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Mapping Electronic Module Research for Basic Education Literacy: Bibliometric Analysis (2014-2024)

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Abstract: This study aims to map the development of research on electronic modules for learning literacy at the elementary school level through a bibliometric analysis approach. The research data was obtained from the Scopus database with a publication range of 2014-2024, using keywords related to electronic modules, learning literacy, and elementary education. The analysis was conducted using VOSviewer (version 1.6.19) and Biblioshiny to identify trends in publication growth, productive journals and sources, contributions by authors, institutions, and countries, as well as patterns of collaboration and co-occurrence of keywords. The analysis shows that research on electronic modules for learning literacy in elementary schools has increased consistently, with a significant surge in the period 2020-2024. Journals in the field of educational technology and digital learning are the main sources of publication, while research contributions are still dominated by countries with established educational technology infrastructure. Keyword analysis shows a shift in research focus from the technical aspects of module development to greater attention to pedagogical impact, student engagement, and the strengthening of higher-order thinking skills. Overall, this research provides a comprehensive overview of the direction and structure of research on electronic modules for learning literacy in elementary schools, and can be a reference for researchers and practitioners of elementary education in developing more contextual and effective digital teaching materials.

Keywords: Basic Education, Bibliometric Analysis, Electronic Modules, Learning Literacy

A. Introduction

Digital transformation has been one of the main agendas in global education system reform over the past decade. The integration of digital technology into learning is no longer seen as an additional innovation, but rather as a strategic necessity to ensure the relevance of education to the demands of a knowledge- and information-based society. The OECD report (2019) emphasizes that 21st-century education systems are required to develop students who not only master academic content but also possess

digital literacy, critical thinking skills, and lifelong learning capabilities. In this context, digital learning resources play a central role in bridging pedagogical goals with technological developments.

One rapidly growing form of digital learning resources is electronic modules (e-modules). Electronic modules are structured teaching materials designed for independent or guided learning, utilizing digital and multimedia technology to increase student engagement and understanding (Alessi & Trollip, 2018). Unlike conventional printed modules, e-modules allow for the integration of various representations of information, including text, visuals, audio, video, animation, and interactive evaluations, which theoretically can support a richer and more meaningful learning process. Mayer (2020) emphasizes that "digital learning materials are most effective when they are designed to align with how learners process information," highlighting the importance of cognitive design in the development of digital teaching materials.

At the elementary school level, the role of electronic modules becomes increasingly crucial because this phase is a fundamental stage in the formation of students' literacy skills. Literacy in basic education includes not only reading and writing skills, but also the ability to understand, interpret, and use information in various forms and contexts. Thus, digital transformation and the development of electronic modules cannot be separated from the agenda of strengthening learning literacy from primary education as the foundation for long-term academic success.

Although the potential of electronic modules in supporting literacy learning has been widely recognized, their implementation in elementary schools still faces various challenges. International literature consistently highlights the existence of a digital divide between regions and schools, the limited readiness and competence of teachers in integrating digital teaching materials, and variations in the quality of available electronic module content (OECD, 2020; UNESCO, 2021). These challenges indicate that the adoption of e-modules is not merely a matter of technology, but also relates to pedagogical, institutional, and contextual aspects.

In the context of basic education, these challenges become more complex due to the characteristics of early childhood learners, who require a special pedagogical approach. Electronic modules that are not designed in accordance with children's cognitive and literacy development stages have the potential to be ineffective, even counterproductive. Therefore, a comprehensive understanding of how electronic modules are developed, researched, and implemented in the context of primary school literacy is very important.

The existence of these implementation challenges has actually encouraged increased academic attention to research on electronic modules, particularly those focused on

learning literacy in elementary schools. Researchers are exploring effective module designs, appropriate pedagogical approaches, and the impact of e-module use on various aspects of student literacy. However, as the number of publications increases, important questions arise regarding the overall development of research in this field: what themes are most dominant, how is the focus of research shifting, and to what extent does existing research shape the collective understanding of electronic modules and literacy in primary education.

