JPPIPA 10(11) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Emerging Trends and Impacts of Mobile Learning in Education: A Bibliometric Analysis

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Received: June 25, 2024
Revised: September 09, 2024
Accepted: November 25, 2024
Published: November 30, 2024

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DOI: 10.29303/jppipa.v10i11.9112

Abstract: This study aims to analyze the trend and impact of mobile learning in education through a bibliometric analysis approach. The method used is bibliometric analysis which involves statistical analysis of 690 publications related to mobile learning in education, collected from the Scopus database. The analysis process included the identification of the most influential publications, the most prolific journal sources, the leading authors, and the countries with the largest contributions. The results show that mobile learning is gaining increasing attention in academia, with a significant increase in the number of publications and citations over the 2019-2023 period. Leading journals and the most prolific authors have played an important role in advancing the discourse on mobile learning. The analysis also reveals emerging trends, such as the integration of mobile learning with augme nted reality technology and the importance of research in the context of higher education and developing countries. In conclusion, mobile learning has become a highly relevant topic in education, with great potential to change the way learning is done and increase the accessibility of education worldwide. This bibliometric analysis provides important guidance for future studies and practical implementation of mobile learning.

Keywords: Bibliometric; Biblioshiny; Educational Technology; Mobile Learning; Research Trends

Introduction

In the digital age, mobile learning has emerged as a transformational force in education, changing the way knowledge is acquired, shared, and applied (Alenezi, 2023; Mukul & Büyüközkan, 2023; Muskhir, Luthfi, Julian, & Fortuna, 2023). Mobile learning, or m-learning, refers to educational practices facilitated through mobile devices such as smartphones, tablets, and laptops, allowing learners to access educational content anytime and anywhere (Naveed, Choudhary, Ahmad, Alqahtani, & Qahmash, 2023; Salhab & Daher, 2023a). The proliferation of mobile technologies not only expands the accessibility of education but also introduces new pedagogical possibilities that meet the needs of diverse learners in various contexts. This shift towards mobile learning reflects broader societal changes where technology is increasingly mediating everyday experiences, including in education (Mohtar, Jomhari, Mustafa, & Yusoff, 2023; van Kraalingen, 2023).

The evolution of mobile learning is influenced by rapid technological advances, including the widespread availability of high-speed internet, the development of sophisticated mobile applications, and the growing capabilities of mobile devices (Banafaa et al., 2023; X. Zhang, Hai, & Li, 2024). These technological advancements create new opportunities for educators and learners, enabling a more interactive, personalized, and flexible learning experience (Josué, Bedoya-Flores, Mosquera-Quiñonez, Mesías-Simisterra, & Bautista-

How to Cite:
Ananda, Y. F., Usmeldi, Giatman, M., & Effendi, H. (2024). Emerging Trends and Impacts of Mobile Learning in Education: A Bibliometric Analysis. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 806–817. https://doi.org/10.29303/jppipa.v10i11.9112

Sánchez, 2023; Rakha, 2023). As mobile devices become more embedded in everyday life, the potential of mobile learning to complement and even replace traditional education methods has received significant attention in academic research and practical implementation.

Despite the growing interest in mobile learning, the field is still relatively new, with ongoing debates about its effectiveness, best practices, and potential challenges (Lai, 2020). Researchers are beginning to explore various aspects of mobile learning, including its impact on student engagement, learning outcomes and the overall educational experience (Al-Rahmi et al., 2021; El-Sabagh, 2021). However, the research landscape is complex, with studies spanning multiple disciplines, methodologies and contexts. Understanding emerging trends in mobile learning research is essential for identifying knowledge gaps, guiding future studies, and informing educational policy and practice.

Bibliometric analysis, a quantitative method for evaluating and mapping the scientific literature, offers a powerful tool for analyzing the trends and impact of research in mobile learning (Muskhir et al., 2024; Samala et al., 2023; Watrianthos, Ahmad, & Muskhir, 2023). By examining patterns in publications, citations, and collaborations, bibliometric analysis provides insights into the evolution of research topics, the most influential studies, and key contributors in the field. This approach enables a comprehensive overview of how mobile learning has evolved over time and the impact it has had on education as a discipline.

One of the main benefits of using bibliometric analysis in the context of mobile learning is its ability to identify the most prominent themes and topics that have emerged over time (Behl et al., 2022; Chen, Zou, Xie, & Wang, 2021). As mobile learning is an interdisciplinary field, research often intersects with areas such as educational technology, instructional design, cognitive psychology and information systems. By analyzing trends in the literature, researchers can uncover the aspects of mobile learning that have received the most attention and how these trends have evolved in response to technological advances and changing educational needs (Tlili et al., 2023).

Another important aspect of mobile learning that can be explored through bibliometric analysis is its impact on education (Irwanto, Saputro, Widiyanti, & Laksana, 2023; Zafrullah & Ramadhani, 2024). Although mobile learning is often discussed for its potential to improve educational outcomes, the actual impact of mobile learning on student achievement, motivation, and retention is still an active area of research. By analyzing the citation patterns and influence of key studies, bibliometric analysis can identify which research findings have had the most significant impact on the field and how these findings have shaped educational practice and policy.

The use of bibliometric analysis also enables the examination of collaboration networks in the field of mobile learning. Collaborations between researchers, institutions and countries can accelerate the development of innovative technologies and educational approaches. By mapping these networks, bibliometric analysis can identify the most influential collaborations and institutions that play a central role in advancing mobile learning research. This kind of information is invaluable for encouraging further collaborations and for building research capacity in regions that are still underrepresented in mobile learning.

Despite its great potential, mobile learning faces several challenges that may affect its future development. These challenges include issues related to digital equity, the digital divide, the quality of mobile learning content, and the need for effective pedagogical strategies that utilize mobile technology. Bibliometric analysis can help identify how these challenges are addressed in the literature and where further research is needed. By providing a comprehensive overview of the current state of mobile learning research, bibliometric analysis can guide educators, policy makers, and researchers in making informed decisions about mobile learning adoption and implementation.

