

A Bibliometric Review of Research Trends on Digital Modules for Literacy and Numeracy in Elementary Schools

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Abstract: Research on digital modules to strengthen literacy and numeracy in elementary schools has increased in line with the growing need for technology-based instructional resources that are practical and have measurable impacts. This study aims to map publication trends, identify the most influential documents, and reveal the thematic structure of digital-module research on literacy and numeracy over the past decade. A bibliometric review was conducted using data retrieved from Google Scholar via Publish or Perish for the 2016–2026 period, applying an integrated keyword string and yielding 870 documents. The analysis includes descriptive statistics of annual publication trends, citation metrics to identify influential works, and thematic mapping through keyword co-occurrence and network visualization in VOSviewer, supported by data cleaning in RStudio. The results show a sharp increase in publications from 2021, peaking in 2025, while 2026 likely reflects partial-year indexing. The co-occurrence analysis (minimum occurrence = 10; 59 terms) produced six clusters dominated by the development–e-module theme and quality evaluation, with problem solving, ethnomathematics, and STEM integration emerging as key thematic strands. Overall, the field is shifting from artifact development toward stronger evidence of quality and learning impact. These findings inform a future research agenda emphasizing cross-context replication and provide guidance for evidence-based design and implementation of digital modules in elementary education.

Keywords: Bibliometric; Digital modules; Literacy and numeracy; Elementary schools

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INTRODUCTION

Literacy and numeracy are widely recognized as fundamental competencies that underpin learning success at the elementary/primary level, as they shape learners' ability to comprehend information, reason, and solve problems in both academic and everyday contexts (Tarusu et al., 2025). In elementary school settings, efforts to strengthen literacy and numeracy are increasingly linked to the demand for technology-based learning, given that digital learning ecosystems require students and teachers to access, interpret, and use digital learning resources effectively (Suwanto et al., 2022; Sulasmi, 2022). Accordingly, digital modules, including e-modules and interactive e-modules, are positioned as instructional artifacts that bridge literacy and numeracy pedagogical goals with learning practices that are adaptive to digital devices and platforms that are becoming more prevalent in schools (Nirmala & Puspita, 2025; Sufianti, 2023).

Nevertheless, a recurring fundamental challenge in implementing literacy and numeracy strengthening in elementary schools is the mismatch between intended competency targets and the readiness of instructional resources, teacher capacity, and the support provided by digital learning environments. (Nurani et al., 2024; Sulasmi, 2022). Studies on digital literacy practices in elementary schools indicate that the strengthening of digital competence in school practice is not always equitable, which in turn leads to variation in the quality of digital learning-resource use, including digital modules, across school contexts. (Suwanto et al., 2022). At the policy and program level, literacy and numeracy strengthening is frequently positioned as a quality-improvement priority; however, classroom realization still requires well-structured instructional resources and realistic implementation strategies. (AR et al., 2024; Nurani et al., 2024).

Consistent with this background, prior studies show that the development and use of digital modules for literacy and numeracy in elementary education have progressed through diverse design and pedagogical approaches. (Nirmala & Puspita, 2025; Sufianti, 2023). Innovations in e-modules to strengthen basic literacy and numeracy have been reported in the context of early foundational skills, indicating sustained research attention to elementary learners' core needs. (Sufianti, 2023). At the same time, e-module design has been linked to specific design models to reinforce literacy and numeracy, underscoring instructional design as a central concern in digital-module research. (Nirmala & Puspita, 2025). Within the domain of numeracy literacy, digital media

innovations and STEAM-based digital learning have been reported as approaches to enhance numeracy, suggesting a tendency to connect numeracy with science- and technology-integrated learning strategies and inquiry-oriented activities. (Hidayat et al., 2024; Hidayanthi et al., 2024). Furthermore, the use of digital STEAM-inquiry learning modules has been associated with improved literacy skills and urban–rural comparisons, reflecting research interest in contextual variation across schools and the equity of learning impacts from module-based instruction. (Susanta et al., 2025).

Beyond student-focused research, other studies indicate that strengthening literacy and numeracy through modules is also related to teacher readiness and competency development, including assistance in preparing teaching modules and the use of digital modules in elementary preservice teacher education. (Nurani et al., 2024; Yustitia & Kusmaharti, 2022). The need for instructional resources is also highlighted in research on reflective modules for literacy and numeracy, which emphasizes the role of modules not only in delivering content but also in facilitating reflection and strengthening thinking skills. (Rakhmawati & Mustadi, 2021). In mathematical domains closely aligned with numeracy, interactive e-modules based on the Realistic Mathematics Education approach and ethnomathematics modules have been reported to improve mathematical literacy, thereby expanding the diversity of pedagogical approaches and content foci in digital-module research. (Aulia & Prahmana, 2022; Yuliana et al., 2023). From an inclusivity perspective, the identified need for digital modules to improve numerical literacy among students with dyscalculia indicates that digital-module research is also moving toward addressing specific learning needs and supporting differentiated instruction. (Purwaningrum et al., 2022). Evaluation-based evidence further appears in studies on the effectiveness of interactive multimedia-based e-modules, which link student responses to learning outcomes in elementary schools and reinforce the argument that digital modules should be assessed not only in terms of design but also in terms of impact. (Alyusfitri et al., 2024).