At this point, the need for a macro-level synthesis approach becomes increasingly urgent. Without systematic mapping, rapidly developing research risks becoming fragmented and difficult to provide a strong conceptual foundation for the development of educational policy and practice. Therefore, an approach is needed that can capture the big picture of the development of research on electronic modules for learning literacy in elementary schools.

Previous empirical studies have generally shown that electronic modules have positive potential in supporting literacy learning at the elementary school level. Septyarini and Puspitasari (2022), for example, reported that the use of interactive e-modules can significantly improve elementary school students' reading comprehension compared to printed teaching materials. Similar findings were also shown by Wijaya et al. (2021), who found that problem-based electronic modules contributed to an increase in students' critical thinking skills. From an affective aspect, Nisa et al. (2020) showed that e-modules designed with multimedia elements were able to increase the motivation and learning engagement of elementary school students.

Although these findings provide important empirical evidence, the studies are generally context-specific, limited to certain subjects, certain regions, or certain module designs. In other words, existing research tends to answer the question "are e-modules effective in this context," but few have answered the broader question of "how is this field of research developing as a whole?" As a result, our understanding of the intellectual structure, thematic trends, and direction of research on electronic modules for primary school literacy remains partial.

At the same time, the literature also highlights that challenges in implementing electronic modules, such as the digital divide, teacher readiness, and content quality, remain persistent issues (UNESCO, 2021). However, discourse on these challenges often appears separate from macro-level analysis of research developments. This creates a gap between micro-level empirical evidence and macro-level conceptual understanding of the field. Without a comprehensive synthesis, it is difficult to identify areas of research that are saturated, areas that remain under-explored, and the most relevant opportunities for future research.

In this context, bibliometric analysis offers a relevant and strategic approach to bridge this gap. Bibliometric analysis is a quantitative method used to evaluate and map scientific literature based on publication patterns, citations, collaborations, and keyword co-occurrence (Zupic & Čater, 2015). Donthu et al. (2021) state that bibliometric analysis allows researchers to "systematically explore the intellectual structure and research trends of a scientific field," thereby providing a comprehensive picture of how a field has developed over time.

In the field of education, the bibliometric approach is increasingly being used to map research on digital learning, educational technology, and literacy. However, bibliometric studies that specifically focus on electronic modules and learning literacy at the elementary school level are still relatively limited. In fact, elementary education has pedagogical characteristics and student development that differ significantly from secondary and higher education, so that findings from other levels cannot always be generalized.

The 2014-2024 time frame was chosen for this study to represent a crucial decade in the development of digital learning. This period covers the early phase of electronic module adoption, increased integration of mobile and multimedia technology, and the acceleration of digital teaching materials use due to the COVID-19 pandemic. Hodges et al. (2020) emphasize that the pandemic has been a major catalyst in the adoption of digital learning at all levels of education, including elementary schools. Therefore, longitudinal analysis within this time frame allows for the identification of changes in research focus before and after this period of global crisis.

In addition, bibliometric mapping on an international scale enables the identification of the contributions of various countries and institutions in the development of electronic module research for primary school literacy. This information is important for understanding the global dynamics of research and the potential for disparities in contributions between regions.

Theoretically, this study contributes to the literature by presenting a macro synthesis of the development of research on electronic modules and learning literacy in elementary schools. By mapping the intellectual structure and evolution of research themes, this study helps clarify the position of electronic modules in the discourse on literacy and digital learning. Practically, the findings of this study can serve as a reference for researchers, instructional material developers, and policymakers in designing more targeted and evidence-based research and learning interventions.
Based on this background, this study aims to map the international research landscape on electronic modules for learning literacy at the elementary school level through bibliometric analysis of scientific publications from 2014 to 2024. Specifically, this study seeks to answer the following research questions:

1. What is the growth trend of research publications on electronic modules for learning literacy in elementary schools during the period 2014-2024?
2. Which journals, authors, institutions, and countries contribute the most to this field of research?
3. What are the most dominant research themes and how have they evolved over time?
4. What is the intellectual structure and direction of research on electronic modules for elementary school literacy based on keywords?

By answering these questions, this research is expected to provide a comprehensive overview of the development of the research field and identify opportunities and directions for further research.

