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TRENDS IN SCIENCE LEARNING MEDIA RESEARCH IN PRIMARY EDUCATION: A BIBLIOMETRIC ANALYSIS

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Abstract

ABSTRACT
The advancement of educational technology has reshaped science learning in primary education, with learning media playing a pivotal role in enhancing students' engagement and scientific literacy. Although research in this area has grown steadily, systematic mapping is still limited. This study applies a bibliometric approach to analyze global trends in science learning media research within primary education using 166 publications indexed in Scopus from 2015 to 2025. Data were processed with Bibliometrix (R packages) to examine publication growth, sources, affiliations, keyword co-occurrence, and thematic evolution. The results reveal an annual growth rate of 4.45%, with research dominated by collaborative and interdisciplinary works involving 1,168 authors and an average of 9.78 co-authors per document. The most relevant publication sources include the Journal of Physics: Conference Series, AIP Conference Proceedings, and PLOS ONE, while leading affiliations are Universitas Negeri Jakarta, University of Rwanda, and University of Southampton. Keyword analysis highlights "students" as the most frequent term, alongside themes such as e-learning, STEM, engineering education, augmented reality, and artificial intelligence. Trend analysis shows a thematic shift from traditional pedagogy toward adaptive and technology-driven approaches. Future opportunities emphasize artificial intelligence, immersive learning (VR/AR), educational robotics, sustainable development, and cross-national collaboration. These findings provide a comprehensive overview of the research landscape, identify key contributors and emerging themes, and suggest strategic directions for advancing innovative science learning media in primary education.

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INTRODUCTION

Natural Science learning in elementary education plays a crucial role in developing students' scientific understanding, curiosity, and critical thinking skills. At this stage, students are still in a concrete stage of cognitive development, requiring learning experiences that connect abstract concepts to everyday realities (Coles & Sinclair, 2019). Learning media serve as a bridge between conceptual material and student understanding, as they can present natural phenomena in visual, interactive, and simulated forms (Arsyad et al., 2024; Kuncoro et al., 2023). Thus, learning media serve not only as aids but also as a means to strengthen knowledge construction and foster interest in learning science from an early age.

Developments in educational technology have increasingly expanded the range of science learning media available in elementary schools. While previously science learning relied heavily on textbooks and simple teaching aids, now a variety of digital-based media such as interactive videos, computer simulations, augmented reality (AR), and educational games are available. This technology-based media allows for the presentation of phenomena that are difficult to observe directly, such as particle movement, human body systems, or natural cycles (Bielik et al., 2022; Papanastasiou et al., 2019). Furthermore, digital media supports more participatory and student-centered learning,

enabling students to become more than just recipients of information, but also actively explore, observe, and experiment in a richer learning environment (Awidi & Paynter, 2024; Abdigapbarova & Zhiyenbayeva, 2023).

The importance of science learning media in elementary education also lies in its contribution to achieving 21st-century educational goals. Innovative media not only enhances understanding of scientific concepts but also fosters critical thinking, problem-solving, creativity, and collaboration skills (Chen, 2021). In this context, the appropriate use of learning media can help reduce the gap in education quality, especially in areas with limited resources (Puspitarini & Hanif, 2019; Wang et al., 2019). Therefore, research on trends in science learning media in elementary schools is very relevant, because it can provide a comprehensive picture of the direction of development, effectiveness, and opportunities for innovation that support improving the quality of science learning at the elementary level.

Several previous studies have discussed the effectiveness of various types of learning media in supporting science learning in elementary schools, ranging from the use of traditional teaching aids to the use of digital technologies such as interactive multimedia, augmented reality, and game-based learning (Ariesta, 2019; Darman et al., 2024; Puspitarini & Hanif, 2019; Salim et al., 2024; Wibowo et al., 2024). These research results generally demonstrate the positive contribution of media in improving students' motivation, conceptual understanding, and critical thinking skills. However, most of these studies are fragmented, focusing on specific media implementations, or conducted locally without providing a comprehensive overview of how science learning media research trends are evolving globally. This raises the need for scientific mapping studies that can present a comprehensive knowledge map.