Although these studies demonstrate progress, the existing state of the art remains dispersed across themes, approaches, and contexts. As a result, the direction of research development, dominant themes, and the evolution of research foci on digital modules for literacy and numeracy in elementary education have not been mapped systematically. (Nirmala & Puspita, 2025; Susanta et al., 2025; Hidayanthi et al., 2024). Topic diversity

ranging from e-module design for literacy and numeracy, STEAM-based digital learning, PBL-oriented digital modules for preservice teachers, to modules for special educational needs suggests thematic fragmentation that may hinder researchers and practitioners from deriving a coherent “big-picture” understanding of the field’s development. (Sufianti, 2023; Yustitia & Kusmaharti, 2022; Purwaningrum et al., 2022). Moreover, supporting literature on teachers’ digital literacy and school-level digital literacy practices indicates that successful digital-module implementation does not operate in isolation; rather, it is shaped by actor readiness and the broader digital ecosystem of schools. Therefore, mapping research trends should consider a wider landscape beyond module design alone. (Sulasmi, 2022; Suwanto et al., 2022; Astiti et al., 2023). Accordingly, the principal gap lies in the absence of a quantitative literature-mapping synthesis that reveals the knowledge structure, leading actors, and themes that emerge and shift over time in research on digital modules for literacy and numeracy in elementary schools. (Rakhmawati & Mustadi, 2021; Alyusfitri et al., 2024; Hidayat et al., 2024).

Building on this gap, the novelty of this article lies in presenting a bibliometric review that explicitly maps the past decade of research trends on digital modules for literacy and numeracy in elementary schools, thereby producing measurable insights into publication growth, thematic concentration, and future development directions. (Nirmala & Puspita, 2025; Susanta et al., 2025; Tarusu et al., 2025). This contribution is further supported by evidence that existing primary studies span a broad range of approaches, including STEAM, inquiry, Realistic Mathematics Education, reflective modules, and supports for special learning needs, all of which require thematic mapping to clarify interconnections and differentiate the contributions of each approach to literacy and numeracy outcomes. (Hidayanthi et al., 2024; Aulia & Prahmana, 2022; Rakhmawati & Mustadi, 2021; Purwaningrum et al., 2022). By mapping the literature bibliometrically, this article is expected to provide an evidence base for formulating future research agendas and implementation strategies for digital modules that are more context-sensitive to teacher readiness and school digital ecosystems. (Nurani et al., 2024; Sulasmi, 2022; Suwanto et al., 2022).

The aims of this study are to analyze publication growth, identify dominant and emerging themes, and map research contributions related to digital modules for literacy and numeracy in elementary schools over the past decade. (Nirmala & Puspita, 2025; Hidayat

et al., 2024; Susanta et al., 2025). The study applies a bibliometric analysis by retrieving data from Google Scholar for the most recent ten-year period (2016–2025) using Publish or Perish, based on a combined keyword strategy representing digital module/e-module, literacy/reading, numeracy/mathematics, and the elementary/primary school context. (Nirmala & Puspita, 2025; Hidayat et al., 2024; Rakhmawati & Mustadi, 2021).

METHODS

This study employs a bibliometric analysis approach to map publication developments, thematic structures, and knowledge networks related to digital modules aimed at strengthening literacy and numeracy in elementary schools. Conceptually, this focus was selected because primary studies indicate that digital modules and technology-based learning can serve as strategic media for enhancing literacy and numeracy; however, the diversity of approaches and implementation contexts remains broad, thereby requiring a mapping grounded in publication data. (Sufianti, 2023; Susanta et al., 2025; Hidayanthi et al., 2024).

Data Sources and Analysis Tools

Bibliographic data were collected from Google Scholar using the Publish or Perish application, as this source indexes multilingual and multi-format publications that are relevant to elementary education contexts and digital learning innovations. For network mapping and bibliometric visualization, this study used VOSviewer to construct term co-occurrence maps and thematic clusters. (Alyusfitri et al., 2024; Susanta et al., 2025). The selection of this tool combination was intended to ensure that the resulting maps could be interpreted substantively in relation to elementary school learning contexts, including effectiveness, implementation readiness, and the range of pedagogical approaches reported in prior studies. (Nurani et al., 2024; Sulasmi, 2022; Aulia & Prahmana, 2022).

