and keyword co-occurrence networks, enabling researchers to comprehensively understand research landscapes. Its interactive interface and regular updates facilitate efficient analysis of large datasets. VOSviewer's capabilities include calculating metrics, customizing visualizations, and compatibility with diverse bibliometric data sources, making it an invaluable tool for scholars investigating complex research domains.

One of VOSviewer's key strengths is its ability to convert complex bibliometric datasets into easily interpretable visual maps and charts. Focused on network visualization, the software excels in clustering related elements, analyzing keyword co-occurrence, and producing density maps. Researchers, whether novices or experts, benefit from its user-friendly interface to efficiently explore research fields. Continuous development ensures VOSviewer stays at the forefront of bibliometric tools, offering advanced insights through metrics computation and flexible visualizations. Its adaptability to data types like co-authorship and citation networks underscores its importance as a versatile tool for deeper scholarly insights.

Datasets containing publication year, title, author names, journal, citations, and keywords in PlainText format were sourced from the Scopus database, covering the period from January 2022 to December 2024. These datasets were analyzed using VOSviewer version 1.6.19. By employing VOS clustering and mapping techniques, the software facilitated the analysis and creation of maps. Unlike the multidimensional scaling (MDS) approach, VOSviewer places items in low-dimensional spaces such that their proximity reflects relatedness and similarity [37]. While similar to MDS in concept [37], VOSviewer diverges by using association strength (ASij) for normalizing co-occurrence frequencies, calculated as [38]:

$$AS_{ij} = \frac{c_{ij}}{w_i w_j}$$

As explained by van Eck and Waltman [38], this index compares the observed co-occurrences of items *ii* and *jj* to their expected co-occurrences under statistical independence. This normalization enables VOSviewer to position items on a map by minimizing the weighted sum of squared distances between all item pairs. LinLog/modularity normalization [39] further supports visualization techniques, enabling analyses like keyword co-occurrence, citation, and co-citation analysis.

Keyword co-occurrence analysis is valuable for tracing the evolution of research fields and identifying key topics across domains [32], [40]. Additionally, citation analysis, as highlighted by Allahverdiyev *et al.* [41] helps uncover critical research questions, trends, and methodologies, providing historical perspective into a discipline's focus. Document co-citation analysis, a staple in bibliometric studies [29], [39], [42], utilizes network theory to map the structural relationships within data [42].

4. RESULTS

The results of the bibliometric analysis are categorized into various dimensions, including document types, source types, publication trends, authorship patterns, keyword analysis, and citation impact. These findings provide significant understanding into the evolution of research in innovative pedagogy, highlighting key contributors, influential publications, and global research trends. The study presents both statistical metrics and visualization tools, such as frequency, percentage, graphical representations, and visualization maps, to illustrate the findings effectively.

4.1. Document and source type

Figure 2 presents the distribution of document types published between 2022 and 2024 across selected journals relevant to innovative pedagogy across five key journals: "Education Sciences", "Sustainability Switzerland", "Frontiers in Education", "Journal of Engineering Education Transformations", and "Education and Information Technologies." Education Sciences maintained a steady contribution with 6-7 documents annually, accounting for 20 to 24% of the total publications each year. Sustainability Switzerland showed the most notable growth, starting with 2 documents in 2022 (7%), increasing to 4 in 2023 (13%), and surging to 8 documents in 2024 (27%), reflecting the rising academic focus on sustainability topics. In contrast, Frontiers in Education experienced fluctuations, peaking at 8 documents in 2023 (27%) but declining to 3 in 2024 (10%), suggesting periodic bursts of activity driven by specific themes or projects.

Meanwhile, the Journal of Engineering Education Transformations maintained consistent yet modest contributions, publishing 4 documents annually, consistently accounting for about 13% of the total output. Education and Information Technologies showed a declining trend, with 6 documents in 2022 (20%), 5 in 2023 (17%), and only 2 in 2024 (7%), indicating a possible shift in its thematic focus. Overall, the data highlights evolving priorities in academic publishing, with significant growth in sustainability-focused research, steady contributions from education-focused journals, and fluctuating or declining outputs in others. These trends are crucial for understanding the dynamic nature of research dissemination and identifying key journals for future contributions.