However, to date, few studies have specifically conducted bibliometric analysis related to science learning media at the primary education level. Existing bibliometric studies often focus on general science education, STEM education, or learning technology at the secondary and tertiary levels. The absence of bibliometric mapping focused on science learning in elementary schools makes it difficult to discern the direction of research developments in this field, including key research actors, dominant thematic trends, and potential future research gaps. Therefore, this study is crucial in providing a comprehensive overview of the scientific landscape of science learning media in elementary education, while also offering a foundation for further research and more targeted educational policymaking.

Given the crucial role of science learning media in elementary education and the limited number of bibliometric studies specifically mapping this field, this study aims to provide a comprehensive overview of emerging research trends. Specifically, this study seeks to trace the growth of scientific publications discussing science learning media in elementary education, the most productive and influential institutions and sources in the field, and to uncover the main themes and keywords that dominate the research. Furthermore, this study aims to identify remaining research gaps, thus providing a basis for future research development. Thus, this research not only contributes to scientific mapping, but also offers strategic guidance for researchers and educational practitioners to strengthen innovation in science learning in elementary schools.

METHOD

This study uses bibliometric analysis methods to map and evaluate scientific publications related to the use of instructional media in science teaching in elementary education indexed in the Scopus database (Chang et al., 2023; Supriadi et al., 2022). Scopus was chosen as the primary data source due to its broad multidisciplinary coverage, rigorous indexing mechanisms, and standardized metadata, ensuring the quality and credibility of the analyzed publications (Haghani, 2023; Pranckutė, 2021). The search strategy was systematically designed using a combination of keywords such as "learning media," "science education," and "primary education," operated through Boolean operators in the title, abstract, and keywords fields to broaden the search scope. This approach aims to capture the variety of terms used by authors while minimizing the risk of missing relevant publications. Initial search results covered all document types and publication years, then filtered based on their relevance to the topic of science instructional media in elementary education in the 2015–2025 period. The search was limited to journal articles and conference proceedings to ensure the data analyzed was relevant and met academic standards.

The bibliometric analysis procedure in this study was systematically structured to ensure that data collection and processing were carried out accurately and in accordance with the research objectives. The stages began with determining keywords and search criteria in the Scopus database, followed by a publication selection process to obtain relevant and high-quality datasets. The metadata of the selected publications was then downloaded in CSV format and analyzed using the Bibliometrix package in RStudio to explore publication trends, influential research actors, collaboration patterns, keyword distribution, and the evolution of research themes. The analysis process was enriched with visualizations through Biblioshiny, facilitating the interpretation of relationship patterns and research dynamics. A brief overview of the bibliometric analysis procedure in this study is shown in Figure 1.

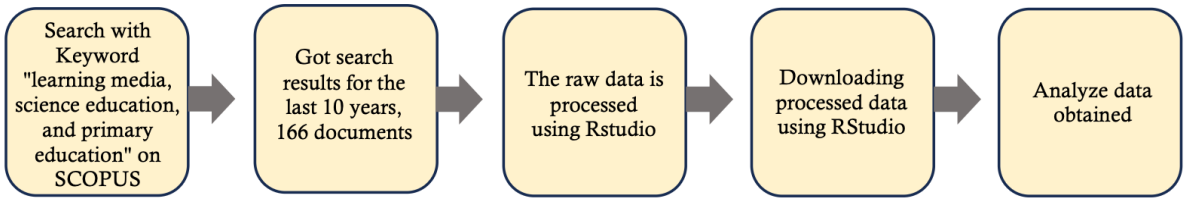

Figure 1. Data Collection and Processing Flow

The data collection process for this study began with a literature search in the Scopus database using the keywords "learning media, science education, and primary education." The search was limited to the past ten years, resulting in a total of 166 documents relevant to the research focus. Scopus was selected based on its broad multidisciplinary coverage and high-quality indexing, ensuring the accuracy of the bibliometric data for analysis. The obtained data was then exported in CSV format to facilitate further processing using analysis software.

The next stage was raw data processing with the help of RStudio through the Bibliometrix package. The processed data was then analyzed in more depth using RStudio to produce various visualizations, such as publication trends, author and institutional collaboration networks, and keyword maps. This analysis enabled the researchers to identify patterns, interconnections, and key themes in research on science learning media in primary education. The results of the analysis provided the basis for answering the research questions and identifying research gaps that remain open for future development.