Using bibliometric analysis to study emerging trends and impacts in mobile learning offers a valuable perspective to understand the development of this dynamic field. As mobile learning grows in importance, it is imperative to monitor and analyze the evolving research landscape to keep educational practices effective, inclusive and responsive to learners' needs. This study aims to provide a detailed bibliometric analysis of mobile learning research, offering insights that can inform future studies and contribute to the advancement of education in the digital age.

Therefore, the main objective of this study is to identify and visualize various aspects of research, including the evolution of publication development, most cited articles, leading countries, authors, and sources related to the utilization of mobile learning in education. In addition, this research aims to explore emerging trends and topics in this domain. The following list outlines the Research Questions (RQs) that define the main objectives of this investigation:

RQ1. What are the main information outcomes produced by descriptive bibliometric analysis?

RQ2. How many publications are published each year?

RQ3. Which research documents are most frequently cited by other researchers?

RQ4. What are the most relevant and active publication sources for generating research articles?

RQ5. Who are the authors of the most published and cited research articles?

RQ6. Which countries are most relevant and productive in generating research on this topic?

RQ7. How to visualize the co-occurrence analysis of authors' keywords on this topic?

Method

The research method used is bibliometric analysis (Ahmad, Watrianthos, Samala, Muskhir, & Dogara, 2023; Muskhir et al., 2024; Samala et al., 2023; Watrianthos et al., 2023; Watrianthos, Ambiyar, Rizal, Jalinus, & Waskito, 2022a, 2022b), this analysis provides a statistical approach to the analysis of scientific-like data that shows how research is progressing, measures the impact of research, illustrates research trends in academic fields, and discovers research themes. This research presents a structured description of statistically described data, and there is also an analysis of trends and topics in a particular research area. In Figure 1 there are four stages of research in conducting bibliometric analysis.

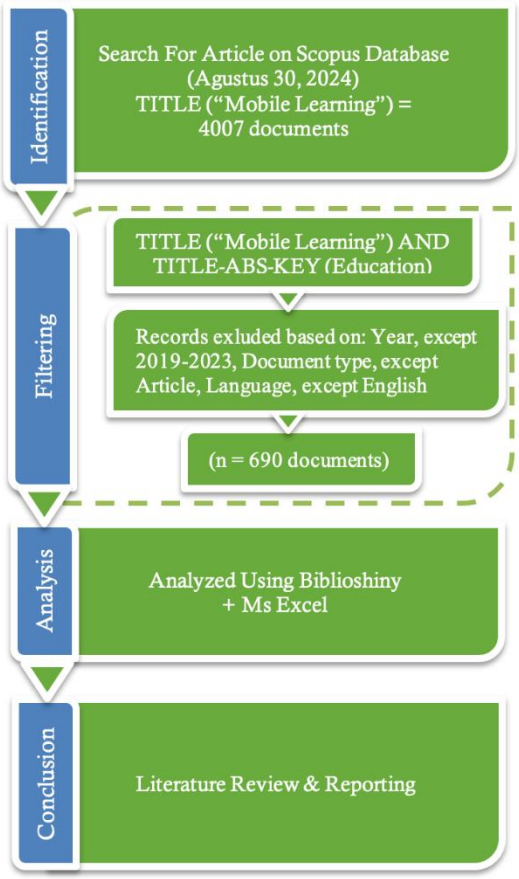

Figure 1. Stages of the Bibliometric Analysis Method

In the first stage, documents were searched according to the research topic to be analyzed. The topic searched was "Mobile learning", found as many as 4007 publication documents. This research uses Scopus as the main primary data source (Baas, Schotten, Plume, Côté, & Karimi, 2020), (AlRyalat, Malkawi, & Momani, 2019). Scopus was chosen because it provides a wide range of features and scope, is known for its comprehensiveness, trusted reputation, solid set of citations, consistency in data standards, and capacity for ongoing analysis (Pölönen, Laakso, Guns, Kulczycki, & Sivertsen, 2020), (Gusenbauer, 2022). The second stage of filtering is carried out with queries specifically designed to identify documents related to the criteria (TITLE ("Mobile Learning") AND TITLE-ABS-KEY (education)), filtering years with a range of 2019-2023, publication type in the form of articles, and only using English. From the results of this screening, 690 documents were obtained which were filtered according to the query or keywords to be analyzed and studied. In the third stage, namely analyzing the data of 690 documents obtained from the results of the filter process on the Scopus database. Data analysis uses biblioshiny software and Microsoft excel in conducting data analysis and visualization. Biblioshiny is software that can visualize and analyze descriptive and conceptual data (Watrianthos et al., 2023). In the fourth or final stage, we review the literature and conclude some questions that we want to get from the research topic related to mobile learning media research trends in education.

Result and Discussion

Descriptive Bibliometric Analysis

To answer RQ1, this descriptive bibliometric analysis provides an overview of key information that can be used to understand the evolution of research topics conducted and published by other researchers on the topic under study. Table 1 shows the key information from the Scopus metadata search results. The descriptions include timespan, source, document, annual growth rate, authors.

Table 1. The main information on bibliometric analysis

Description	Results
Timespan	2019-2023
Sources (Journals, Books, etc)	304
Documents	690
Annual Growth Rate %	6.52 %
Authors	1881

Table 1 shows the key information from the descriptive bibliometric analysis. The process started with Scopus data filtering related to the use of mobile learning in education, which resulted in a total of 690

publications from 2023 to 2023. Of these, 304 were sourced from journals, books and other media. On average, there was a 6.52% increase in publications per year in this topic. In addition, there were 1881 contributing authors, indicating that the interest of researchers and academics in this field is large and starting to grow in this era of digital technology.