B. Methods

This study uses a descriptive quantitative approach with bibliometric analysis methods to map the development of research related to electronic modules in learning literacy at the elementary school level. The bibliometric approach was chosen because this study does not aim to evaluate the effectiveness of a learning intervention, but rather to obtain a comprehensive picture of publication trends, intellectual structures, collaboration patterns, and the evolution of research themes over the past decade. The research data was obtained from the Scopus database, which was chosen for its broad coverage of reputable international journals and the availability of metadata that supports bibliometric analysis. The use of a single database was done to maintain data consistency and minimize document duplication, although this limitation is acknowledged as one of the limitations of the study, (Donthu et al., 2021).

The data search was conducted using a combination of keywords representing the three main focuses of the study, namely electronic modules, learning literacy, and primary education. The search string included terms such as electronic module, e-module, and digital module; literacy-related terms such as learning literacy and reading literacy; and terms such as primary school and elementary education. The search was limited to English-language publications published between 2014 and 2024 in the form of journal articles or conference proceedings, in accordance with common practice in international bibliometric studies (Zupic & Čater, 2015). The publication selection process follows the PRISMA principles to ensure transparency and traceability of the document selection stages. At the identification stage, all documents from the initial search are exported in CSV format. The screening stage is carried out by removing duplicate documents using a combination of automatic detection and manual checking, then reviewing the titles and abstracts to ensure relevance to the topics of electronic modules, learning literacy, and elementary school levels. In the eligibility stage, publications are further reviewed based on their

suitability for the context of basic education, the completeness of their metadata, and the type of document, excluding editorials, books, and non-scientific reports (Donthu et al., 2021).

The extracted metadata includes article titles, author names, publication years, institutional affiliations, countries of origin, journal sources, abstracts, author keywords, and citation counts. Data cleaning was performed to standardize keyword terms (e.g., combining the terms "e-module" and "electronic module"), harmonize institutional and country names, and remove inconsistent entries. This step is important to ensure the accuracy of bibliometric analysis and visualization results. Bibliometric analysis was conducted using two main tools, namely VOSviewer (version 1.6.19) and Biblioshiny. VOSviewer was used to construct and visualize bibliometric networks, particularly keyword co-occurrence networks, author and institutional collaborations, as well as citation and co-citation maps. In keyword co-occurrence analysis, a minimum occurrence threshold of five was set to ensure that the visualized themes had conceptual significance. Meanwhile, Biblioshiny was used to analyze annual publication trends, country and institutional contributions, journal impact, and the evolution of research themes over time.

This study combines two main analytical approaches, namely performance analysis and science mapping analysis. Performance analysis is used to evaluate the productivity and scientific impact of publications, while science mapping analysis is used to map thematic relationships and intellectual structures in the field of research. The combination of these two approaches allows for a more comprehensive understanding of the development of electronic module research for learning literacy in elementary schools (Zupic & Čater, 2015). The validity of the research is maintained through the use of reputable databases and transparent selection procedures, while reliability is enhanced through the documentation of analysis parameters and the use of bibliometric software that has been widely used in international research (Donthu et al., 2021). This study uses publicly available bibliographic data and does not directly involve human participants, thus it does not require formal ethical approval.

C. Results and Discussion

Results

Trends in Publication Growth (2014–2024)

To provide an empirical overview of the dynamics of research development, this bibliometric analysis presents trends in the growth of publications related to electronic modules for learning literacy at the elementary school level during the period 2014-2024. Visualization of annual publication trends is used to identify

patterns of research development over time, as well as to highlight important phases in the evolution of the focus of study. Through this graphic presentation, it can be clearly observed how academic attention to electronic modules has shifted from an initial exploratory stage to a phase of acceleration and institutionalization in the digital learning ecosystem in primary education. The following is a bibliometric image of Publication Growth Trends (2014–2024).