Search Strategy and Keywords

The search was conducted with a single Boolean string designed to capture variations in international and Indonesian terminology regarding digital modules, literacy, numeracy, and the elementary school context. The search strings used were: ("digital module" OR "e-module" OR "electronic module" OR emodule OR "modul digital" OR e-module OR emodule) AND (literacy OR reading OR "reading literacy" OR literasi OR membaca) AND (numeracy OR mathematics OR arithmetic OR numerasi OR Matematika) AND



("elementary school" OR "primary school" OR "sekolah dasar" OR SD). The term variations literacy/reading and numeracy/mathematics/arithmetic were retained because studies in elementary schools often report numeracy through the mathematical literacy framework, while literacy is often operationalized as reading literacy or basic reading skills (Yuliana et al., 2023; Aulia & Prahmana, 2022; Sufianti, 2023). The term elementary/primary/elementary school/SD context is used to ensure the relevance of the level, considering that digital module studies also appear at other levels of education and non-literacy–numeracy domains (Purwaningrum et al., 2022; Dewi et al., 2022).

Time Span and Document Count

This study limited the publication window to the most recent ten years (2016–2026) to capture contemporary dynamics in the development and implementation of digital modules for strengthening literacy–numeracy in elementary education. The search conducted within this period yielded 870 documents as the initial corpus for bibliometric analysis. The inclusion of 2026 was maintained to accommodate the emergence of recent studies on numeracy literacy modules and digital learning innovations within an evolving curriculum context.

Inclusion and Exclusion Criteria

Documents were included if they (1) addressed digital modules/e-modules as the primary instructional resource, (2) focused on literacy/reading and/or numeracy/mathematics, and (3) were situated in elementary/primary school contexts or their learning ecosystems (for example, studies on strengthening elementary teachers' competencies related to module use). Documents were excluded if they primarily focused on non-elementary levels without direct relevance to elementary education, or if the digital modules targeted domains that were not aligned with literacy–numeracy as the intended competencies. These criteria were established to maintain thematic coherence with the study title and to reduce corpus bias arising from the broad use of the term “module” across disciplines.

Bibliometric Analysis and Visualization

The analysis comprised (1) descriptive statistics of annual publication trends, (2) identification of the most influential documents and sources based on citation metrics, and (3) thematic mapping using keyword co-occurrence analysis and network visualization in VOSviewer. Interpretation of the findings considered implementation and

ecosystem readiness, as the effectiveness of digital modules in elementary schools is often shaped by student responses, learning outcomes, teachers' digital competence, and school-level digital practices.

RESULTS

Annual Publication Trends

Figure 1 presents the annual publication trajectory on digital modules for literacy and numeracy in elementary/primary school contexts over the 2016–2026 period. Publication output was very limited in the early years (2016 = 0; 2017 = 2; 2018 = 0), then began to increase in 2019 (8 documents) and 2020 (23 documents), followed by a marked acceleration in 2021 (60 documents) and a substantial surge in 2022 (141 documents). The upward trend continued in 2023 (180 documents) and 2024 (208 documents), reaching its peak in 2025 (220 documents). This pattern is consistent with the growing body of work on the development and implementation of e-modules/digital modules and technology-enhanced learning innovations aimed at strengthening literacy and numeracy in elementary education. (Sufianti, 2023; Hidayanthi et al., 2024; Nirmala & Puspita, 2025; Susanta et al., 2025; Anggun et al., 2025).

In 2026, the number of documents declines sharply (17 documents). Methodologically, this decrease is more appropriately interpreted as a current-year effect, because 2026 records were not fully indexed at the time of data collection, rather than as evidence of reduced research interest. This interpretation is supported by the continued appearance of recent publications addressing module development and digital innovations for literacy and numeracy, suggesting that the 2026 decline is an artefact of incomplete indexing coverage. (Tuychiyevich, 2024; Nirmala & Puspita, 2025; Susanta et al., 2025).