RESULTS AND DISCUSSION

Results:

The dataset analyzed in this study covers the publication period between 2015 and 2025, with a total of 166 documents originating from 108 publication sources, both journals and conference proceedings. Overall, the research trend shows an annual growth rate of 4.45%, with an average document age of 4.33 years and an average citation rate of 8.27 citations per document. In terms of content, the analyzed literature contains 870 Keywords Plus and 1,279 keywords from authors, indicating the diversity of terms and themes developed in this research. The analysis also involved 1,168 authors with a high level of collaboration, reflected in 9.78 authors per document, as well as 13.25% international collaboration. No single-author publications were found, confirming that this field is generally developed through collective collaboration. In terms of document type, the majority are journal articles (98 documents), followed by conference papers (68 documents). The characteristics of these data provide an initial overview of the development of science learning media research in elementary education and serve as a basis for further analysis of publication patterns, collaborations, and thematic focus. The results of the bibliographic analysis using Rstudio are as follows:

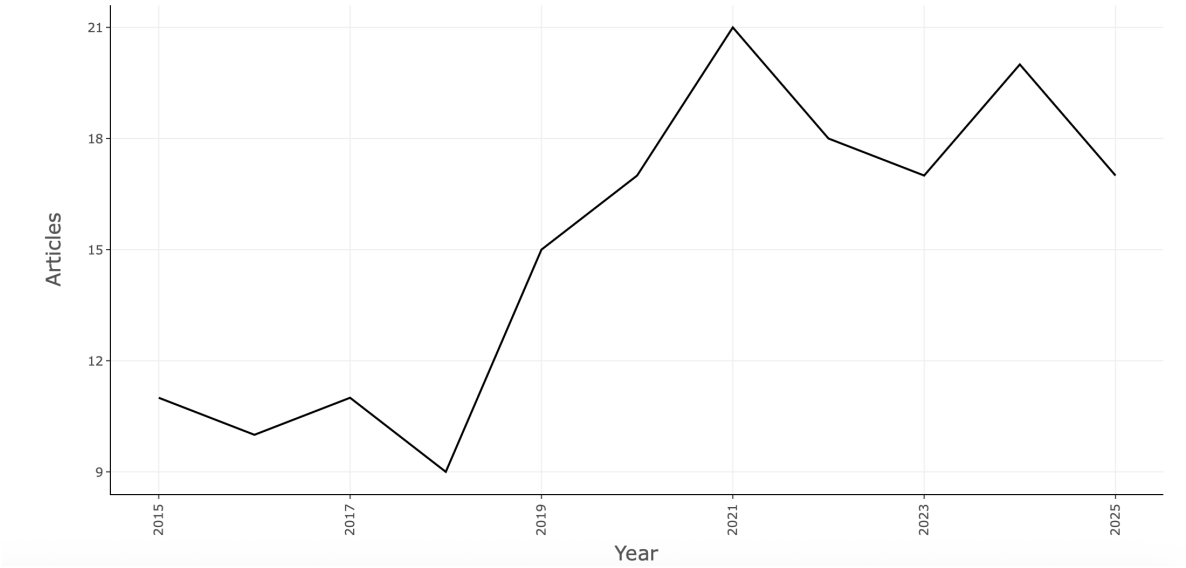

Figure 2. Annual Scientific Production

Analisis produksi ilmiah tahunan menunjukkan adanya peningkatan tren publikasi terkait Analysis of annual scientific production indicates an increasing trend in publications related to science learning media in elementary education during the period 2015–2025. At the beginning of the period, the number of publications was relatively stable with an average of 10–11 articles per year (2015–2017), then experienced a slight decline in 2018 (9 articles). However, from 2019 to 2021, consistent growth was seen, with the highest peak in 2021 of 21 articles, reflecting increased researcher attention to this topic, possibly also influenced by the need for learning innovation during the COVID-19 pandemic. After that, publications tended to fluctuate but remained at a relatively high level, ranging from 17 to 20 articles per year until 2025. This pattern confirms that research on science learning media in elementary education is not only continuing but also diversifying its focus in accordance with the dynamic needs of science education in elementary schools.