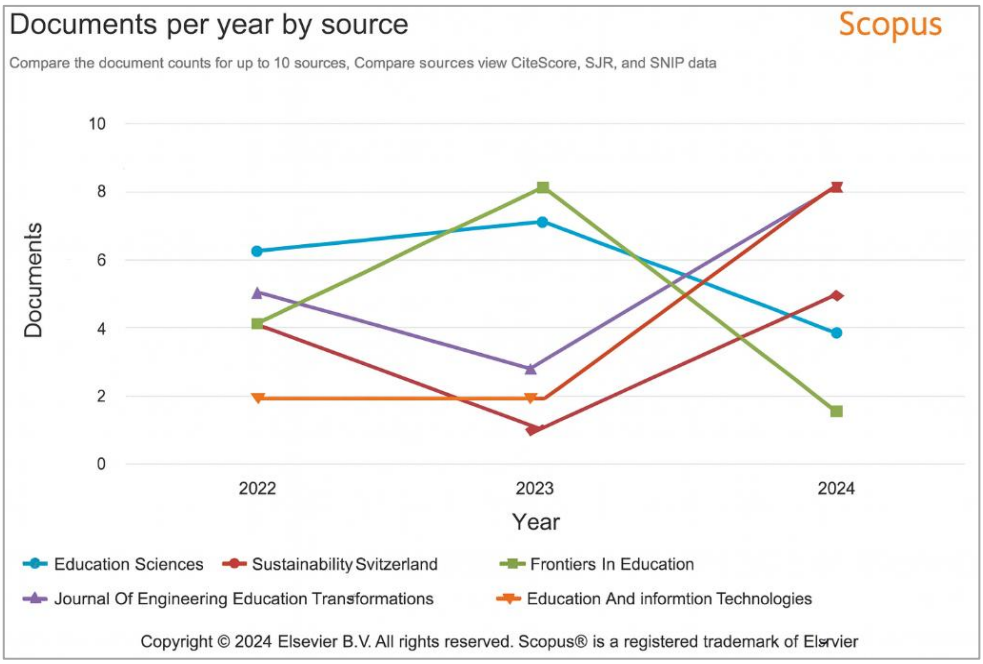

Figure 2. Document type

4.2. Authorship analysis

The figure showcases the distribution of documents by author, highlighting the top contributors to the analyzed research field based on Scopus data. Baek, S. and Dyson, B. are the leading contributors, each with 4 documents, demonstrating a significant engagement in this area of study. Their high output likely reflects consistent focus and expertise in the subject matter, positioning them as influential figures in the field. Following closely are Howley, D., Anitha, D., and Charteris, J., each contributing 3 documents, showcasing their active involvement and notable impact. These authors form a critical core group driving academic discourse in this research area, as indicated by their prominent presence in the analysis.

Other contributors, including Fowler, J., Hickey, A., Olelewe, C.J., Shen, Y., and Athanases, S.Z., have each authored 2 documents, reflecting a moderate but consistent contribution. The range of document counts highlights a balanced mix of prolific authors and moderately active contributors, demonstrating the diverse authorship landscape in the field. These insights emphasize the collaborative and distributed nature of research in this area while identifying key authors whose work has shaped its development. This analysis provides valuable guidance for researchers seeking to collaborate or understand the influential voices within the domain. Table 1 details the most prolific authors in the field of innovative pedagogy.

Table 1. Number of authors per document

Author name	Number of document	Percentages (%)
Baek, S.	4	0.44
Dyson, B.	4	0.44
Howley, D.	3	0.33
Anitha, D.	3	0.33
Charteris, J.	3	0.33
Fowler, J.	2	0.22
Hickey, A.	2	0.22
Olelewe, C. J.	2	0.22
Shen, Y.	2	0.22
Athanases, S. Z.	2	0.22

4.3. Subject area

The Scopus analyzer chart showcases the distribution of documents across different subject areas, with social sciences leading at 45.3%. This dominance indicates a substantial focus on societal and interdisciplinary issues, including education, sociology, political science, and economics. Arts and

humanities follow at 9.7%, reflecting the importance of research in literature, history, philosophy, and cultural studies. These two categories together highlight the prominence of qualitative and social research within the analyzed dataset. Additionally, computer science (7.6%) and engineering (5.7%) underline the increasing emphasis on technological advancements and applied sciences, showcasing their role in addressing global challenges like automation, data science, and sustainable engineering.

Fields such as psychology (4.7%) and medicine (4.6%) signify the growing interest in understanding human behavior and advancing healthcare systems. Business, management, and accounting (4.3%) emphasize economic research, corporate strategies, and management practices, often intersecting with social sciences to explore topics like sustainability and innovation. Smaller shares are seen in nursing (2.8%) and health professions (2.3%), which, though critical, represent more specialized areas of healthcare research. Environmental science, at 1.8%, reflects its specialized concentration but emphasizes the need for tackling climate change, ecological preservation, and sustainability. The "other" group category, accounting for 11.1%, encompasses new and transdisciplinary topics, hence enhancing the dataset's variety.

This data is derived from a specific database (Scopus) and may not comprehensively represent the entire research landscape on innovative pedagogy. Furthermore, the pie chart does not offer insights into the quality or impact of the research articles within each subject area. In summary, the chart in Figure 3 presents an overview of the various subject areas involved in research on innovative pedagogy. It underscores the prominence of social sciences in this domain while also reflecting the increasing interest in employing innovative approaches across diverse disciplines.