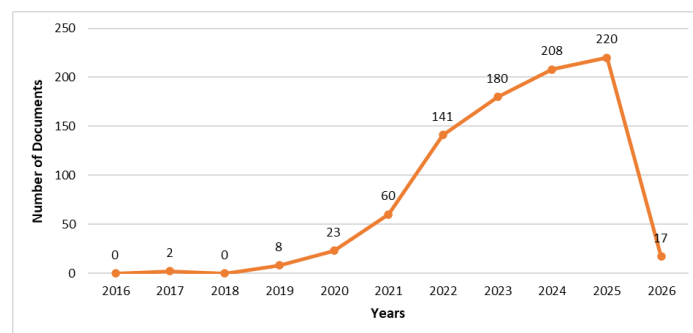


Figure 1. Development of the number of publications from year to year

Most Influential Documents and Sources by Citation Metrics

Table 1 presents the 20 most highly cited documents, which overall indicate the dominance of e-module development, the use of digital platforms/tools (such as Canva and flipbook-based formats), and efforts to strengthen mathematics learning and numeracy at the elementary school level. In Table 1, the most influential documents (highest citation counts) suggest that the digital-module literature during the study period is largely shaped by research on developing and utilizing e-modules as instructional media, particularly within elementary mathematics and numeracy contexts. This pattern is evident from the recurring emphasis on terms such as “development” and “e-module,” as well as the frequent use of widely adopted platforms and formats, including Canva and flipbook tools (for example, Flip PDF, Flipbook Maker, and Heyzine), indicating a strong orientation toward producing digital instructional artefacts that teachers can readily adopt. The most highly cited works also show a pronounced tendency to link e-modules with learning outcomes or instructional quality (for instance, effectiveness of Realistic Mathematics Education, Problem-Based Learning, and critical thinking skills), implying that the most frequently referenced contributions emphasize not only design features but also evidence of learning impact. In addition, the presence of several highly cited documents outside the elementary level (for example, junior and senior secondary education, and vocational schools) indicates that the term “e-module” is used across educational levels; therefore, additional screening is required in subsequent analyses to ensure that interpretations remain aligned with the study’s focus on elementary schools.

Table 1. 20 articles with the highest citations.

No.	Cites	Authors	Title	Year
1	252	Jannah, F. N. M., Nuroso, H., & Mudzanatun, M.	<i>Penggunaan aplikasi canva dalam media pembelajaran matematika di sekolah dasar</i>	2023
2	237	Dewi, M. S. A., & Lestari, N. A. P.	<i>E-modul interaktif berbasis proyek terhadap hasil belajar siswa</i>	2020
3	155	Susanti, E. D., & Sholihah, U.	<i>Pengembangan e-modul berbasis flip pdf corporate pada materi luas dan volume bola</i>	2021
4	153	Alamsyah, T. P.	<i>Efektivitas Pendekatan Realistic Mathematics Education (RME) untuk meningkatkan kemampuan pemahaman konsep matematika siswa kelas V</i>	2020
5	139	Feriyanti, N., Hidayat, S., & Asmawati, L.	<i>Pengembangan e-modul matematika untuk siswa SD</i>	2019

No.	Cites	Authors	Title	Year
6	130	Maharcika, A. A. M., Suarni, N. K., et al.	<i>Pengembangan modul elektronik (E-Modul) berbasis flipbook maker untuk subtema pekerjaan di sekitarku kelas IV SD/MI</i>	2021
7	120	Azkiya, H., Tamrin, M., Yuza, A., et al.	<i>Pengembangan e-modul berbasis nilai-nilai pendidikan multikultural di sekolah dasar islam</i>	2022
8	117	Ramadhina, S. R., & Pranata, K.	<i>Pengembangan E-Modul Berbasis Aplikasi Flipbook di Sekolah Dasar</i>	2022
9	116	Turnip, R. F., Rofi'i, R., & Karyono, H.	<i>Pengembangan e-modul matematika dalam meningkatkan keterampilan berpikir kritis</i>	2021
10	115	Ramadanti, F., Mutaqin, A., et al.	<i>Pengembangan E-Modul Matematika Berbasis PBL (Problem Based Learning) pada Materi Penyajian Data untuk Siswa SMP</i>	2021
11	106	Manzil, E. F., & Thohir, M. A.	<i>Pengembangan e-modul interaktif heyzine flipbook berbasis scientific materi siklus air bagi siswa kelas V sekolah dasar</i>	2022
12	102	Endaryati, S. A., Atmojo, I. R. W., et al.	<i>Analisis e-modul flipbook berbasis problem based learning untuk memberdayakan keterampilan berpikir kritis pembelajaran IPA sekolah dasar</i>	2021
13	86	Erawati, N. K., & Purwati, N. K. R., et al.	<i>Pengembangan e-modul logika matematika dengan Heyzine untuk menunjang pembelajaran di SMK</i>	2022
14	86	Gufran, G., & Mataya, I.	<i>Pemanfaatan e-modul berbasis smartphone sebagai media literasi masyarakat</i>	2020
15	84	Sanova, A., Bakar, A., Afrida, A., et al.	Digital literacy on the use of e-module towards students' self-directed learning on learning process and outcomes evaluation courses	2022
16	83	Elistiana, V., Novita, N., et al.	A Development of E-Module Learning Media based on SETS (Science, Environment, Technology, and Society) on Sound Wave Material	2024
17	83	Maryam, M.	Pengembangan e-modul matematika berbasis Open Ended pada materi sistem persamaan linear dua variabel kelas VIII	2019
18	79	Hermansyah, S., Nasmilah, N., Pammu, A., et al.	Socialization making media learning interactive e-module based Flippbook in Elementary School 4 Maiwa	2023
19	78	Ilmi, R., Arnawa, I. M., Yerizon, et al.	Development of an android-based for math e-module by using Adobe Flash Professional Cs6 for grade X students of senior high school	2021
20	77	Kumala, F. N., Ghufon, A., & Astuti, P. P., et al.	MDLC model for developing multimedia e-learning on energy concept for primary school students	2021