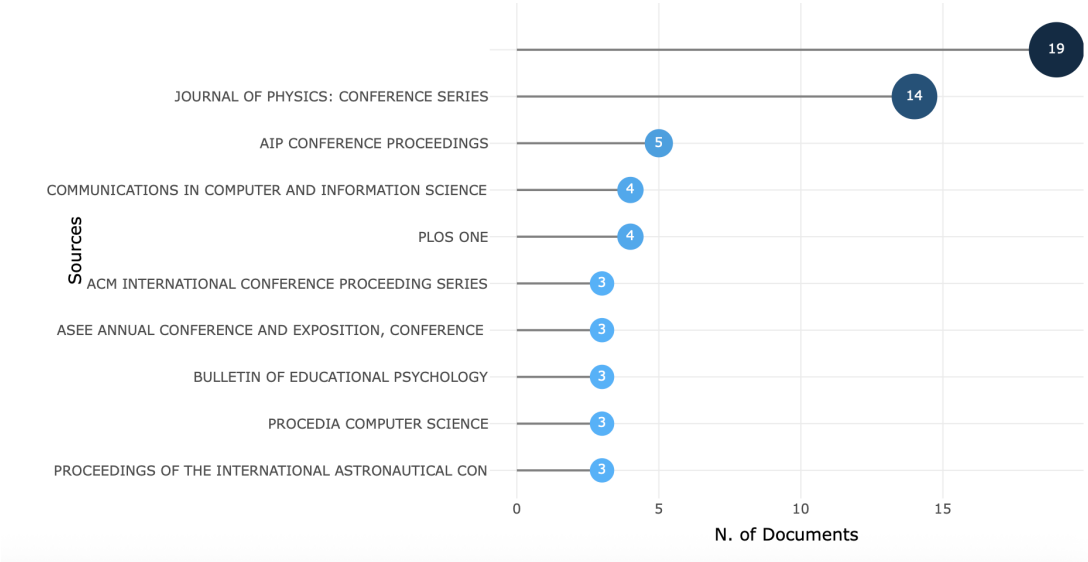

Figure 3. Most Relevant Sources

The analysis of the most relevant publication sources shows that research on science learning media in elementary education is spread across various journals and international conference proceedings. Journal of Physics: Conference Series is in the top position with 14 articles, followed by AIP Conference Proceedings with 5 articles, and Communications in Computer and Information Science and PLOS ONE which each contributed 4 articles. Several other sources that also contributed are ACM International Conference Proceeding Series, ASEE Annual Conference and Exposition, Bulletin of Educational Psychology, Procedia Computer Science, and Proceedings of the International

Astronautical Congress (IAC) with a relatively balanced number of articles, namely 3 articles. This finding shows that the topic of science learning media in elementary education is not only receiving attention in the fields of education and psychology, but also in the fields of computer science and applied science, indicating the interdisciplinary nature of this research.