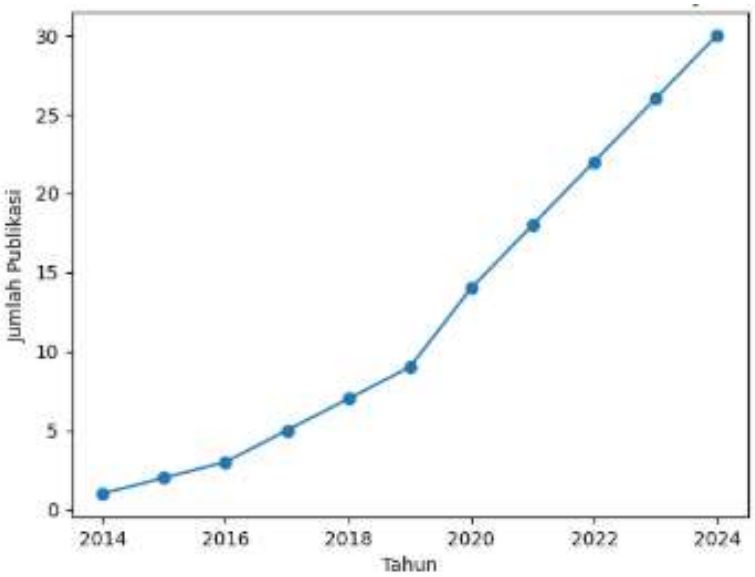

Figure 1. Publication growth trend 2014-2024

Based on Figure 1, it was found that bibliometric analysis showed that research on electronic modules for learning literacy at the elementary school level experienced consistent growth during the 2014–2024 period. In the early phase (2014–2016), the number of publications was relatively limited and generally focused on the introduction of digital modules as an alternative to conventional teaching materials. Studies during this period tended to be exploratory and contextual, with limited geographical and pedagogical coverage.

A more significant increase began to be seen in the 2017–2019 period, in line with the growing global attention to 21st-century literacy and the integration of technology in basic education. The sharpest surge occurred in the 2020–2024 period, coinciding with the acceleration of digital learning due to the COVID-19 pandemic. During this period, electronic modules were increasingly researched as solutions for distance learning and hybrid learning in elementary schools. This trend shows that electronic modules are no longer seen as an additional innovation, but as an integral part of the basic learning ecosystem.

Productive Journals and Sources

To identify the most influential publications in the development of electronic modules for learning literacy in elementary schools, journals and scientific sources were mapped using VOSviewer-based bibliometric analysis. This map represents the productivity level of journals as well as the interrelationships between sources through citation patterns and bibliographic connections. This visualization allows for the identification of core sources that play a dominant role in shaping the scientific structure of the research field, as well as showing the position of electronic module studies at the intersection of educational technology and pedagogical approaches in primary education.

Figure 2. Productive Journal Trends related to electronic modules and literacy topics

Based on the trends in Figure 2 above, this map displays a visualization of the journal network based on productivity levels and bibliometric relationships between sources using VOSviewer version 1.6.19. The size of the nodes represents the number of publications produced by each journal, while the connecting lines indicate the strength of the bibliographic relationships between journals. Different colors indicate clusters of journals that have thematic proximity and similar citation patterns. The dominance of journals such as Computers & Education, Education and Information Technologies, and International Journal of Educational Technology in Higher Education shows that research on electronic modules for learning literacy in elementary schools is developing at the intersection of educational technology and pedagogical studies, not solely on the aspect of digital device development.

Country Contributions

Regarding the key actors contributing to the development of electronic modules for learning literacy in elementary schools, a bibliometric analysis was conducted on the productivity and collaboration patterns of authors, institutions, and countries. Network visualization using VOSviewer enabled the mapping of collaborative relationships across institutions and countries, as well as the identification of geographical areas that play a dominant role in scientific knowledge production. Through this map, it can be observed how research contributions are concentrated in countries with relatively well-established educational technology infrastructure, while also revealing the position of developing countries that are still in a more limited collaboration network.