Keyword Co-occurrence and Thematic Network Mapping

The keyword co-occurrence analysis was conducted on a corpus of 870 documents (2016–2026) using a minimum occurrence threshold of 10, resulting in 59 terms that met the inclusion criterion for thematic network mapping. This threshold was applied to highlight the most stable and dominant terms in the literature, ensuring that the resulting thematic structure reflects the mainstream research stream on digital modules for literacy and numeracy in elementary education. (Rakhmawati & Mustadi, 2021; Alyusfitri et al., 2024; Tarusu et al., 2025).

Based on **Figure 2** (Network visualization), large nodes such as “e module/e modul,” “development,” and “sekolah dasar” indicate that the literature over the past decade has been strongly dominated by a focus on e-module development and its implementation in elementary school contexts. The prominent presence of terms such as “elementary school,” “literacy,” “numeracy,” and “mathematical literacy” further suggests that digital modules are most frequently examined as tools to strengthen foundational competencies, particularly numeracy, which is often operationalized within the mathematical literacy framework. (Aulia & Prahmana, 2022; Yuliana et al., 2023; Hidayat et al., 2024). The dense interconnections among nodes also indicate strong thematic linkages among module design/development, instructional strategies, and impact evaluation, which is consistent with evidence from e-module effectiveness studies that connect student responses to learning outcomes. (Alyusfitri et al., 2024; Anggun et al., 2025; Susanta et al., 2025).

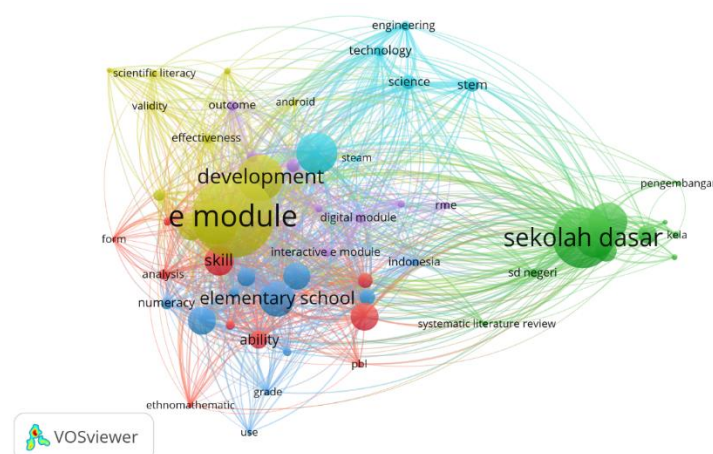


Figure 2. Network visualization

Figure 3 (Overlay visualization) shows the temporal dimension (scale 2023.2–2024.0) which indicates that key topics in this network are strengthening, especially in the latest publications, so that research on digital modules for literacy and numeracy is in an intensive growth phase in the period 2023–2024 (Susanta et al., 2025; Hidayanthi et al., 2024; Hidayat et al., 2024). Substantively, the strengthening of the development–effectiveness–validity–practicality themed node shows that the latest trend not only emphasizes the production of e-module artifacts, but also the affirmation of instrument/product quality through validity, practicality, and effectiveness tests, as is common in interactive multimedia-based e-module evaluation studies. In the context of implementation, the interconnectedness of terms that lead to the utilization of digital devices and ecosystems (e.g., Android) is also in line with the need for elementary schools to strengthen digital learning practices and teacher capacity in using learning technology devices (Sulasmi, 2022; Suwanto et al., 2022; Dewi et al., 2022).