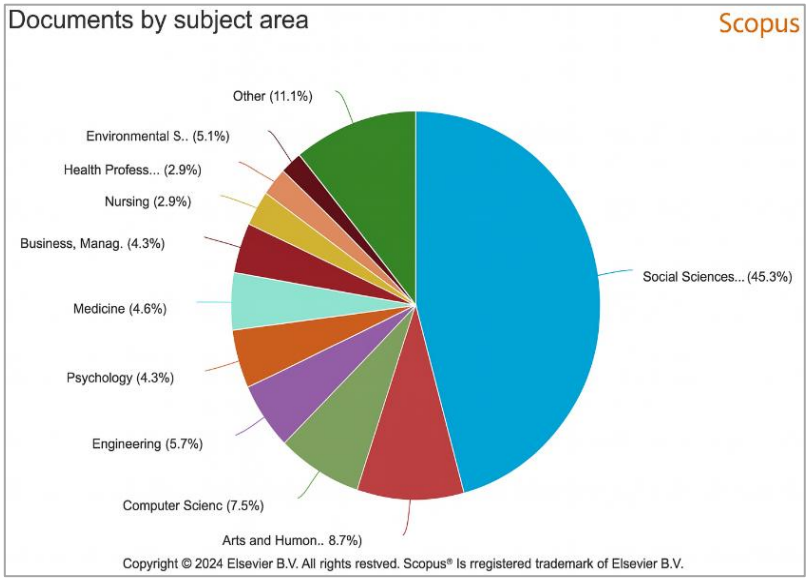

Figure 3. Documents by subject area

4.4. Citation analysis

The Scopus citation analysis reveals significant trends and impacts within the field of educational research, particularly in the integration of technology and innovative pedagogies. The most-cited work by Yang [11], underscoring its critical role in advancing AI education for younger learners. Additionally, articles by Allahverdiyev *et al.* [41] and Bai *et al.* [42] highlight the growing scholarly interest in immersive learning technologies and ethical considerations in their application for children. Several articles address emerging research themes and their potential to transform education. The article by Chiu [14] reflects the urgency of integrating generative AI into educational systems, while Bizami *et al.* [43] explores how technology acceptance models influence teacher and student dynamics in modern learning environments. Similarly, publications on AR applications by Papakostas *et al.* [21] demonstrate AR's growing significance in vocational and technical education.

In the field of medical education, Patra *et al.* [22] investigates how innovative educational technologies, such as AR and virtual simulations, are revolutionizing anatomy teaching. Their study highlights the benefits of interactive 3D modeling tools, which improve spatial understanding and diagnostic reasoning, making medical education more immersive and effective. Kaimara *et al.* [44] in their study propose a student-centered blended learning (SCBL) approach, which combines face-to-face and digital

learning to enhance engagement and personalization in education. Their research indicates that institutions adopting SCBL models experience improved learning outcomes and student satisfaction, making it a crucial framework for modern higher education transformation. In a related study, Islam *et al.* [45] further emphasize the role of SCBL in shaping higher education practices.

Finally, the analysis reflects a broader focus on the challenges and opportunities brought by innovative educational technologies. Articles by Muniandy [25] and Almaiah *et al.* [46] emphasize the need to address ethical concerns and practical challenges in adopting digital technologies. Similarly, research by Mhlongo *et al.* [47] discuss the broader challenges, opportunities, and prospects of implementing smart digital technologies in learning environments. Collectively, these findings underscore the increasing reliance on AI, blended learning, internet of things (IoT)-based approaches, and immersive simulations in reshaping education. However, they also highlight challenges such as teacher preparedness, accessibility barriers, high costs of emerging technologies, and ethical concerns that must be addressed for equitable adoption of innovative pedagogies. Table 2 ranks the most influential papers based on citation metrics.

Table 2. Most influential paper (top 10)

Authors	Title	Publication year	Cited by
Yang [11]	Artificial intelligence education for young children: Why, what, and how in curriculum design and implementation	2022	161
Bizami *et al.* [43]	Innovative pedagogical principles and technological tools capabilities for immersive blended learning: a systematic literature review	2023	81
Kaimara *et al.* [44]	Could virtual reality applications pose real risks to children and adolescents? A systematic review of ethical issues and concerns	2022	81
Chiu [14]	Future research recommendations for transforming higher education with generative AI	2024	68
Almaiah *et al.* [46]	Integrating teachers' TPACK levels and students' learning motivation, technology innovativeness, and optimism in an IoT acceptance model	2022	62
Papakostas *et al.* [21]	User acceptance of augmented reality welding simulator in engineering training	2022	57
Patra *et al.* [22]	Integration of innovative educational technologies in anatomy teaching: new normal in anatomy education	2022	50
Iqbal *et al.* [23]	Current challenges and future research directions in augmented reality for education	2022	49
Islam *et al.* [45]	Promoting student-centred blended learning in higher education: A model	2022	49
Mhlongo *et al.* [47]	Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review	2023	47

4.5. Keywords analysis

The network visualization map generated using VOSviewer in Figure 4 highlights the co-occurrence of keywords related to "innovative pedagogy," clustering them into thematic groups. The red cluster prominently focuses on pedagogy within higher education, with central keywords such as "pedagogy," "students," "higher education," and "innovative pedagogy." This cluster underscores the importance of improving instructional methods and creating student-centered learning experiences. Additional terms like "online learning," "curricula," "teacher training," and "AI" emphasize the integration of technology and interdisciplinary approaches into modern pedagogy, showcasing how education adapts to evolving digital and societal needs.