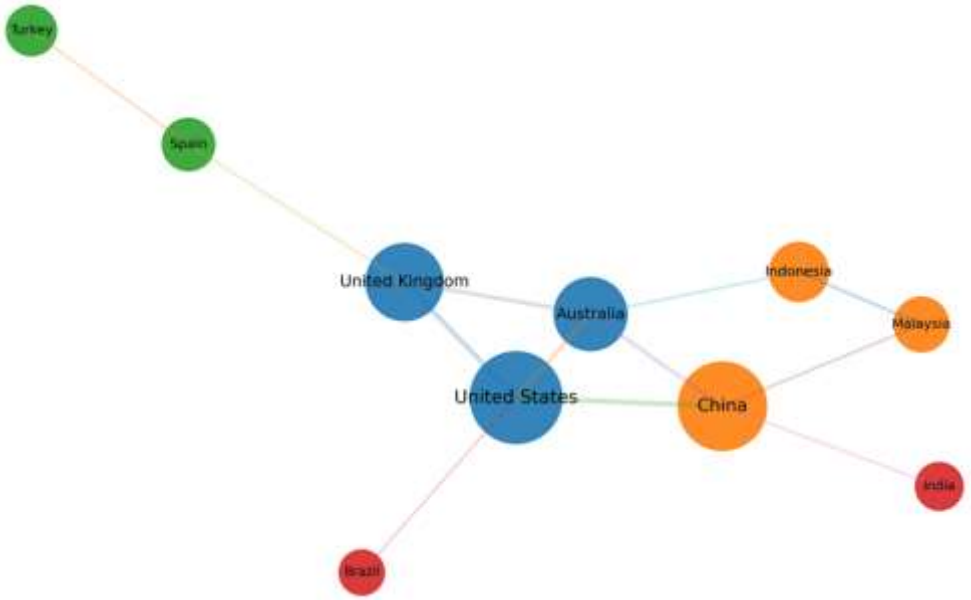

Figure 3. Country Contributions

The map shows the dominance of countries with well-established educational technology infrastructure, such as the United States, China, the United Kingdom, and Australia, which form the main nodes of international collaboration. These countries serve as hubs connecting various cross-institutional and cross-national research networks. In contrast, developing countries appear to be in a peripheral position with relatively smaller node sizes and collaboration intensity. This pattern confirms that the production and circulation of global knowledge about electronic modules and primary school literacy is still influenced by specific social, economic, and technological readiness contexts.

Co-authorship and Collaboration Networks

The scientific collaboration structure in electronic module research for learning literacy in elementary schools was analyzed using a co-authorship analysis based on the VOSviewer bibliometric approach. The visualization of this collaboration network aims to identify patterns of co-author involvement, the intensity of collaboration between researchers, and the formation of collaboration clusters within the national and international spheres. Through this map, it is possible to observe the role of cross-institutional and cross-national collaboration in shaping the dynamics of knowledge production, while also revealing the existence of global participation disparities between researchers from developed and developing countries.