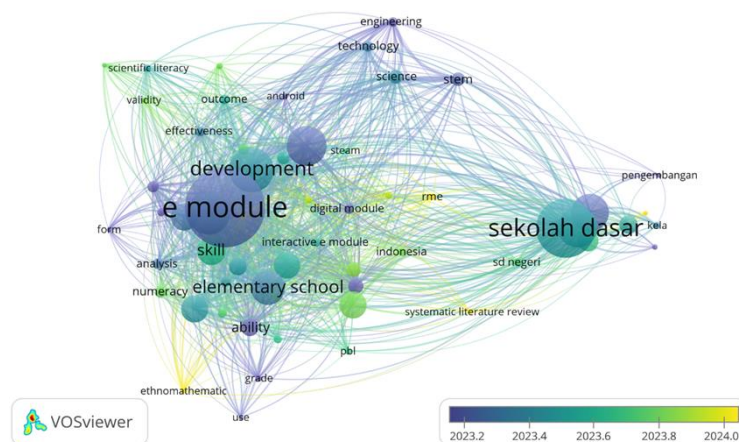


Figure 3. Overlay visualization

Based on **Table 3** (Cluster of Network Visualization), the mapping yielded six clusters that represent dominant themes in research on digital modules for literacy and numeracy in elementary schools. Collectively, these clusters indicate that the field is structured around several thematic strands: (i) module design/development and outcome measurement, (ii) elementary school contexts (particularly Indonesia) accompanied by strong bilingual terminology, (iii) core literacy and numeracy keywords within the elementary level, (iv) product evaluation and implementation media, (v) mathematics pedagogy approaches such as Realistic Mathematics Education and ethnomathematics,

alongside interactive/flipbook formats, and (vi) the integration of STEM with science and technology disciplines.

Cluster 1 (ability; analysis; emodule; ethnomathematic; numeracy literacy; pbl; problem; skill; students' mathematical literacy) indicates a strong focus on strengthening learners' abilities and skills through e-modules that are frequently linked to Problem-Based Learning, problem solving, and orientations toward numeracy and mathematical literacy, including context-based approaches such as ethnomathematics. This pattern is consistent with literature positioning modules as media for improving numeracy competence through problem-centered instructional strategies and approaches that are closely aligned with students' learning experiences. (Hidayat et al., 2024; Sufianti, 2023; Rakhmawati & Mustadi, 2021).

Cluster 2 (dan; e modul; kelas; matematika; penelitian ini; pengembangan; sd negeri; sekolah dasar; siswa; systematic literature review) shows the dominance of Indonesian-language terms, confirming that contributions from the Indonesian context are substantial within the Google Scholar corpus. It also reflects a tendency toward development-oriented studies (development/e-modules) and classroom-based research reports in elementary schools. The presence of the term "systematic literature review" within this cluster further suggests an overlap between evidence mapping and instructional resource development, which aligns with the need to consolidate research evidence in this area.

Cluster 3 (elementary school; literacy; numeracy; mathematical literacy; module; learning; research; use) represents the core domain that directly aligns with the study title, as it links the educational level (elementary), competencies (literacy and numeracy), and the instructional medium (modules) within learning and research practices. The linkage to "mathematical literacy" underscores that numeracy in the elementary literature is often treated as a broader mathematical reasoning competence, as reflected in studies employing Realistic Mathematics Education and ethnomathematics modules to improve mathematical literacy. (Aulia & Prahmana, 2022; Yuliana et al., 2023; Hidayat et al., 2024).

Cluster 4 (android; development; effectiveness; electronic module; practicality; science literacy; scientific literacy; validity) highlights a strong strand related to the evaluation and quality assurance of e-module products, including android-based implementation media and an extension of targeted competencies toward more specific forms of literacy,

such as scientific/science literacy. The emphasis on validity, practicality, and effectiveness is consistent with development-oriented e-module studies that test product feasibility and its effects on learning outcomes.

Cluster 5 (digital module; flipbook; interactive e module; fraction; mathematics e module; outcome; Realistic Mathematics Education; rme) indicates that numeracy-oriented digital-module research frequently intersects with mathematics content (for example, fractions) and interactive formats (interactive e-modules/flipbooks), with Realistic Mathematics Education emerging as a dominant pedagogical approach. The focus on learning outcomes reinforces that contributions extend beyond media design to include impact measurement on numeracy and mathematical literacy. (Alyusfitri et al., 2024; Aulia & Prahmana, 2022; Yuliana et al., 2023).

Cluster 6 (engineering; mathematics; science; steam; stem; technology) reflects the integration of literacy and numeracy with cross-disciplinary STEAM/STEM approaches, connecting numeracy learning with science-and-technology contexts and inquiry-based activities. This trend is consistent with studies reporting STEAM-based digital learning implementations and digital inquiry modules to strengthen literacy and numeracy in elementary school settings, including urban–rural comparisons. (Hidayanthi et al., 2024; Susanta et al., 2025; Tarusu et al., 2025).