The green cluster centers around human-centered and engagement-focused themes, including keywords like "learning," "human," "engagement," and "nursing education." This cluster highlights the role of personalized learning approaches and feedback mechanisms in enhancing the educational experience. The presence of terms such as "thematic analysis," "feedback," and "perception" reflects the ongoing emphasis on evaluating teaching methods and understanding student needs. Furthermore, its connection to healthcare education, particularly in nursing, illustrates the application of innovative pedagogical approaches in professional and clinical training, where adaptability and learner-centered techniques are crucial.

The blue cluster focuses on medical education and PBL, featuring keywords like "medical education," "clinical competence," and "problem-based learning." These terms underline the application of innovative pedagogy in fostering practical and critical thinking skills in medical and healthcare settings. Connections to terms like "distance learning," "pandemics," and "COVID-19" highlight the significant adaptations made in education during global crises, including the adoption of virtual and hybrid learning technologies. Collectively, the visualization underscores the interdisciplinary and evolving nature of innovative pedagogy, its response to global challenges, and its integration across diverse fields like healthcare, technology, and higher education. These clusters reflect both the current trends and future directions for educational innovation.

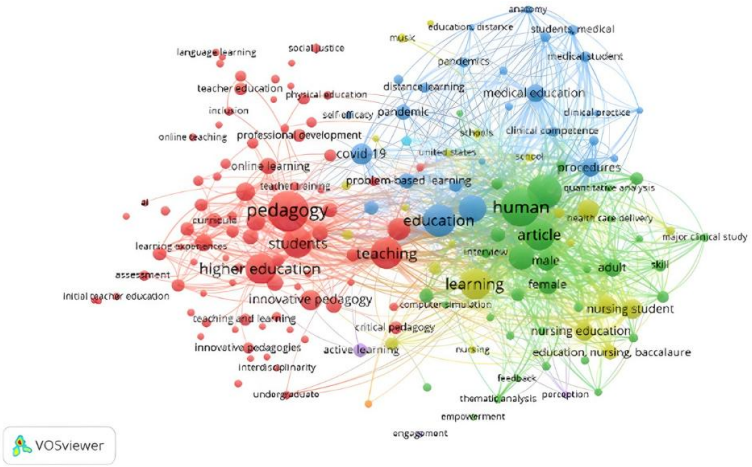

Figure 4. Network visualization map of keywords' co-occurrence

4.6. Countries' bibliographic coupling analysis

The VOSviewer network visualization map illustrates countries' bibliographic coupling in the domain of "innovative pedagogy," highlighting global research contributions and collaborations. The United States emerges as the most dominant node, representing its significant influence and extensive research output in this field. The large size of its node and numerous connections indicate strong bibliographic ties with a wide array of countries, reflecting its role as a central hub in innovative pedagogy research. Similarly, countries like Australia, China, and India show prominent nodes, signifying their substantial contributions and increasing influence in global research on educational innovation.

The map further reveals regional clusters, reflecting thematic or geographic collaborations. The red cluster, including China, Malaysia, India, and Taiwan, underscores the active role of Asian countries in educational research, particularly in areas like technological integration and pedagogical adaptation for local contexts. The blue cluster, consisting of European countries such as Germany, France, and Spain, represents a cohesive regional focus on advanced pedagogy and educational policies. Meanwhile, the green cluster, dominated by the United States and Australia, showcases a blend of North American and Oceanic collaboration, often emphasizing digital pedagogy and large-scale educational innovations. Smaller clusters, such as those formed around Brazil and South Africa, indicate regional efforts that are becoming increasingly connected to the global research landscape.

The dense web of connections across the map highlights the high level of international collaboration in innovative pedagogy research. Countries like the United States, Australia, and China act as bridges, fostering cross-regional academic partnerships. Emerging contributors, including Nigeria, Vietnam, and the Philippines, indicate the growing participation of developing regions in this field, reflecting a more inclusive and globalized research effort. Figure 5 depicts the bibliographic coupling network among contributing countries.