Annual Production

In RQ2, we conducted an annual analysis of publications related to the use of mobile learning in education. The results of this analysis revealed that the number of publications and citations fluctuated from year to year. Figure 2 shows the annual trend of publications, with certain years standing out as peaks in the number of publications published.

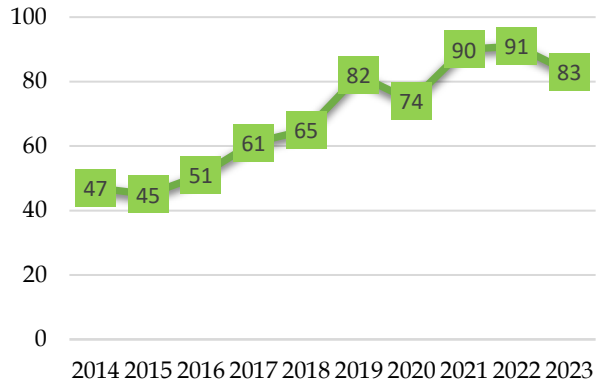

Figure 2. Evolution of publication (2019-2023)

The graph in Figure 2 illustrates the evolution of article publications related to the use of mobile learning in education from 2014 to 2023. From this graph, we can see that the number of articles published on this topic shows an overall increasing trend, although there are some fluctuations in certain years. The number of articles published increased from 47 in 2014 to 83 in 2023, with a peak of 91 articles in 2022. A significant spike was seen in 2018 to 2019, where the number of articles increased from 65 to 82, signaling a considerable growth in interest in mobile learning research in that period.

This increase in the number of publications can be attributed to the growing awareness and application of mobile learning in various educational contexts. This trend suggests that more researchers are interested in exploring the potential of mobile learning as an effective educational tool. One factor that may contribute to this increase is the rapid development of technology, as well as easier access to mobile devices by learners and educators. This has led to an increase in academic exploration of the impact and benefits of mobile learning, which is reflected in a growing number of publications.

In the context of bibliometric analysis, this graph indicates that mobile learning is becoming an increasingly important topic in academic discourse in education. The spike in publications in the period 2019 to 2022 indicates a big push to understand more about how mobile learning can be implemented and optimized in various educational environments. It also shows that researchers are starting to realize the long-term impact of mobile learning, both in terms of learning effectiveness and in terms of technology adaptation in education. As such, this publication trend reflects the growing influence of mobile learning in education and the need to continue exploring and developing this approach in the future.

Top 10 Most Cited Article

Related to RQ3, the documents with the highest number of citations worldwide can be seen and identified in Table 2. The table lists 10 articles out of 690 total articles related to the use of mobile leraning in education, which detail the title of the article, DOI (Digital Object Identifiers)/Link, the number of citations received, and a column labeled TC (Total Cited) per year or average total citations per year.

Table 2. Top Ten Most Cited Article

Title	DOI/Link	Cited	TC
An Augmented Reality-based Mobile Learning System to Improve Students' Learning Achievements and Motivations in Natural Science Inquiry Activities (Chiang, Yang, & Hwang, 2014)	https://www.jstor.org/stable/jeductechsoci.17.4.352	404	36.73
Investigating attitudes towards the use of mobile learning in higher education (Al-Emran, Elsherif, & Shaalan, 2016)	10.1016/j.chb.2015.11.033	388	43.11
The use of mobile learning in higher education: A systematic review (Crompton & Burke, 2018)	10.1016/j.compedu.2018.04.007	372	53.14
A Review of Research on Mobile Learning in Teacher Education (Baran, 2014)	https://www.jstor.org/stable/jeductechsoci.17.4.17	289	26.27
Analysis of the essential factors for the adoption of mobile learning in higher education: A case study of students of the University of Technology (Hamidi & Chavoshi, 2018)	10.1016/j.tele.2017.09.016	263	37.57

Title	DOI/Link	Cited	TC
Applying the UTAUT Model to Explain the Students' Acceptance of Mobile Learning System in Higher Education (Almaiah, Alamri, & Al-Rahmi, 2019)	10.1109/ACCESS.2019.2957206	191	31.83
The use of mobile learning in PK-12 education: A systematic review (Crompton, Burke, & Gregory, 2017)	10.1016/j.compedu.2017.03.013	179	22.38
Mobile learning for science and mathematics school education: A systematic review of empirical evidence (Bano, Zowghi, Kearney, Schuck, & Aubusson, 2018)	10.1016/j.compedu.2018.02.006	170	24.29
Trends and research issues of mobile learning studies in nursing education: A review of academic publications from 1971 to 2016 (Chang, Lai, & Hwang, 2018)	10.1016/j.compedu.2017.09.001	168	24.00
Blended learning, e-learning and mobile learning in mathematics education (Borba et al., 2016)	10.1007/s11858-016-0798-4	156	17.33

Table 2 highlights the significant contributions in the use of mobile learning in the field of education. These articles have been recognized for their impact, which is reflected in the number of citations they receive. This table provides a quantitative measure of the influence these publications have had on the academic discourse on mobile learning, demonstrating the relevance of mobile learning in contemporary educational research.

The most cited article, "An Augmented Reality-based Mobile Learning System to Improve Students' Learning Achievements and Motivations in Natural Science Inquiry Activities," stands out with 404 citations. This research is pivotal in illustrating how augmented reality (AR) can be effectively integrated into mobile learning to improve students' learning experience and motivation (Chiang et al., 2014). The high number of citations indicates that this article has been widely recognized for its innovative approach and practical implications in the educational context. This is in line with the new trend of utilizing advanced technologies such as AR in mobile learning, which is increasingly emerging in educational research (Kamińska et al., 2023).

