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Mathematical E-Modules in the Digital Era: A Bibliometric Analysis of Trends, Gaps, and Opportunities (2015–2025)

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ABSTRACT

The integration of digital technology into school learning processes has become a significant trend, with e-modules emerging as an essential form of digital learning resources. This study aims to identify research trends related to the use of e-modules in mathematics education at schools. A bibliometric analysis was employed, involving the mapping of research trends through metadata analysis. This study applied a systematic quantitative method, with metadata retrieved from Scopus and Google Scholar databases using the Publish or Perish software, and further analyzed using VOSviewer. The findings, based on Scopus and Google Scholar data, reveal that research on e-modules in mathematics learning is largely dominated by the ADDIE model, with most applications occurring at the secondary school level. However, relatively few studies have focused on 21st-century skills. The most recent research topics on e-modules in mathematics education, as reflected in keyword trends, include interactive e-modules, realistic mathematics education, ethnomathematics, and mathematical literacy. In contrast, areas such as computational thinking, mathematical reasoning, mathematical literacy, augmented reality (AR), artificial intelligence (AI), game-based learning, and higher-order thinking skills (HOTS) remain underexplored. These gaps indicate broad opportunities for future research on the use of e-modules in mathematics learning

Keywords : Bibliometric Analysis, Mathematical E-Modules, Analysis of Trends

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INTRODUCTION

In the 21st century, mathematics education in Indonesia still faces various challenges, including adapting to technological changes and fostering critical thinking and digital literacy skills (Ariani et al., 2025; Indrawati, 2023). Mathematics education should be directed toward the 4Cs skills designed to equip students to face the challenges of the 21st century (Thornhill-Miller et al., 2023) and problem-solving skills that have proven effective in dealing with daily challenges and professional fields (Elaby et al., 2022; Sridana & Sarjana, 2020; Yasin et al., 2020). The development of information and communication technology (ICT) presents a great opportunity to transform the learning process into something more dynamic, flexible, and personalized. The use of ICT in education not only assists school administration but also greatly supports classroom learning. ICT-assisted learning enables students to learn not only in the classroom but also to learn anytime and anywhere independently. One application of ICT is digital instructional materials in the form of electronic modules. E-modules are digital teaching materials that are systematically and interactively structured, often accompanied by animations, videos, interactive quizzes, and real-time feedback features. These modules support self-

directed and mobile-based learning (Erita, 2022) and contribute to enhancing students' digital literacy and problem-solving skills (Annisa et al., 2025).

Mobile learning e-modules allow students to access materials on devices such as smartphones and tablets. This supports flexible learning outside of school hours and during distance learning (Aulia & Prahmana, 2022)). Students also find it easier to review materials, complete practice exercises, and receive immediate feedback, which makes the learning process more meaningful and efficient (Annisa et al., 2025)Teachers, on the other hand, gain access to teaching materials that align with the characteristics of today's digital generation (Aulia & Prahmana, 2022; Erita, 2022).

Various studies have shown that using e-modules for mathematics education can improve learning outcomes (Mampouw et al., 2023; Sagita & Mulyani, 2023; Yunianta et al., 2023) and enhance students' critical thinking skills (Hikayat et al., 2020; Seruni et al., 2020) mathematical communication (Lestari & Wijayanti, 2021; D. P. Putri et al., 2020; Wandani, Setyansah, & Masfingatin, 2023), problem-solving skills (Islahiyah et al., 2021; Izzah et al., 2023; Widya et al., 2023), and learning independence (Mutiara Sakinah & Dori Lukman Hakim, 2023; Pasaribu, 2024). This study examines how publications on e-modules in mathematics education have been conducted over the past 10 years using a bibliometric approach. Bibliometrics is a statistical method for analyzing publication data (Jia et al., 2022). It is a comprehensive analytical tool that can analyze data sets organized into matrices (Arruda et al., 2022).