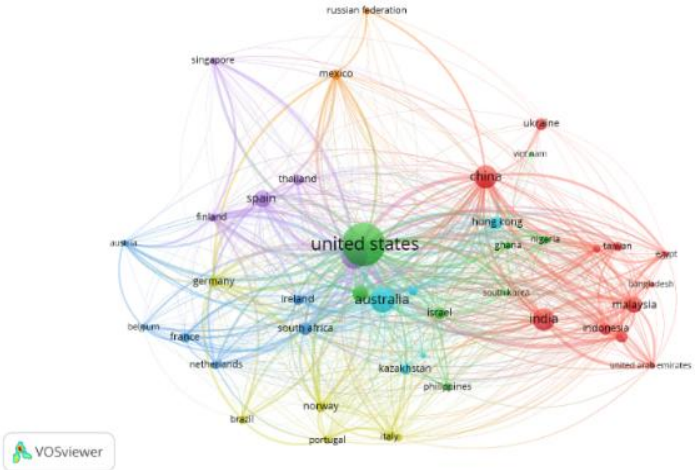

Figure 5. Network visualization, countries contributed to the publications

5. DISCUSSION

The results indicate a significant increase in research output on innovative pedagogy, particularly in developed regions such as the United States, Australia, and China, which lead in publication volume and citation impact. Additionally, the growing presence of research from India, Malaysia, and other developing regions highlights a shift toward more diverse global contributions in educational innovation. These findings suggest that pedagogical innovation is gaining traction worldwide, influenced by advancements in AI-driven learning, immersive technologies, and digital pedagogies.

Keyword analysis and citation network findings suggest that technology-enhanced learning environments are a key area of interest. AI in education, PBL, and gamification strategies are among the most often referenced research subjects, indicating a definite shift towards more personalized and data-driven teaching methods. Furthermore, sustainability-focused pedagogy is emerging as a crucial area, with studies emphasizing the role of educational technology in fostering long-term learning resilience and accessibility.

In contrast to earlier studies that predominantly focused on theoretical frameworks, this study provides an empirical, data-driven examination of research trajectories. Previous research largely centered on individual case studies or qualitative assessments of innovative teaching methods. However, bibliometric analysis highlights a broader, quantitative landscape by identifying co-citation relationships, research clusters, and interdisciplinary collaborations that were previously underexplored. For example, while the TPACK framework has been foundational in integrating technology into education, findings suggest a move beyond TPACK toward more dynamic, AI-enhanced adaptive learning models [10]. Similarly, the flipped classroom model, widely adopted over the past decade, is now evolving into hybrid and immersive learning environments supported by augmented and virtual reality technologies.

The increasing adoption of AI-powered educational tools presents both opportunities and challenges. While these technologies enable personalized learning and automated feedback, they also raise concerns about data privacy, algorithmic bias, and equitable access to digital resources. Policymakers must address these challenges by establishing ethical guidelines and digital literacy programs for educators and learners alike. Additionally, developing nations face infrastructural barriers that hinder the widespread adoption of innovative pedagogy. Bridging this gap requires policy interventions, investment in teacher training, and the integration of affordable educational technologies to ensure that technological advancements benefit all learners.

6. CONCLUSION

This study provides a comprehensive, data-driven roadmap for future research in innovative pedagogy. By systematically mapping key contributors, influential publications, and emerging themes, it offers quantitative insights into global research impact and interdisciplinary collaboration. The findings suggest that educational innovation is increasingly shaped by technological advancements, global collaborations, and evolving student needs. Unlike previous qualitative assessments, this bibliometric approach reveals objective patterns in research trends, helping educators and policymakers align pedagogical strategies with future technological developments. Furthermore, the increasing research contributions from developing regions indicate a shift towards a more inclusive global discourse on pedagogy.

Although this study provides a robust bibliometric analysis, certain limitations must be acknowledged. The reliance on Scopus as the primary database may have excluded relevant studies indexed in other repositories, such as Web of Science or ERIC. Additionally, the focus on English-language publications may introduce linguistic bias, potentially overlooking valuable research from non-English-speaking regions. Another limitation is the bibliometric approach itself, which, while effective for mapping research trends, does not assess the practical implementation and impact of innovative pedagogical strategies. Future studies should integrate qualitative methodologies, such as case studies, classroom-based interventions, and student feedback assessments, to provide more profound insights into how these pedagogical innovations influence learning outcomes.

Further research should also explore the ethical and accessibility challenges associated with AI-driven education, ensuring that technological advancements are equitably implemented across diverse educational contexts. Expanding the scope to include cross-regional comparative analyses could provide a more holistic understanding of how innovative pedagogy is shaped by cultural, economic, and policy differences worldwide. By addressing these limitations and extending the scope of inquiry, future research can build on these findings to create a more comprehensive, global perspective on innovative pedagogy. This study thus serves as a foundational resource for educational transformation in the 21st century.

FUNDING INFORMATION

We would like to thank Universiti Kebangsaan Malaysia for enable us to do the research and research Grant GG-2024-036.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Nurul Eeffah Awang	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Hafizhah Zulkifli	✓	✓		✓		✓		✓	✓	✓	✓	✓	✓	
Mohd Isa Hamzah		✓	✓			✓	✓			✓	✓	✓		

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

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.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author [HZ]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions. Derived data supporting the findings of this study are available from the corresponding author [HZ] on request.