Another noteworthy article, "Investigating attitudes towards the use of mobile learning in higher education," which received 388 citations, delves into the psychological aspects of mobile learning adoption. Understanding students' attitudes towards mobile learning is crucial as this has a direct impact on the effectiveness of the system. The high number of citations suggests that this research has had a significant influence on how educators and researchers approach the design and implementation of mobile learning strategies, ensuring they align with student preferences and attitudes (Al-Emran et al., 2016).

The systematic review titled "The use of mobile learning in higher education: A systematic review," which was cited 372 times, synthesized findings from various studies to provide a comprehensive overview of mobile learning in higher education (Al-Emran et al., 2016). Systematic reviews are essential in consolidating knowledge and identifying gaps in the literature, and this particular review is likely to have been a foundational reference in determining future research directions. Its impact can be seen in the large number of citations, demonstrating its role as a fundamental reference in mobile learning research.

The article "A Review of Research on Mobile Learning in Teacher Education," with 289 citations, emphasizes the importance of mobile learning in the professional development of educators. As teachers play a central role in the educational process, equipping them with mobile learning tools is essential for successful technology integration in the classroom (Baran, 2014). The significant number of citations reflects the growing recognition of the need to focus on teacher education in mobile learning research, which is a critical area for the widespread adoption of mobile learning technologies.

The article "Applying the UTAUT Model to Explain the Students' Acceptance of Mobile Learning System in Higher Education" (191 citations) applies a known theoretical model, the Unified Theory of Acceptance and Use of Technology (UTAUT), in the context of mobile learning. This research contributes to the understanding of the factors that influence the acceptance and use of mobile learning systems by students, which is crucial for the successful implementation of these technologies. The application of UTAUT in this context highlights the interdisciplinary nature of mobile learning research, drawing on theories from information systems and educational psychology (Almaiah et al., 2019).

Overall, analysis of these most cited articles reveals emerging trends in mobile learning research, such as the integration of advanced technologies like AR, the importance of understanding student and teacher attitudes, and the expansion of mobile learning studies across different levels of education and disciplines. These articles collectively illustrate the profound impact that mobile learning is having on the educational landscape and highlight key areas where future research and innovation is likely to be focused on.

The Most Relevant and Productive Sources

In RQ4, the key sources of journals and proceedings that are most relevant and productive in producing publications on the topic of mobile learning in education were identified. Figure 3 displays a diagram summarizing the five most productive sources of publications that address the latest trends and impact of mobile learning in education. This analysis is important to assist researchers in determining the appropriate journals for future publication of research results. If the research focuses on topics that are frequently discussed in these journals, then these journals can be considered as the top choice for paper submission. From this bibliometric analysis, a total of 304 publication sources were obtained which were then filtered into five journals that were most productive in producing research related to mobile learning in education, as shown in Figure 3.

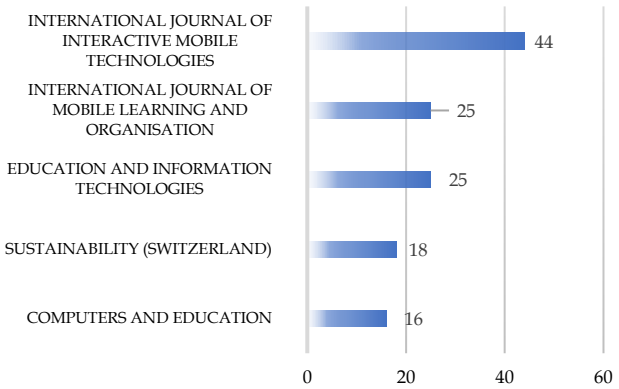

Figure 3. Top five most productive sources

Figure 3 shows the five most productive journal sources in publishing articles related to the topic of mobile learning in education, based on the number of articles published. From the figure, it can be seen that the International Journal of Interactive Mobile Technologies is the most productive source, with 44 articles published. This journal has played a central role in disseminating research related to mobile learning, suggesting that it is a key reference for researchers working in this field. Its prominent position in mobile learning publications also reflects the great interest in interactive technologies that can enhance the learning experience.

The second and third most productive sources are the International Journal of Mobile Learning and Organization and Education and Information Technologies, each with 25 articles. These two journals have also been very influential in developing the academic discourse on mobile learning. The International Journal of Mobile Learning and Organisation focuses on how mobile learning can be integrated into educational and business organizations, while Education and Information Technologies is broader in scope, including various aspects of information technology that affect education. The contributions of these two journals are crucial in shaping the global understanding of the role of mobile learning in educational and organizational contexts.

Overall, this bibliometric analysis shows that there are some journal sources that are very productive in publishing research on mobile learning. The five journals shown in Figure 3 are not only the main sources for research in this field, but also show the main trends and focus in mobile learning development. For researchers who wish to contribute to the academic discourse on mobile learning, choosing to publish in one of these journals can be an effective strategy, given the influence and wide reach of these publications. Thus, an understanding of these most prolific journals can help researchers in directing their research to the most relevant and influential channels in the field of mobile learning.

The Most Productive Auhors

In the context of RQ5 which focuses on the most relevant and prolific authors on the topic of mobile learning in education, Table 3 highlights the five authors who have significantly contributed with the most publications in this area. This analysis provides guidance for researchers to take these authors as primary references, given their contributions in exploring the trends and impact of mobile learning in education. From the bibliometric analysis, a total of 1881 authors were identified, and Table 3 distills five of them as the most prolific authors in conducting and publishing research related to mobile learning in education.

Table 3. Top Five Most Productive Authors

Authors	Doc	Affiliation
Mohamed Sarrab	11	Sultan Qaboos University
Gwo-Jen Hwang	9	National Taiwan University of Science and Technology
Mohammed Amin Almaiah	8	King Faisal University
Hafedh Al-Shihi	6	Sultan Qaboos University
Ahmed Al-Hunaiyyan	5	Public Authority for Applied Education and Training

Table 3 displays the five most prolific authors who have contributed significantly to research related to mobile learning in education. Mohamed Sarrab from Sultan Qaboos University takes the top spot with 11 publications, showing that he has strong contributions in this field. This top position shows that Sarrab plays an important role in driving academic discussion and research on mobile learning. With a focus on educational technology, Sarrab's contributions have helped identify

and analyze the latest trends and impacts of mobile learning in the modern educational context.