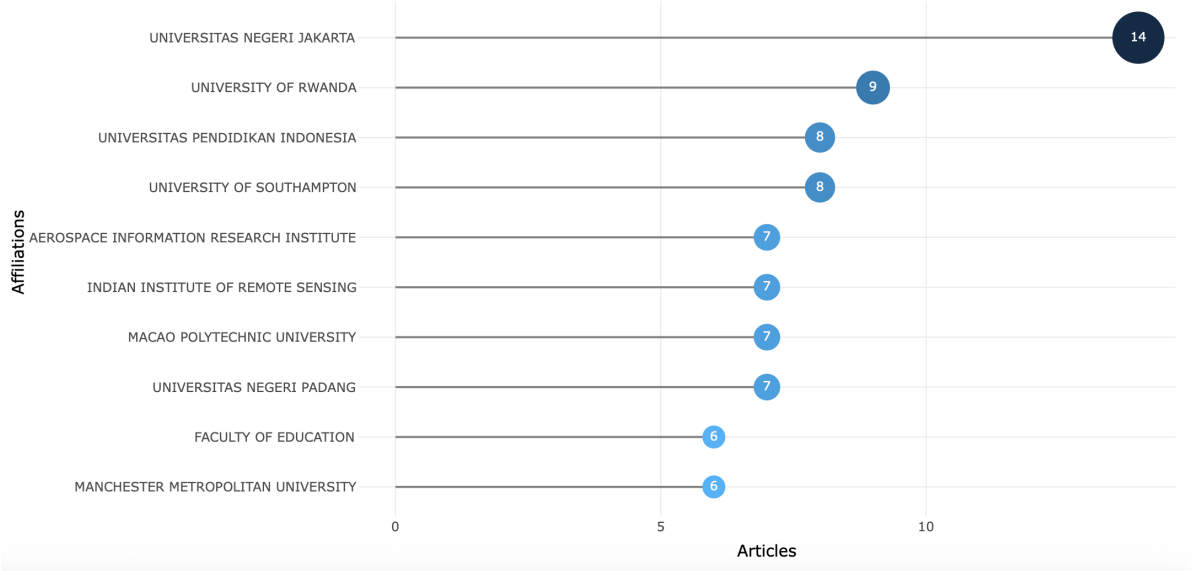

Figure 4. Most Relevant Affiliations

The analysis of the most relevant affiliations shows that the largest contribution in the publication of science learning media research in elementary education comes from the State University of Jakarta with 14 articles, followed by the University of Rwanda with 9 articles, and the Indonesian University of Education and the University of Southampton, which each contributed 8 articles. Furthermore, several other institutions that are quite dominant include the Aerospace Information Research Institute, the Indian Institute of Remote Sensing, Macao Polytechnic University, and Padang State University with the same number of publications, namely 7 articles. In addition, the Faculty of Education and Manchester Metropolitan University are also recorded as active with 6 articles each. This pattern shows that research in this field has a strong contribution from both Indonesian universities and international institutions, thus confirming the existence of global collaboration and broad attention to the development of science learning media in elementary education.

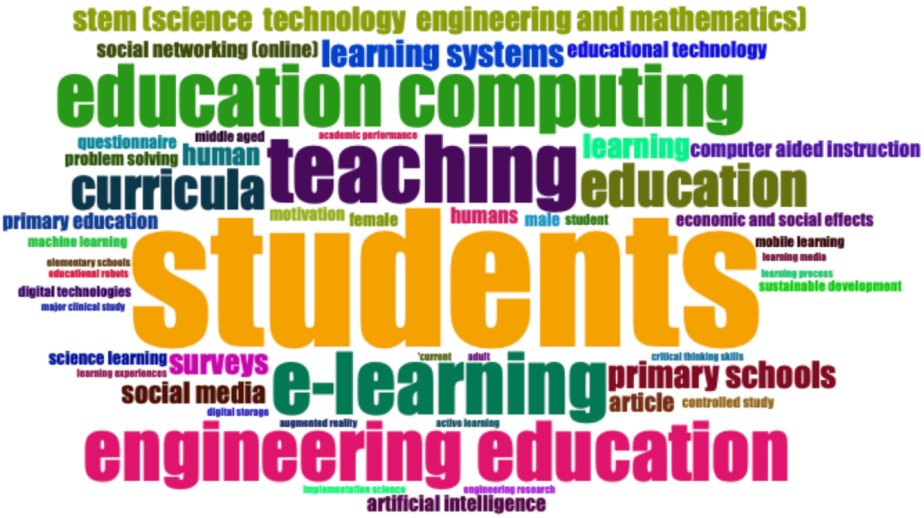

Figure 5. WordCloud

The WordCloud analysis results show that the most dominant term in research on science learning media in elementary education is "students," which emphasizes the research's primary focus

on the role and experience of students as learning subjects. Other prominent terms include "teaching," "education," "e-learning," "computing," and "engineering education," reflecting a strong focus on the integration of digital technology and innovative approaches in learning practices. Furthermore, keywords such as "curricula," "primary schools," "STEM," and "social media" also emerged, demonstrating the diversity of contexts and the interconnectedness of learning media with the curriculum, digital literacy, and the development of 21st-century competencies. The presence of terms such as "artificial intelligence," "machine learning," and "augmented reality" also indicates a new direction in utilizing cutting-edge technology to support science learning in elementary schools. Overall, this WordCloud illustrates a trend toward multidisciplinary research, with an emphasis on the synergy between technology, pedagogy, and the needs of students in the digital era.