REFERENCES

[1] T. M. Bhuttah, Q. Xusheng, M. N. Abid, and S. Sharma, "Enhancing student critical thinking and learning outcomes through innovative pedagogical approaches in higher education: the mediating role of inclusive leadership," *Scientific Reports*, vol. 14, no. 1, p. 24362, Oct. 2024, doi: 10.1038/s41598-024-75379-0.

[2] D. Wu, C. Zhou, X. Liang, Y. Li, and M. Chen, "Integrating technology into teaching: Factors influencing rural teachers' innovative behavior," *Education and Information Technologies*, vol. 27, no. 4, pp. 5325–5348, 2021, doi: 10.1007/s10639-021-10815-6.

[3] E. Khoo, L. Mitchell, and M. Sammons, "Teacher use of digital stories to promote reflective practice supportive of migrant and refugee children's sense of belonging," *Early Childhood Education Journal*, vol. 52, no. 8, pp. 1993–2007, 2024, doi: 10.1007/s10643-023-01538-z.

[4] J. Han and M. Li, "Exploring ChatGPT-supported teacher feedback in the EFL context," *System*, vol. 126, p. 103502, Nov. 2024, doi: 10.1016/j.system.2024.103502.

[5] A. de B. Lima, J. Sorroche, A. M. Tagiku, and J. D. de O. Neto, "Digital pedagogy: experiential learning theory improves mathematics learners' engagement and learning outcomes in optical physics course," *Physics Education*, vol. 59, no. 5, p. 055007, 2024, doi: 10.1088/1361-6552/ad5f6d.

[6] M. Mokhele-Ramulumo, K. A. Badaru, and G. Iroha, "Innovative pedagogy: revealing secondary physical science teachers' perspectives on the opportunities and challenges of the flipped classroom model during times of crisis," *Africa Education Review*, vol. 20, no. 5, pp. 63–77, 2024, doi: 10.1080/18146627.2024.2403677.

[7] B. Jeroen, S. Michiel, P. Andrew, C. Gregoire, and R. Karimi, "Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies," *Quantitative Science Studies*, vol. 1, no. 1, pp. 377–386, 2019.

[8] H. F. Moed, F. de Moya-Anegon, V. Guerrero-Bote, C. Lopez-Illescas, and M. Hladchenko, "Bibliometric assessment of national scientific journals," *Scientometrics*, vol. 126, no. 4, pp. 3641–3666, 2021, doi: 10.1007/s11192-021-03883-5.

[9] S. Ahmad, S. Umirzakova, G. Mujtaba, M. S. Amin, and T. Whangbo, "Education 5.0: requirements, enabling technologies, and future directions," *arXiv*: 2307.15846, 2023.

[10] H.-K. D. Peña, "Innovative pedagogies for student success: strategies for engagement, motivation, and academic achievement," *Pantao (International Journal of the Humanities and Social Sciences)*, vol. 4, no. 2, pp. 148–157, 2025, doi: 10.69651/PIJHSS040217.

[11] W. Yang, "Artificial intelligence education for young children: why, what, and how in curriculum design and implementation," *Computers and Education: Artificial Intelligence*, vol. 3, p. 100061, 2022, doi: 10.1016/j.caeai.2022.100061.

[12] R. Schmid, C. Pauli, R. Stebler, K. Reusser, and D. Petko, "Implementation of technology-supported personalized learning—its impact on instructional quality," *The Journal of Educational Research*, vol. 115, no. 3, pp. 187–198, May 2022, doi: 10.1080/00220671.2022.2089086.

[13] A. Patmasari, D. S. Ahmar, A. Anggreni, M. F. Azzajjad, P. Ningsih, and A. S. Ahmar, "Comparative analysis of the implementation of technology, pedagogy, and education trends on sciences and non-sciences program students in Sulawesi," *International Journal on Informatics Visualization*, vol. 8, no. 3–2, pp. 1552–1559, 2024, doi: 10.62527/joiv.8.3-2.3213.

[14] T. K. F. Chiu, "Future research recommendations for transforming higher education with generative AI," *Computers and Education: Artificial Intelligence*, vol. 6, p. 100197, Jun. 2024, doi: 10.1016/j.caeai.2023.100197.

[15] A. C. Dixit, B. Harshavardhan, B. C. Ashok, M. A. Sriraj, and K. N. Prakasha, "Innovative pedagogical approaches for diverse learning styles and student-centric learning," *Journal of Engineering Education Transformations*, vol. 37, no. Special Issue 2, pp. 178–188, 2024, doi: 10.16920/jeet/2024/v37is2/24039.

[16] J. S. C. Hsieh, W.-C. V. Wu, and M. W. Marek, "Using the flipped classroom to enhance EFL learning," *Computer Assisted Language Learning*, vol. 30, no. 1–2, pp. 1–21, Feb. 2017, doi: 10.1080/09588221.2015.1111910.