Gwo-Jen Hwang from the National Taiwan University of Science and Technology follows in second place with 9 publications. Hwang is recognized as one of the leading researchers in the field of educational technology, particularly in the use of mobile devices for learning. His contributions reflect the increasing attention to the application of mobile technology in educational settings and how it can improve learning effectiveness. Hwang's publications are often referenced by other researchers interested in the development and implementation of mobile learning, making him one of the central figures in this study.

Other authors on the list, such as Mohammed Amin Almaiah, Hafedh Al-Shihi, and Ahmed Al-Hunaifyan, each come from different institutions and have contributed with a significant number of publications. This diversity of affiliations shows that research on mobile learning in education has a broad spectrum and has attracted attention from different regions of the world. Their contributions to this field reflect the global trend in the use of mobile technology to enhance learning and teaching. These authors not only broaden the horizons of mobile learning but also play a role in driving the adoption of this technology globally, creating a far-reaching impact in modern education.

The Most Productive Countries

In RQ6, the most relevant and productive countries in producing publications related to mobile learning research in education were identified. Figure 4 displays the contributions of the different countries around the world that participated in this study. The analysis revealed that there were a total of 75 countries involved. The authors then filtered this data to highlight the five most productive affiliations that significantly contributed to research on the use of mobile learning in education in educational contexts, as displayed in Figure 4.

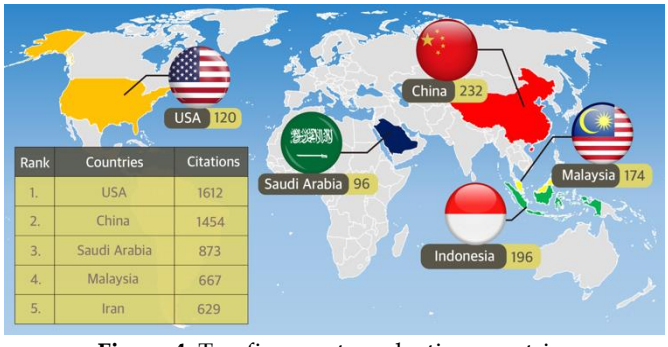

Figure 4. Top five most productive countries

Figure 4 displays a world map identifying the five countries with the most significant contributions to mobile learning research in education, measured by the number of publications and citations. The United States (USA) takes the top spot with 1612 citations and 120 publications, indicating that the country has a very dominant role in directing and influencing the development of mobile learning research globally. This dominance can be attributed to its strong research infrastructure, financial support, as well as the large number of higher education institutions that focus on educational technology innovation.

China, with 1454 citations and 232 publications, took second place. The country has shown significant growth in mobile learning-related research contributions, reflecting China's massive efforts in integrating modern technology into its education system. These contributions show that mobile learning is becoming one of the main focuses in education research in China, with the aim of improving the quality of education and reaching a wider population through mobile technology.

Other countries that also play an important role are Saudi Arabia, Malaysia and Indonesia, with 873, 667 and 629 citations respectively. The presence of these countries in the publication map shows that mobile learning is not only trending in Western countries, but also gaining considerable attention in Asia and the Middle East. This suggests that mobile learning research has evolved into a global phenomenon, with widespread impact across different cultural and geographical contexts. The seriousness with which these countries are developing mobile learning research reflects an awareness of the importance of this technology in improving access and quality of education, as well as enriching learning strategies in various educational environments.

Co-Occurrence Analysis

To answer RQ7 in the context of mobile learning, a keyword co-occurrence analysis was conducted using keywords provided by authors related to mobile learning research in education. This co-occurrence analysis is a bibliometric method used to identify trends and patterns in mobile learning research (Irwanto et al., 2023). With this method, trend analysis can reveal frequently occurring themes and help predict the future direction of mobile learning research. By observing and analyzing patterns in mobile learning-related publications over time, this method reveals the evolving academic interests, research methodologies, and topic focus in this field. This technique is essential for researchers and academics interested in the evolution and impact of mobile learning in education.

Co-occurrence analysis method in this context is a bibliometric technique that aims to identify trends and patterns in mobile learning literature. This technique is

based on the assumption that keywords or terms that frequently co-occur in mobile learning research are more strongly related than those that occur by chance. In mobile learning trend analysis, this method is used to recognize emerging topics, track the development of mobile learning research themes over time, and even project the future direction of this research. In addition, the results of this trend analysis can be an important reference for researchers who want to identify research gaps in mobile learning that need to be investigated further.