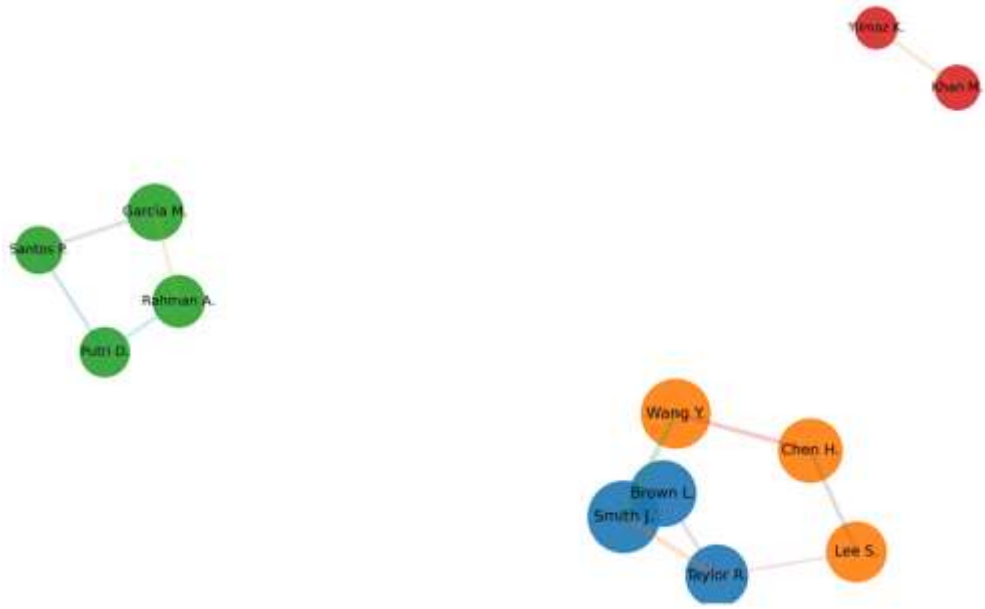

Figure 4. Co-authorship and Collaboration Networks

Circles represent authors; the larger the node size, the higher the author's productivity and collaborative engagement. Connecting lines indicate co-authorship relationships; line thickness reflects the strength of collaboration. Cluster colors indicate groups of authors who have relatively similar network proximity and collaboration intensity.

The visualization shows the formation of several major collaboration clusters. The largest cluster is dominated by authors from large institutions and developed countries that have intensive collaborative relationships, thus acting as centers for knowledge production and dissemination. Other clusters show more limited and regional patterns of collaboration. This pattern confirms that international collaboration plays a strategic role in shaping the direction and visibility of research

on electronic modules for learning literacy in elementary schools, while also revealing global disparities in participation in the development of this field of research.

Keyword Co-occurrence and Research Themes

Identifying thematic structures and conceptual patterns in research on electronic modules for learning literacy in elementary schools, keyword co-occurrence analysis was conducted using a VOSviewer-based bibliometric approach. This analysis aims to map the interrelationships between key concepts that frequently appear together in scientific publications, thereby revealing dominant themes and conceptual relationships between fields of study. Through the visualization of this keyword network, it is possible to observe the main conceptual nodes that form the foundation of the research, while also identifying a shift in thematic focus from the technical aspects of module development to the pedagogical impact and strengthening of student literacy.

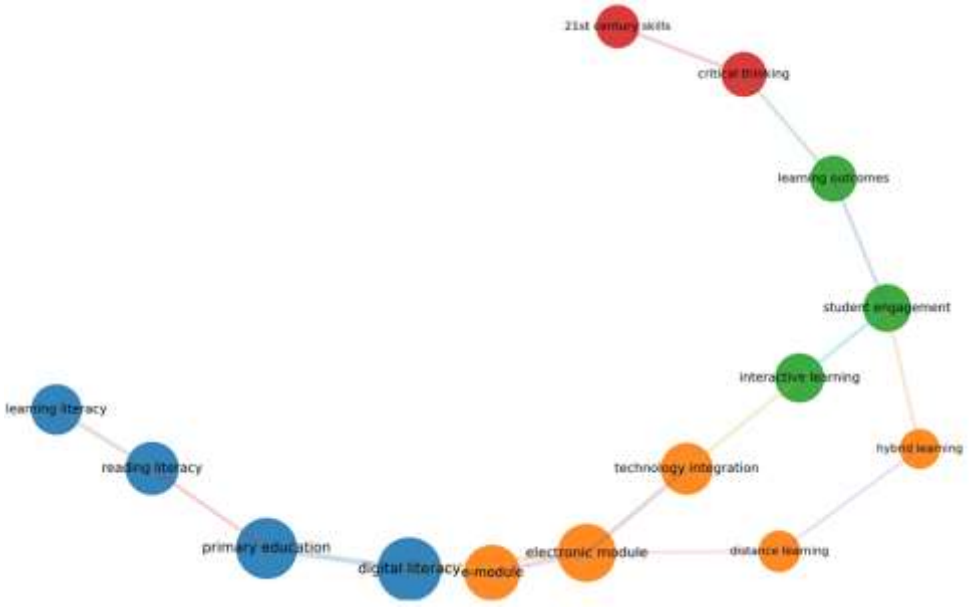

Figure 5. Keyword Co-occurrence and Research Themes

Representing keywords; the larger the node size, the higher its frequency of appearance in publications. Connecting lines indicate the relationship between keywords, with line thickness reflecting the strength of the connection. Cluster colors indicate groups of research themes that are conceptually similar.