[17] A. Pardo, F. Han, and R. A. Ellis, "Combining university student self-regulated learning indicators and engagement with online learning events to predict academic performance," *IEEE Transactions on Learning Technologies*, vol. 10, no. 1, pp. 82–92, 2017, doi: 10.1109/TLT.2016.2639508.

[18] S. Freeman, J. Fletcher, K. Clouston, and A. Higson, "Gamifying simulated nursing education: a digital technology approach to enhancing pedagogy and student experience," *British Journal of Nursing*, vol. 33, no. 4, pp. 206–214, 2024, doi: 10.12968/bjon.2024.33.4.206.

[19] Q. Zhang, "Mixed effects of cooperative/competitive gamification on language learning regarding engagement, foreign language enjoyment, and classroom social climate," *International Journal of Information Technology (Singapore)*, vol. 16, no. 6, pp. 3437–3448, 2024, doi: 10.1007/s41870-024-01976-x.

[20] M. A. Almuhanna, "Teachers' perspectives of integrating AI-powered technologies in K-12 education for creating customized learning materials and resources," *Education and Information Technologies*, vol. 30, no. 8, pp. 10343–10371, Jun. 2025, doi: 10.1007/s10639-024-13257-y.

[21] C. Papakostas, C. Troussas, A. Krouska, and C. Sgouropoulou, "User acceptance of augmented reality welding simulator in engineering training," *Education and Information Technologies*, vol. 27, no. 1, pp. 791–817, 2022, doi: 10.1007/s10639-020-10418-7.

[22] A. Patra, A. Asghar, P. Chaudhary, and K. S. Ravi, "Integration of innovative educational technologies in anatomy teaching: new normal in anatomy education," *Surgical and Radiologic Anatomy*, vol. 44, no. 1, pp. 25–32, 2022, doi: 10.1007/s00276-021-02868-6.

[23] M. Z. Iqbal, E. Mangina, and A. G. Campbell, "Current challenges and future research directions in augmented reality for education," *Multimodal Technologies and Interaction*, vol. 6, no. 9, p. 75, Sep. 2022, doi: 10.3390/mti6090075.

[24] M. J. Dsouza, R. Divyabharathy, and A. J. Daniel, "Benefits and limitations of flipped classroom," *Indian Journal of Community Medicine*, vol. 50, no. 2, pp. 274–277, 2025, doi: 10.4103/ijcm.ijcm_535_23.

[25] T. Muniandy and N. Abdullah, "A comprehensive review: An innovative pedagogy for future education," *International Journal of Online Pedagogy and Course Design*, vol. 13, no. 1, pp. 1–15, 2023, doi: 10.4018/IJOPCD.315816.

[26] L. Krstić, V. Aleksić, and M. Krstić, "Artificial intelligence in education: a review," in *9th International Scientific Conference Technics and Informatics in Education – TIE 2022*, 2022, pp. 223–228, doi: 10.46793/TIE22.223K.

[27] J. L. Alves, I. B. Borges, and J. de Nadae, "Sustainability in complex projects of civil construction: bibliometric and bibliographic review," *Gestão & Produção*, vol. 28, no. 4, p. e5389, 2021, doi: 10.1590/1806-9649-2020v28e5389.

[28] Y. C. J. Wu and T. Wu, "A decade of entrepreneurship education in the Asia Pacific for future directions in theory and practice," *Management Decision*, vol. 55, no. 7, pp. 1333–1350, 2017, doi: 10.1108/MD-05-2017-0518.

[29] B. Fahimnia, J. Sarkis, and H. Davarzani, "Green supply chain management: a review and bibliometric analysis," *International Journal of Production Economics*, vol. 162, pp. 101–114, 2015, doi: 10.1016/j.ijpe.2015.01.003.

[30] C. Ogrean, "Rethinking dynamic capabilities for a digital world: a bibliometric analysis of emerging trends and conceptual shifts," *Studies in Business and Economics*, vol. 20, no. 1, pp. 374–391, 2025, doi: 10.2478/sbe-2025-0021.

[31] G. P. Khiste and R. R. Paithankar, "Analysis of bibliometric term in Scopus," *International Journal of Library Science and Information Management (IJLSIM)*, vol. 3, no. 3, pp. 81–88, 2017.

[32] A. Al-Khoury *et al.*, "Intellectual capital history and trends: a bibliometric analysis using Scopus database," *Sustainability*, vol. 14, no. 18, p. 11615, 2022, doi: 10.3390/su141811615.

[33] D. Gu, T. Li, X. Wang, X. Yang, and Z. Yu, "Visualizing the intellectual structure and evolution of electronic health and telemedicine research," *International Journal of Medical Informatics*, vol. 130, p. 103947, 2019, doi: 10.1016/j.ijmedinf.2019.08.007.