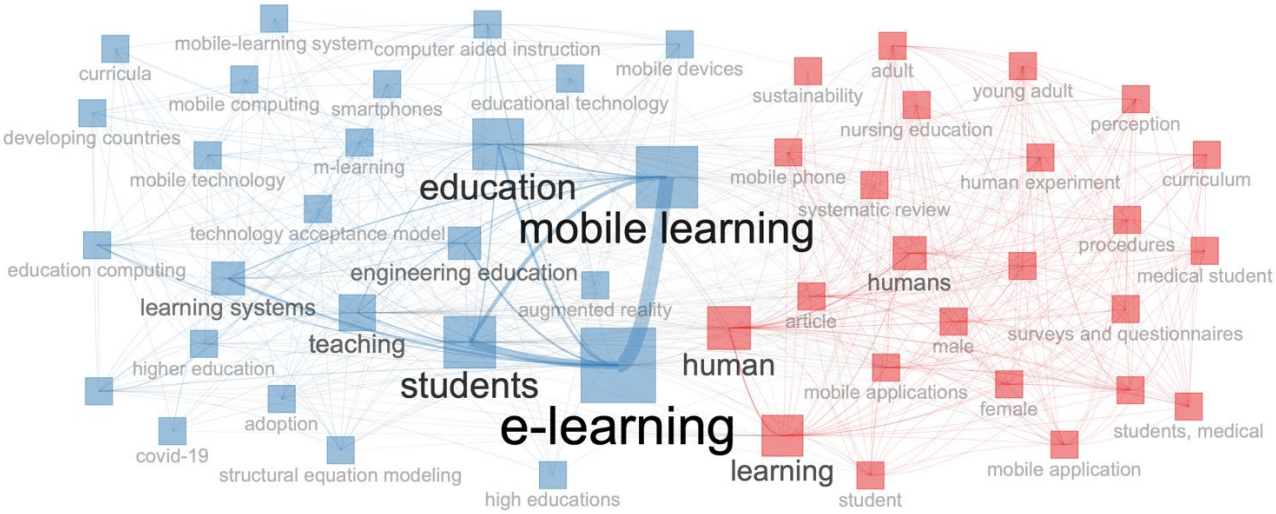

Figure 5. Co-Occurrence Analysis

Figure 5 displays a visual map illustrating the co-occurrence of keywords in the literature related to mobile learning in education. Using co-occurrence analysis, we can see how various keywords relate to each other in the context of mobile learning research. In this map, keywords that co-occur frequently are shown in a larger size, reflecting the importance of these topics in the academic discourse related to mobile learning. Keywords such as "mobile learning," "education," "e-learning," and "students" appear as major centers in the network, highlighting the main focus of research on how mobile learning is applied in education to support student learning.

One of the main themes that emerges from this analysis is the interconnection between mobile learning and e-learning, showing that many studies combine these two concepts in an attempt to improve the quality of learning. E-learning itself has become a pillar in modern education, and the emergence of mobile learning extends this concept by utilizing mobile devices for more flexible and accessible learning (Kamińska et al., 2023; Zafrullah & Ramadhani, 2024). The strong connection between these two keywords indicates that mobile learning is often seen as an integral part of the wider e-learning ecosystem.

In addition, the strong relationship between mobile learning and "education" suggests that research in this area focuses heavily on the practical application of mobile technologies in an educational context. This includes the use of mobile technologies to support various aspects of education, from teaching to self-directed learning by students (Hussain, Tabbasum, & Hashmi, 2023; Li, Bonk, & Zhou, 2024; Raeisi, 2023). Keywords such as "teaching" and "learning systems" also indicate the importance of exploring how learning systems can be optimized through mobile technology, as well as how teaching methods can be adapted to harness the full potential of mobile learning (Alam & Mohanty, 2023; Gligorea et al., 2023).

Another theme that emerges is the focus on students, which is reflected by the frequent occurrence of the keyword "students" in this map. This suggests that much of the research on mobile learning is focused on its impact on students' learning experiences. These studies often explore how mobile learning can help increase student engagement, provide access to learning materials anytime and anywhere, and support more personalized learning tailored to individual needs (Abduljawad & Ahmad, 2023; Khasawneh & Khasawneh, 2023; Pratama, Sampelolo, & Lura, 2023; Salhab & Daher, 2023b).

The co-occurrence analysis also shows the importance of related technologies, such as "smartphones" and "mobile devices," which appear in relation to mobile learning. This indicates that mobile devices, especially smartphones, are an important component in the implementation of mobile learning. Research in this area often explores how these devices can be used effectively in educational settings, as well as the challenges that may arise in their use, such as limited

access or the need for adequate infrastructure (Criollo-C, Guerrero-Arias, Jaramillo-Alcázar, & Luján-Mora, 2021; Nikolopoulou, 2020).

Buzzwords such as "augmented reality" also appear in the context of mobile learning, indicating a growing interest in combining this technology with mobile learning. Augmented reality offers new opportunities to create more immersive and interactive learning experiences, which can improve student understanding and retention (Alzahrani, 2020; Dhar, Rocks, Samarasinghe, Stephenson, & Smith, 2021). This reflects a broader trend in educational technology research, where advanced technologies such as augmented reality and virtual reality are increasingly being integrated into educational practice (H. Zhang et al., 2020).

Finally, the map also shows a focus on specific contexts, such as "developing countries" and "higher education," indicating that research on mobile learning is not limited to specific contexts, but also covers a variety of educational environments around the world. This suggests that mobile learning is considered a potential solution to educational challenges across countries and levels of education, especially in higher education and developing country contexts that may face infrastructure or access to educational resources constraints. (Al-Rahmi et al., 2021; Criollo-C et al., 2021).

Overall, this co-occurrence map analysis provides rich insights into trends and research focuses in mobile learning. It shows that mobile learning has become a highly relevant topic in education, with research covering a wide range of aspects from the technologies used to their impact on students and how these technologies can be integrated into different educational systems. Through this analysis, we can understand how mobile learning is developing as an important research field and how these trends may influence future research directions.

Conclusion

In the digital era, mobile learning has emerged as a significant transformative force in education, changing the way knowledge is acquired, shared, and applied. Mobile learning or m-learning refers to educational practices facilitated through mobile devices such as smartphones, tablets, and laptops, allowing learners to access educational content anytime and anywhere. The proliferation of mobile technologies has not only expanded the accessibility of education but also introduced new pedagogical possibilities that meet the needs of diverse learners in a variety of contexts. With rapid technological advances, including the availability of high-speed internet, the development of sophisticated mobile applications, and the increasing capabilities of devices, mobile learning is creating new opportunities for educators and learners for more interactive, personalized, and flexible learning experiences. Although the field is relatively new and still faces challenges such as digital equity and content quality, mobile learning has attracted significant interest in academic research and practical implementation. Bibliometric analysis helps identify trends, emerging themes, and knowledge gaps, providing guidance for future studies and education policy in the increasingly digital era..