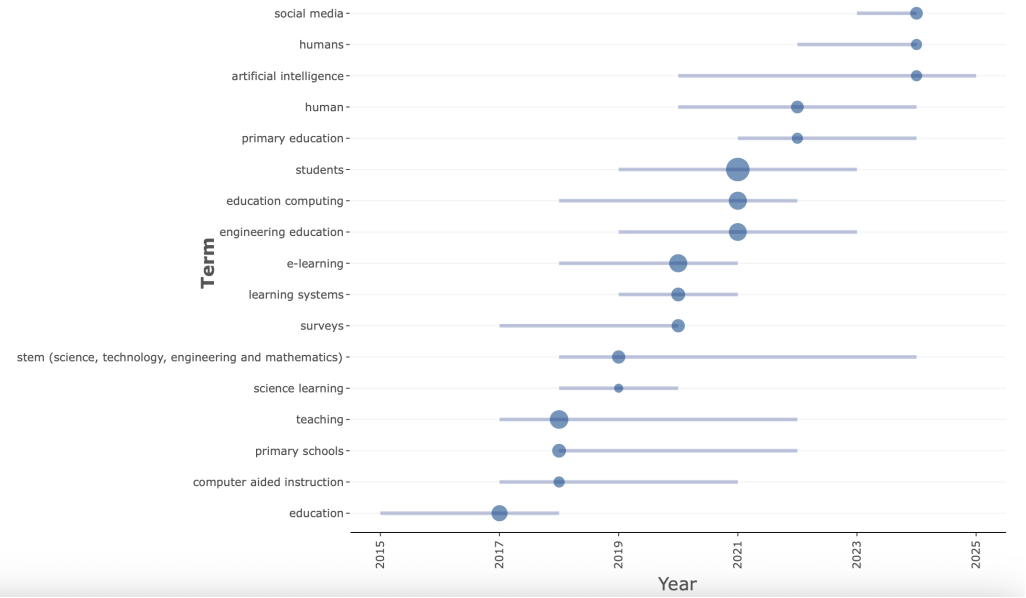

Figure 6. Trend Topics

The trend topic analysis shows the dynamic development of science learning media research themes in elementary education, which continue to adapt to the needs of the times. At the beginning of the period, topics such as education (2015–2018) and teaching (2017–2022) dominated, indicating an initial focus on pedagogical aspects and learning practices. Since 2018, attention has shifted to more specific issues such as primary schools, STEM, science learning, and the use of e-learning and learning systems, which aligns with the integration of digital technology in elementary education. Entering the 2019–2023 period, topics such as students, educational computing, and engineering education have become more prominent, reflecting an emphasis on the role of learners in technology-based learning environments. The latest emerging trends are themes related to cutting-edge technologies, such as artificial intelligence (2020–2025) and social media (2023–2024), indicating a shift in research toward the use of digital innovation and interactive platforms in learning. Overall, these developments demonstrate a transformation of research from a traditional pedagogical focus to a multidisciplinary approach that emphasizes the synergy between education, technology, and learner needs in the digital era.