[34] X. L. Pham and T. T. Le, "Bibliometric analysis and systematic review of research on expert finding: a PRISMA-guided approach," *International Arab Journal of Information Technology*, vol. 21, no. 4, pp. 661–674, 2024, doi: 10.34028/iajit/21/4/9.

[35] M. J. Page *et al.*, "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews," *Systematic Reviews*, vol. 10, no. 1, p. 89, Dec. 2021, doi: 10.1186/s13643-021-01626-4.

[36] N. J. van Eck and L. Waltman, "Citation-based clustering of publications using CitNetExplorer and VOSviewer," *Scientometrics*, vol. 111, no. 2, pp. 1053–1070, 2017, doi: 10.1007/s11192-017-2300-7.

[37] H. Arruda, E. R. Silva, M. Lessa, D. Proença Jr., and R. Bartholo, "VOSviewer and bibliometrix," *Journal of the Medical Library Association*, vol. 110, no. 3, pp. 392–395, Dec. 2022, doi: 10.5195/jmla.2022.1434.

[38] N. J. van Eck and L. Waltman, *VOSviewer manual*. Leiden, Netherlands: Universiteit Leiden: CWTS meaningful metrics, 2015. [Online]. Available: http://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.1.pdf

[39] K. Subeesh and M. A. Joseph, "Bibliometric review and co-citation analysis of documents published in the derivative market: a study based on the Scopus database," *International Journal of Advanced Research*, vol. 11, no. 4, pp. 424–434, 2023, doi: 10.21474/ijar01/16676.

[40] T. Zhang *et al.*, "A bibliometric analysis of atrophic gastritis from 2011 to 2021," *Frontiers in Medicine*, vol. 9, p. 843395, 2022, doi: 10.3389/fmed.2022.843395.

[41] M. Allahverdiyev, Y. Yucesoy, and B. Baglama, "An overview of arts education and reflections on special education," *International Journal of Educational Sciences*, vol. 19, no. 2–3, pp. 127–135, 2017, doi: 10.1080/09751122.2017.1393956.

[42] Y. Bai, H. Li, and Y. Liu, "Visualizing research trends and research theme evolution in e-learning field: 1999–2018," *Scientometrics*, vol. 126, no. 2, pp. 1389–1414, 2021, doi: 10.1007/s11192-020-03760-7.

[43] N. A. Bizami, Z. Tasir, and S. N. Kew, "Innovative pedagogical principles and technological tools capabilities for immersive blended learning: a systematic literature review," *Education and Information Technologies*, vol. 28, no. 2, pp. 1373–1425, 2023, doi: 10.1007/s10639-022-11243-w.

[44] P. Kaimara, A. Oikonomou, and I. Deliyannis, "Could virtual reality applications pose real risks to children and adolescents? a systematic review of ethical issues and concerns," *Virtual Reality*, vol. 26, no. 2, pp. 697–735, 2022, doi: 10.1007/s10055-021-00563-w.
[45] M. K. Islam, M. F. H. Sarker, and M. S. Islam, "Promoting student-centred blended learning in higher education: a model," *E-Learning and Digital Media*, vol. 19, no. 1, pp. 36–54, 2022, doi: 10.1177/20427530211027721.
[46] M. A. Almaiah *et al.*, "Integrating Teachers' TPACK Levels and Students' Learning Motivation, Technology Innovativeness, and Optimism in an IoT Acceptance Model," *Electronics*, vol. 11, no. 19, p. 3197, 2022, doi: 10.3390/electronics11193197.
[47] S. Mhlongo, K. Mbatha, B. Ramatsetse, and R. Dlamini, "Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: an iterative review," *Heliyon*, vol. 9, no. 6, p. e16348, 2023, doi: 10.1016/j.heliyon.2023.e16348.

BIOGRAPHIES OF AUTHORS

Nurul Eeffah Awang is a Ph.D. candidate, Faculty of Education, National University of Malaysia, Bangi, Selangor, Malaysia. Her research interests are innovative pedagogy, creative teaching, future education, and technology integration in teaching. She can be contacted at email: p107451@siswa.ukm.edu.my.

Hafizhah Zulkifli is a lecturer in National University of Malaysia. She is interested in research on philosophy for children called Hikmah pedagogy in Malaysia, moral education and Islamic education. Recently, she is involved in research on Hikmah (wisdom) in Islamic education. Currently, she is working on producing materials that are more appropriate for the Malaysian and Islamic cultures and traditions. She can be contacted at email: hafizhah_zulkifli@ukm.edu.my.

Mohd Isa Hamzah is a lecturer in National University of Malaysia. He is interested in research on Islamic education and Arabic language instruction. Recently, he is involved in the research of information communication technology and Islamic education on andragogy teaching and learning. Currently, he is working on Waqaf project on andragogy teaching and learning. He also working on development of preschool Al-Quran module. He can be contacted at email: isa_hamzah@ukm.edu.my.