Author Contributions
Yulia Fitri Ananda: Writing—original draft preparation, methodology, Analysis; Usmeldi: Conceptualization, review and editing, formal analysis.

Funding
This research received no external funding

Conflicts of Interest
The authors declare no conflict of interest.

References

Abduljawad, M., & Ahmad, A. (2023). An analysis of mobile learning (M-Learning) in education. *Multicultural Education*, *9*(2), 2023.

Ahmad, S. T., Watrianthos, R., Samala, A. D., Muskhir, M., & Dogara, G. (2023). Project-based Learning in Vocational Education: A Bibliometric Approach. *International Journal Modern Education and Computer Science*, *15*(4), 43–56. https://doi.org/10.5815/ijmecs.2023.04.04

Alam, A., & Mohanty, A. (2023). Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools. *Cogent Engineering*, *10*(2), 2283282.

Al-Emran, M., Elsherif, H. M., & Shaalan, K. (2016). Investigating attitudes towards the use of mobile learning in higher education. *Computers in Human Behavior*, *56*, 93–102.

Alenezi, M. (2023). Digital learning and digital institution in higher education. *Education Sciences*, *13*(1), 88.

Almaiah, M. A., Alamri, M. M., & Al-Rahmi, W. (2019). Applying the UTAUT model to explain the students' acceptance of mobile learning system in higher education. *Ieee Access*, *7*, 174673–174686.

Al-Rahmi, A. M., Al-Rahmi, W. M., Alturki, U., Aldraiweesh, A., Almutairy, S., & Al-Adwan, A. S. (2021). Exploring the factors affecting mobile learning for sustainability in higher education. *Sustainability*, *13*(14), 7893.

AlRyalat, S. A. S., Malkawi, L. W., & Momani, S. M. (2019). Comparing bibliometric analysis using PubMed, Scopus, and Web of Science databases. *JoVE (Journal of Visualized Experiments)*, (152), e58494.

Alzahrani, N. M. (2020). Augmented reality: A systematic review of its benefits and challenges in e-learning contexts. *Applied Sciences*, *10*(16), 5660.

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, *1*(1), 377–386.

Banafaa, M., Shayea, I., Din, J., Azmi, M. H., Alashbi, A., Daradkeh, Y. I., & Alhammadi, A. (2023). 6G mobile communication technology: Requirements, targets, applications, challenges, advantages, and opportunities. *Alexandria Engineering Journal*, *64*, 245–274.

Bano, M., Zowghi, D., Kearney, M., Schuck, S., & Aubusson, P. (2018). Mobile learning for science and mathematics school education: A systematic review of empirical evidence. *Computers & Education*, *121*, 30–58.

Baran, E. (2014). A review of research on mobile learning in teacher education. *Journal of Educational Technology & Society*, *17*(4), 17–32.

Behl, A., Jayawardena, N., Pereira, V., Islam, N., Del Giudice, M., & Choudrie, J. (2022). Gamification and e-learning for young learners: A systematic literature review, bibliometric analysis, and future research agenda. *Technological Forecasting and Social Change*, *176*, 121445.

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM*, *48*, 589–610.

Chang, C.-Y., Lai, C.-L., & Hwang, G.-J. (2018). Trends and research issues of mobile learning studies in nursing education: A review of academic publications from 1971 to 2016. *Computers & Education*, *116*, 28–48.

Chen, X., Zou, D., Xie, H., & Wang, F. L. (2021). Past, present, and future of smart learning: a topic-based bibliometric analysis. *International Journal of Educational Technology in Higher Education*, *18*(1), 2.

Chiang, T. H. C., Yang, S. J. H., & Hwang, G.-J. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. *Journal of Educational Technology & Society*, *17*(4), 352–365.

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile learning technologies for education: Benefits and pending issues. *Applied Sciences*, *11*(9), 4111.

Crompton, H., & Burke, D. (2018). The use of mobile learning in higher education: A systematic review. *Computers & Education*, *123*, 53–64.

Crompton, H., Burke, D., & Gregory, K. H. (2017). The use of mobile learning in PK-12 education: A systematic review. *Computers & Education*, *110*, 51–63.

Dhar, P., Rocks, T., Samarasinghe, R. M., Stephenson, G., & Smith, C. (2021). Augmented reality in medical education: students' experiences and learning outcomes. *Medical Education Online*, *26*(1), 1953953.

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 53.

Gligorea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., & Tudorache, P. (2023). Adaptive learning using artificial intelligence in e-learning: a literature review. *Education Sciences*, *13*(12), 1216.

Gusenbauer, M. (2022). Search where you will find most: Comparing the disciplinary coverage of 56 bibliographic databases. *Scientometrics*, *127*(5), 2683–2745.

Hamidi, H., & Chavoshi, A. (2018). Analysis of the essential factors for the adoption of mobile learning in higher education: A case study of students of the University of Technology. *Telematics and Informatics*, *35*(4), 1053–1070.

Hussain, T., Tabbasum, S., & Hashmi, A. (2023). Examining the Relationship between Students' Utilization of Technology and Self-Directed Learning: A Research in Pakistan. *Annals of Human and Social Sciences*, *4*(2), 471–480.

Irwanto, I., Saputro, A. D., Widiyanti, W., & Laksana, S. D. (2023). Global trends on mobile learning in higher education: A bibliometric analysis (2002–2022). *IJIET: International Journal of Information and Education Technology*, *13*(2), 223–231.

Josué, A., Bedoya-Flores, M. C., Mosquera-Quiñonez, E. F., Mesías-Simisterra, Á. E., & Bautista-Sánchez, J. V. (2023). Educational Platforms: Digital Tools for the teaching-learning process in Education. *Ibero-American Journal of Education & Society Research*, *3*(1), 259–263.