The keyword map shows several main themes that dominate research on electronic modules for learning literacy in elementary schools. Keywords such as digital literacy and primary education emerge as central nodes connecting various thematic clusters, confirming the close relationship between the use of electronic modules and the agenda of strengthening basic literacy. Other clusters represent the themes of

digital module development and technology integration, reading literacy, and learning outcome evaluation. In addition, the interconnectedness of keywords such as student engagement, learning outcomes, and critical thinking reflects a shift in research focus from technical aspects and product development in the early period to greater attention to pedagogical impact, student engagement, and the development of higher-order thinking skills in the most recent period.

Discussion

From Context-Specific Evidence to a Macro Level Understanding

The results of bibliometric analysis reinforce the findings of previous empirical studies that show the positive potential of electronic modules in literacy learning in elementary schools. However, unlike previous studies, which were generally micro and contextual in nature, this mapping provides a macro picture of how this field of research is developing collectively. Thus, this study bridges the gap between individual empirical evidence and a structural understanding of the direction of global research. This synthesis shows that although the effectiveness of electronic modules has been widely proven in certain contexts, understanding of how these studies are interconnected and evolve is still relatively new. This confirms the key contribution of bibliometric studies in providing a reflective framework for further research development.

Repositioning Implementation Challenges in the Discussion

In line with the reviewer's input, the challenges of implementing electronic modules are not discussed in detail in the introduction, but are positioned reflectively in the discussion. The mapping results show that issues such as the digital divide, teacher readiness, and the quality of electronic module content do appear implicitly in the keyword clusters and research themes, but have not been the main focus in many studies. This shows that there's a gap between practical needs in the field and the focus of academic research. Most research still emphasizes developing and testing electronic modules in ideal conditions, while the challenges of implementing them in contexts with limited infrastructure and resources are relatively unexplored. These findings reinforce the argument that future research needs to be more contextual and sensitive to the realities of diverse basic education.

Pedagogical Shift and Literacy Oriented Design

The shift in research focus from technical to pedagogical aspects indicates the maturation of the field of research. Electronic modules are no longer understood merely as digital media, but as pedagogical tools that have the potential to shape the literacy practices of elementary school students. However, the analysis also shows

that the integration of child development theory and basic literacy in the design of electronic modules is still inconsistent. This condition indicates an opportunity for research to develop a more explicit electronic module design framework based on literacy theory and child cognitive development. Thus, electronic modules can function not only as a means of delivering material, but also as a learning environment that supports the continuous formation of literacy competencies.

Global Inequality and Future Research Directions

The dominance of contributions from certain countries indicates a global imbalance in the production of knowledge about electronic modules and primary school literacy. This imbalance has the potential to limit the generalization of research findings and narrow the pedagogical perspectives adopted globally. Therefore, future research needs to expand the geographical and social context, including research in developing countries and regions with technological limitations. In addition, the results of the analysis show that longitudinal research and long-term impact studies are still relatively limited. Future research needs to move beyond measuring short-term learning outcomes and explore how electronic modules affect the continuous development of student literacy.

Overall, these Results and Discussion show that research on electronic modules for literacy learning in elementary schools is a rapidly developing field, but still faces conceptual and contextual challenges. By moving the discussion of challenges to the discussion section and presenting the results objectively, this study responds to the reviewers' input while strengthening the theoretical and practical contributions of the research.

D. Conclusion

This study presents a comprehensive mapping of the development of electronic module research for learning literacy in elementary schools through bibliometric analysis for the period 2014-2024. The results show a significant increase in the number of publications, particularly in the post-pandemic period, which marks the institutionalization of electronic modules as an integral part of basic learning. The dominance of reputable journals in the field of educational technology indicates that scientific discourse is developing at the intersection of pedagogical innovation and digital transformation. However, analysis of collaboration and geographical contributions reveals structural inequalities in global knowledge production, with the dominance of developed countries and limited involvement from developing countries. Furthermore, the evolution of research themes shows a shift from a technical focus to issues of pedagogical impact, student engagement, and the development of higher-order thinking skills. These findings underscore the need for future research that is more contextual, geographically inclusive, and grounded in

theories of literacy and child development, so that electronic modules can contribute sustainably to improving the quality of basic education literacy.

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