Table 2. Cluster of Network Visualization

Cluster	Number of Item	Items
Cluster 1	11	ability; analysis; emodule; ethnomathematic; form; medium; numeracy literacy; pbl; problem; skill; students' mathematical literacy
Cluster 2	11	dan; e modul; kelas; matematika; penelitian ini; pengembangan; salah; sd negeri; sekolah dasar; siswa; systematic literature review
Cluster 3	11	elementary school; elementary school students; grade; indonesia; learning; literacy; mathematical literacy; module; numeracy; research; use
Cluster 4	11	android; development; e module; effectiveness; electronic module; practicality; science literacy; scientific literacy; student; study; validity
Cluster 5	9	approach; digital module; flipbook; fraction; interactive e module; mathematics e module; outcome; Realistic Mathematics Education; rme
Cluster 6	6	engineering; mathematics; science; steam; stem; technology

DISCUSSION

The findings indicate that research on digital modules for strengthening literacy and

numeracy in elementary schools has accelerated markedly since 2021 and reached a peak in 2025. This pattern is plausible when linked to the increasingly intensive adoption of educational technology in elementary settings and the growing demand for practical digital instructional resources that teachers can readily use. Evidence from primary studies emphasizing the development of e-modules as instructional artifacts, both for foundational literacy and numeracy and for more specific mathematics content, supports the interpretation that publication growth reflects substantive pedagogical needs rather than merely a quantitative trend. (Sufianti, 2023; Nirmala & Puspita, 2025; Hidayat et al., 2024). By contrast, the sharp decline in 2026 is more reasonably understood as a current-year effect due to incomplete indexing at the time of data extraction, rather than as a substantive shift in research interest; therefore, 2026 should be treated as partial-year evidence in trend interpretation.

The keyword co-occurrence mapping suggests that the research landscape is dominated by a product-oriented emphasis, reflected in the prominence of nodes such as e-module and development, reinforced by evaluative terms including validity, practicality, and effectiveness. This structure mirrors a common pattern in educational design and development research, where the production of digital instructional resources is accompanied by feasibility testing and impact-oriented evaluation. The consistency of this pattern is evident in studies reporting e-module innovations for literacy and numeracy, or numeracy literacy, alongside assessments of quality or effectiveness in elementary classroom contexts. (Nirmala & Puspita, 2025; Sufianti, 2023; Alyusfitri et al., 2024). Critically, the dominance of the “development” theme can be interpreted as both a strength and a risk: it signals strong innovation productivity, yet it may also foster fragmentation if research contributions remain concentrated on artifact development without a sufficiently cumulative evidence base on replication, sustainability, and transferability across diverse school contexts. (Rakhmawati & Mustadi, 2021; Susanta et al., 2025).

The six identified clusters further demonstrate that the field is not monolithic, but instead consists of interconnected thematic strands with distinct emphases. Clusters linking numeracy literacy, students’ mathematical literacy, and approaches such as Problem-Based Learning and ethnomathematics indicate that numeracy is frequently conceptualized as mathematical reasoning that requires contextual task design and

problem-centered instructional strategies. (Yustitia & Kusmaharti, 2022; Yuliana et al., 2023; Aulia & Prahmana, 2022). This is consistent with research on mathematics modules grounded in Realistic Mathematics Education and ethnomathematics that explicitly target mathematical literacy, implying that numeracy within the corpus does not stand alone but intersects with specific mathematics pedagogy frameworks. (Aulia & Prahmana, 2022; Yuliana et al., 2023; Hidayat et al., 2024). Another cluster highlighting android and product quality suggests that mobile implementation and quality assurance have become mainstream in e-module research. This interpretation aligns with evidence that interactive multimedia-based e-modules are associated with learning outcomes and student responses, indicating that evaluation is not merely a methodological formality but a core component of the contribution claim in digital instructional resource research. (Alyusfitri et al., 2024; Dewi et al., 2022).

A critical observation is the emergence of a strong Indonesian-language cluster, including terms such as *sekolah dasar*, *sd negeri*, and *pengembangan*, as well as generic article-framing terms such as “*penelitian ini*,” which points to two issues. First, research contributions from Indonesia appear highly dominant in the Google Scholar corpus, potentially enriching contextual evidence while also introducing geographic bias because Google Scholar captures a substantial volume of local publications and proceedings. (Sufianti, 2023; Nurani et al., 2024; AR et al., 2024). Second, the presence of non-conceptual terms (for example, conjunctions and generic phrasing) indicates that data cleaning procedures and thesaurus construction in VOSviewer are essential to ensure that thematic maps represent scientific concepts rather than linguistic artefacts derived from metadata or term extraction. Methodologically, this underscores the need to explicitly report term normalization and stopword filtering as quality controls in bibliometric analysis. (Suwanto et al., 2022; Sulasmi, 2022).