Kamińska, D., Zwoliński, G., Laska-Leśniewicz, A., Raposo, R., Vairinhos, M., Pereira, E., … Anbarjafari, G. (2023). Augmented reality: Current and new trends in education. *Electronics*, *12*(16), 3531.

Khasawneh, M. A. S., & Khasawneh, Y. J. A. (2023). Analyzing the Effectiveness of Mobile Devices and

Apps in Supporting Learning. *Migration Letters*, *20*(S1), 901–910.

Lai, C. (2020). Trends of mobile learning: A review of the top 100 highly cited papers. *British Journal of Educational Technology*, *51*(3), 721–742.

Li, Z., Bonk, C. J., & Zhou, C. (2024). Supporting learners self-management for self-directed language learning: a study within Duolingo. *Interactive Technology and Smart Education*, *21*(3), 381–402.

Mohtar, S., Jomhari, N., Mustafa, M. B., & Yusoff, Z. M. (2023). Mobile learning: research context, methodologies and future works towards middle-aged adults–a systematic literature review. *Multimedia Tools and Applications*, *82*(7), 11117–11143.

Mukul, E., & Büyüközkan, G. (2023). Digital transformation in education: A systematic review of education 4.0. *Technological Forecasting and Social Change*, *194*, 122664.

Muskhir, M., Luthfi, A., Julian, R., & Fortuna, A. (2023). Exploring iSpring Suite for Android-Based Interactive Instructional Media in Electrical Lighting Installation Subject. *International Journal of Interactive Mobile Technologies*, *17*(22).

Muskhir, M., Luthfi, A., Watrianthos, R., Usmeldi, U., Fortuna, A., & Dwinggo Samala, A. (2024). Emerging Research on Virtual Reality Applications in Vocational Education: A Bibliometric Analysis. *Journal of Information Technology Education: Innovations in Practice*, *23*, 005. https://doi.org/10.28945/5284

Naveed, Q. N., Choudhary, H., Ahmad, N., Alqahtani, J., & Qahmash, A. I. (2023). Mobile Learning in Higher Education: A Systematic Literature Review. *Sustainability*, *15*(18), 13566.

Nikolopoulou, K. (2020). Secondary education teachers' perceptions of mobile phone and tablet use in classrooms: benefits, constraints and concerns. *Journal of Computers in Education*, *7*(2), 257–275.

Pölönen, J., Laakso, M., Guns, R., Kulczycki, E., & Sivertsen, G. (2020). Open access at the national level: A comprehensive analysis of publications by Finnish researchers. *Quantitative Science Studies*, *1*(4), 1396–1428.

Pratama, M. P., Sampelolo, R., & Lura, H. (2023). Revolutionizing education: harnessing the power of artificial intelligence for personalized learning. *Klasikal: Journal of Education, Language Teaching and Science*, *5*(2), 350–357.

Raeisi, S. (2023). Self-Directed and Autonomous Learning Concerning Using Technology-Based Activities in Distance Learning. *Language and Translation*, *13*(4), 181–189.

Rakha, N. A. (2023). Revolution in learning through digitization: How technology is changing the landscape of education. *International Journal of Cyber Law*, *1*(3).

Salhab, R., & Daher, W. (2023a). The impact of mobile learning on students' attitudes towards learning in an educational technology course. *Multimodal Technologies and Interaction*, *7*(7), 74.

Salhab, R., & Daher, W. (2023b). University students' engagement in mobile learning. *European Journal of Investigation in Health, Psychology and Education*, *13*(1), 202–216.

Samala, A. D., Usmeldi, Taali, Daineko, Y., Indarta, Y., Nando, Y. A., … Almasri. (2023). Global Publication Trends in Augmented Reality and Virtual Reality for Learning: The Last Twenty-One Years. *International Journal of Engineering Pedagogy (IJEP)*, *13*(2), 109–128. https://doi.org/10.3991/ijep.v13i2.35965

Tlili, A., Padilla-Zea, N., Garzón, J., Wang, Y., Kinshuk, K., & Burgos, D. (2023). The changing landscape of mobile learning pedagogy: A systematic literature review. *Interactive Learning Environments*, *31*(10), 6462–6479.

van Kraalingen, I. (2023). Theorizing technological mediation in the outdoor classroom. *Postdigital Science and Education*, *5*(3), 754–776.

Watrianthos, R., Ahmad, S. T., & Muskhir, M. (2023). Charting the Growth and Structure of Early ChatGPT-Education Research: A Bibliometric Study. *Journal of Information Technology Education: Innovations in Practice*, *22*, 235–253.

Watrianthos, R., Ambiyar, A., Rizal, F., Jalinus, N., & Waskito, W. (2022a). Research on Vocational Education in Indonesia: A Bibliometric Analysis. *JTEV (Jurnal Teknik Elektro Dan Vokasional)*, *8*(2). https://doi.org/https://doi.org/10.24036/jtev.v8i2.117045

Watrianthos, R., Ambiyar, A., Rizal, F., Jalinus, N., & Waskito, W. (2022b). Research on Vocational Education in Indonesia: A Bibliometric Analysis. *JTEV (Jurnal Teknik Elektro Dan Vokasional)*, *8*(2), 187. https://doi.org/10.24036/jtev.v8i2.117045

Zafrullah, Z., & Ramadhani, A. M. (2024). The use of mobile learning in schools as a learning media: Bibliometric analysis. *Indonesian Journal of Educational Research and Technology*, *4*(2), 187–202.

Zhang, H., Cui, Y., Shan, H., Qu, Z., Zhang, W., Tu, L., & Wang, Y. (2020). Hotspots and trends of virtual reality, augmented reality and mixed reality in education field. *2020 6th International Conference of the Immersive Learning Research Network (ILRN)*, 215–219. IEEE.

Zhang, X., Hai, Y. J., & Li, C. (2024). Learning Management System in Education via Mobile App: Trends and Patterns in Mobile Learning.

International Journal of Interactive Mobile Technologies, *18*(9).