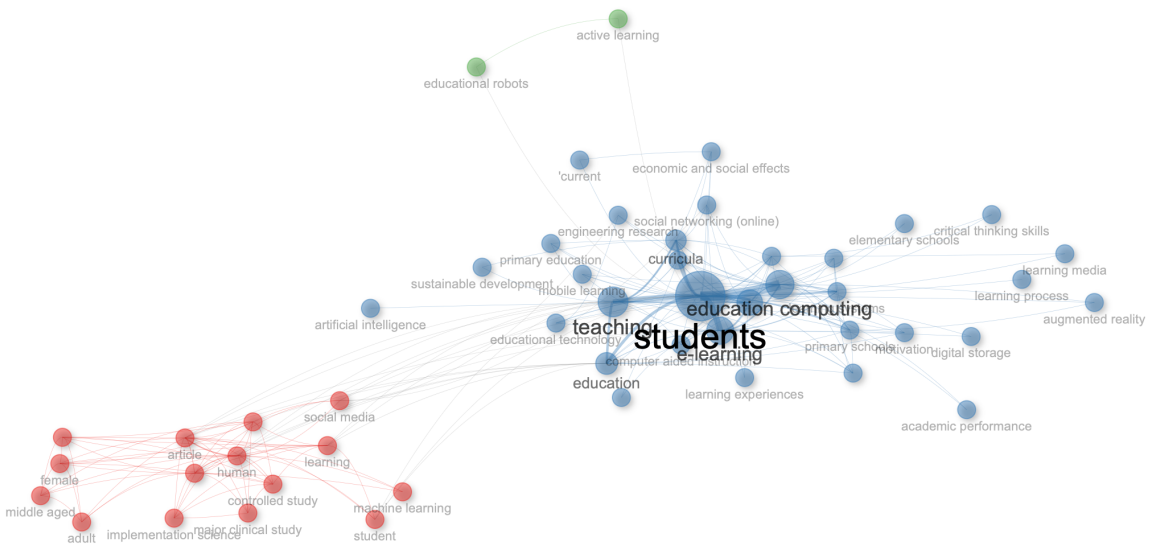

Figure 7. Co-occurrence Network

The Co-occurrence Network data demonstrates the interconnectedness of research concepts divided into several main clusters. In Cluster 1, topics focus on human aspects, such as human, humans, female, male, student, adult, middle-aged, and research methods such as questionnaires and controlled studies, indicating the dominance of empirical studies based on human populations with scientific approaches, including machine learning and implementation science that support data analysis. Cluster 2 represents the educational domain with keywords such as students, teaching, e-learning, curriculum, learning systems, educational technology, STEM, motivation, critical thinking skills, augmented reality, mobile learning, and sustainable development. This emphasizes the research direction on the integration of digital technology in learning, improving academic performance, and its relevance to sustainable development. Meanwhile, Cluster 3 highlights innovative learning strategies through active learning and the use of educational robots, reflecting the trend of interactive technology-based education to enhance the learning experience. Overall, this network shows that research not only emphasizes social and human aspects but also develops towards the application of digital technology and pedagogical innovation to support the effectiveness of modern education.

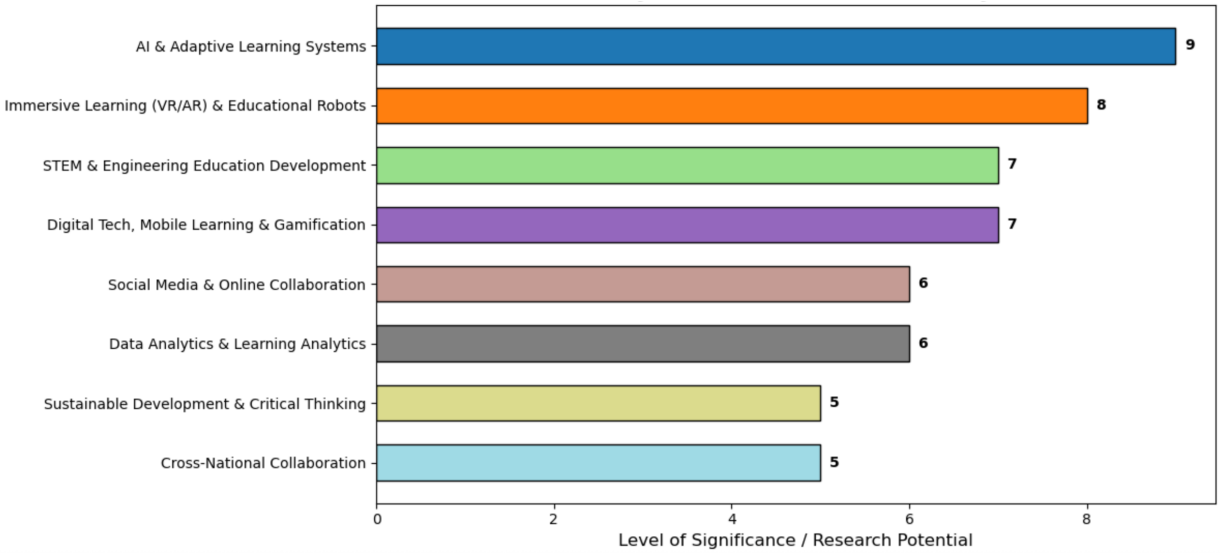

Figure 7. Future Research Opportunities in Science Learning Media

Based on the results of the bibliometric analysis regarding Future Research Opportunities in Science Learning Media, it appears that the most significant research opportunities are in the fields of

Artificial Intelligence (AI) and Adaptive Learning Systems with the highest scores, followed by Immersive Learning (VR/AR) and Educational Robots. This indicates that the integration of intelligent technology and immersive learning experiences remains a primary focus for the development of science learning media. In addition, the topics of STEM & Engineering Education Development as well as Digital Technology, Mobile Learning, and Gamification also occupy important positions, confirming their relevance in supporting 21st-century skills. Meanwhile, the fields of Social Media and Online Collaboration and Data Analytics & Learning Analytics highlight the role of digital interaction and data utilization in optimizing learning. The issues of Sustainable Development & Critical Thinking and Cross-National Collaboration remain significant, albeit with lower scores, which indicates the need for a cross-national approach and strengthening critical thinking skills for the sustainability of science education in the future.