In the list of the most influential documents based on citation counts, works related to widely used platforms (such as Canva), flipbook-based e-module development, and effectiveness studies in mathematics pedagogy (such as Realistic Mathematics Education) are particularly prominent. This pattern supports two interpretations: first, the practicality of development tools (Canva and flipbook formats) may facilitate replication and rapid adoption, which can increase citation exposure; second, studies that connect modules or pedagogical approaches to learning outcomes are likely perceived as more

valuable and therefore more frequently cited. (Nirmala & Puspita, 2025; Sufianti, 2023; Alyusfitri et al., 2024). However, the highly cited list also includes several documents clearly situated outside elementary education (for example, lower and upper secondary or vocational contexts), which should be understood as a consequence of Google Scholar's breadth: the term "e-module" spans educational levels and subject areas, and without strict screening, highly cited non-elementary studies can enter an elementary-focused thematic corpus. Academically, this reinforces the importance of transparent reporting of inclusion and exclusion criteria and dataset cleaning procedures to prevent conclusions about elementary literacy and numeracy from being distorted by cross-level literature. (Tarusu et al., 2025; Rakhmawati & Mustadi, 2021).

Substantively, the thematic patterns imply an important shift: the literature appears to be moving beyond merely "developing e-modules" toward a tighter emphasis on evidence of quality and richer pedagogical integration, including Problem-Based Learning, Realistic Mathematics Education, and STEAM/STEM. (Hidayanthi et al., 2024; Aulia & Prahmana, 2022; Susanta et al., 2025). The emergence of STEAM/STEM as a distinct cluster indicates a tendency to treat numeracy and literacy not as separate competencies, but as integrated outcomes embedded in cross-disciplinary science and technology activities. (Hidayanthi et al., 2024; Susanta et al., 2025). Nevertheless, research on teacher readiness and digital practices in elementary schools emphasizes that successful adoption of digital modules depends on actor capacity and ecosystem support. This suggests that the surge in digital-module publications should be interpreted alongside uneven teacher digital competence and school-level implementation conditions, implying that future research should more systematically examine sustainability, implementation readiness, and scalability across diverse school contexts. (Sulasmi, 2022; Suwanto et al., 2022; Nurani et al., 2024).

Finally, these findings point to a realistic research agenda. First, stronger standardization of terminology and conceptual frameworks for literacy and numeracy is needed to improve consistency in measurement and thematic mapping across studies. Second, research should move beyond single-product development toward more robust evaluations, such as comparative designs across pedagogical approaches or across school contexts, consistent with emerging work using urban–rural comparisons and outcome-based evaluations. Third, digital-module development should be situated within an

implementation ecosystem that includes strengthening teacher competence and improving access to school-level digital learning resources. (Susanta et al., 2025; Alyusfitri et al., 2024; Suwanto et al., 2022). Accordingly, the bibliometric contribution of this study extends beyond mapping what has been studied most frequently to clarifying why these patterns have emerged and what their implications are for the future development of digital-module research targeting literacy and numeracy in elementary education. (Tarusu et al., 2025; Nirmala & Puspita, 2025; Rakhmawati & Mustadi, 2021).

CONCLUSION

This bibliometric study shows that publications on digital modules for strengthening literacy and numeracy in elementary schools have grown rapidly since 2021 and peaked in 2025, while 2026 is likely to reflect partial-year data. The keyword co-occurrence mapping confirms the dominance of the e-module development theme, accompanied by an evaluative orientation and differentiated pedagogical approaches, particularly Realistic Mathematics Education, Problem-Based Learning, and STEM integration. These findings indicate that the literature is not only concerned with producing instructional artefacts but is increasingly emphasizing evidence of quality and learning impact in elementary education contexts. For future research, it is recommended that the research agenda move beyond single-case development studies toward stronger and more generalizable evaluations, such as multi-site studies, cross-context replications, and direct comparisons of pedagogical approaches using equivalent literacy and numeracy indicators.

The limitations of this study stem from the use of Google Scholar via Publish or Perish, which may include cross-level documents because the term “e-module” is broadly used across educational levels, and from the presence of non-conceptual term artefacts within clusters that necessitate more rigorous data cleaning. In addition, Google Scholar citation metrics are dynamic and may change over time; therefore, interpretations of “most influential” should be understood as a snapshot at the time of data collection.

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