Discussion:

The analysis shows an increasing trend in publications related to science learning media in elementary education, with a growth rate of 4.45% per year. A significant spike occurred in 2021, with 21 articles, likely influenced by the COVID-19 pandemic, which accelerated the use of digital technology in learning. This finding aligns with research by Gorina et al. (2023) and Nurhas et al. (2022), which emphasized that the pandemic has accelerated the transformation of education toward the use of digital-based media. Thus, the increase in publications reflects not only academic needs but also a response to changing global conditions that demand innovation in science learning in elementary schools.

The distribution of publications in international journals and proceedings, such as the Journal of Physics: Conference Series and PLOS ONE, indicates that this topic is attracting attention not only from the field of education but also from computer science and applied science. This phenomenon demonstrates the interdisciplinary nature of science learning media research. According to Wu et al. (2025), cross-disciplinary integration is a crucial feature in the development of 21st-century education because it enables enrichment of pedagogical approaches through collaboration between disciplines. This indicates that science learning media in elementary schools is seen as a domain that requires multidisciplinary contributions to create innovative solutions.

In terms of affiliations, Indonesian universities such as Jakarta State University and the Indonesian University of Education have made significant contributions, alongside international institutions such as the University of Rwanda and the University of Southampton. The fact that no single-authored publications were found underscores the strong collaborative culture within this research. This is consistent with Rossoni et al.'s (2024) view that academic collaboration fosters research quality improvement through the exchange of knowledge and resources. These findings also emphasize the importance of global collaboration, given that the challenges of science education at the elementary level are universal and require a cross-border approach.

Word Cloud analysis shows that the term "students" is the most dominant keyword, confirming that students are the primary focus in the development of learning media. The presence of terms such as "e-learning," "computing," and "engineering education" underscores the relevance of digital technology in shaping the learning experience. Consistent with Oroni and Xianping (2024), learning media functions as mediating tools that enable students to construct knowledge through interaction with the digital environment. This demonstrates that media innovation is not only aimed at conveying information, but also at fostering active student engagement in the science learning process (Rengel, 2019).

Analysis of trend topics indicates a shift from the traditional focus on "education" and "teaching" to cutting-edge themes such as artificial intelligence, social media, and augmented reality. This shift indicates that science learning media research is moving toward a new paradigm that emphasizes the use of intelligent technology and digital interactivity. According to Sajja et al. (2025) and Bhutoria (2022), the integration of AI in education opens up opportunities for personalized learning and deeper learning data analysis. Therefore, research in this area no longer simply emphasizes media effectiveness but also how media can adapt to individual learners' needs.

Findings regarding Future Research Opportunities identify AI, adaptive learning, and immersive learning (VR/AR) as the most promising research opportunities. This confirms the future direction of science learning media, which is increasingly oriented towards utilizing cutting-edge

technology to improve the quality of the learning experience (Crittenden et al., 2019; Oliveira et al., 2019). Furthermore, the issues of sustainable development and cross-national collaboration remain relevant, given the importance of science education in addressing global challenges. In line with UNESCO's (2021) perspective, science education in the 21st century must integrate technology, international collaboration, and sustainability values to prepare a generation that is adaptive to change. Therefore, this research provides a strategic contribution in directing future research focus to be more relevant to the global needs and challenges of science education in elementary schools.

CONCLUSION

The results of this study confirm that studies on science learning media in elementary education show a steady growth trend, characterized by collaboration, interdisciplinary approaches, and a focus on the use of cutting-edge digital technology. The dominance of student-focused themes and the shift in research topics from traditional pedagogical aspects to artificial intelligence, immersive learning, and STEM integration indicate a paradigm shift in science learning in elementary schools. The contributions of institutions from various countries demonstrate that this issue is receiving global attention, while also opening up opportunities for cross-border collaboration. The implications of these findings are the need for policy directions and further research that emphasize the development of adaptive, contextual, and sustainable learning media, which not only enhance understanding of scientific concepts but also equip students with 21st-century skills, such as critical thinking, digital literacy, and sustainability awareness. Thus, this study provides a conceptual and strategic basis for the development of innovative science learning media in elementary education, both in academic contexts and in educational practice.

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