This study uses bibliometric analysis to determine the scope of e-module research, providing future researchers with guidance on new topics and helping them avoid duplicating previous studies. Several systematic bibliometric studies have mapped the development of e-module research in mathematics education. For example, V. J. Putri & Hasanuddin, (2025) concluded that the use of GeoGebra in interactive e-modules has shown an increasing trend in publications since 2021. Themes such as mathematical representation and interactive learning have dominated these publications. Simbolon (2024) noted in their study that e-module research topics can serve as references for future research by using or combining new keywords, such as computational thinking, augmented reality, mathematical literacy, and higher-order thinking skills (HOTS), to expand the scope of research. Sulistiawati et al. (2022), concluded that research on the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model in mathematics education has developed rapidly in the last five years. However, there are still gaps in which new research can be developed from previous studies. Utami et al. (2025) concludes that E-modules not only provide interactive and engaging learning materials but also cater to the diverse needs of students, thereby encouraging their participation in the learning process. Ningrum (2023) concluded that the keyword "e-module" is the most frequently used keyword in research on e-modules based on project-based learning in elementary schools, with 68 occurrences, while keywords such as "primary school," "critical thinking," "PBL," "integration," "local wisdom," and "application" are themes that can be further developed by subsequent researchers. Among the five researchers who conducted bibliometric analysis, there were two differences in their approaches: the keywords used and the data sources, which were obtained from Scopus and Google Scholar.

Therefore, this study is important for identifying trends, gaps, and research opportunities that can be developed in the future by referring to scientific publications on e-modules in mathematics learning during 2015–2025.

Theoretcal Review

Modules or teaching materials are one type of printed media that are structured and systematically organized to enable students to learn more easily on their own (Nuranisa et al., 2023; Wulandari et al., 2020). The development of digital technology in education has significantly transformed the way teachers and students interact with learning materials. One form of this transformation is the development and utilization of e-modules or electronic modules. E-modules are electronic versions of printed modules that can be read on computers and are designed using the necessary software (Maryam et al., 2019; Rochsun & Agustin, 2020). Electronic modules are multimedia-based instructional materials that include text, animations,

sound, and video tailored to the subject matter, using attractive templates and high-resolution quality, with formats such as tutorials, simulations, drill games, etc (Rumansyah, 2016). E-modules are a systematic transfer from printed to electronic form that supports self-directed learning by requiring students to practice solving problems independently (Arya Udayana et al., 2017; Winata et al., 2018). E-modules are digital modules containing text, images, or both, with relevant digital content to support the learning process (Arya Udayana et al., 2017; Winata et al., 2018). Unlike traditional printed modules, e-modules include various components such as text, images, audio, video, and animations presented interactively and accessible via electronic devices such as computers, tablets, or smartphones.

The main characteristics of e-modules include self-instructional, comprehensive, stand-alone, adaptive to learning needs, user-friendly, interactive and integrative with digital media, easily accessible, and developed with high validity in terms of content, language, presentation, and graphics. All of these characteristics support the transformation of learning to be more flexible, innovative, and effective in the digital age (Fadilah & Dj, 2023).

METHOD

This study employed two methods: descriptive analysis and bibliometric visualization. A bibliometric analysis is a popular, rigorous method used to explore and analyze large amounts of scientific data within a specific database. It is also used to discover new trends in articles and journals (Donthu et al., 2020).

In the data collection process, we used the Scopus and Google Scholar databases and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for document retrieval (Page et al., 2021; Shah et al., 2020). These guidelines cover identification, screening, eligibility, and inclusion (see Figure 3). First, the researcher determined the topic and scope of the research to be conducted. At this stage, the researcher selected the topic "E-Modules in Mathematics Education." The purpose of selecting this topic was to examine current e-module research trends in mathematics education to enable further comprehensive and innovative e-module study research. Next is the first PRISMA stage, Identification. This stage aims to obtain published articles corresponding to the keywords entered into the Scopus database search engine and the Publish or Perish (PoP) application. The researcher identified the research topic by searching for published research related to e-modules in mathematics education using the Publish or Perish application with the following keywords: "*mathematics*" OR "*mathematical*" OR "matematika" AND "e-*module*" OR "digital module" OR "*electronic module*" OR "modul digital" OR "e-modul" AND "*learning*" OR "*education*" OR "pembelajaran". As for searching for Scopus metadata on its official website using keywords: "*mathematics*" OR "*mathematical*" AND "e-*module*" OR "digital module" OR "*electronic module*" AND "*learning*" OR "*education*". The difference in keywords is due to the fact that Scopus metadata uses English. Through a search engine search of the Scopus database, 91 articles were obtained, and through a search engine search of the Publish or Perish database, researchers used a maximum search limit of 1,000 articles and obtained 999 articles. The following are images of keyword searches on the Scopus page and the Publish or Perish application.

Figure 1. Journal search display on the Harzing's Publish or Perish application

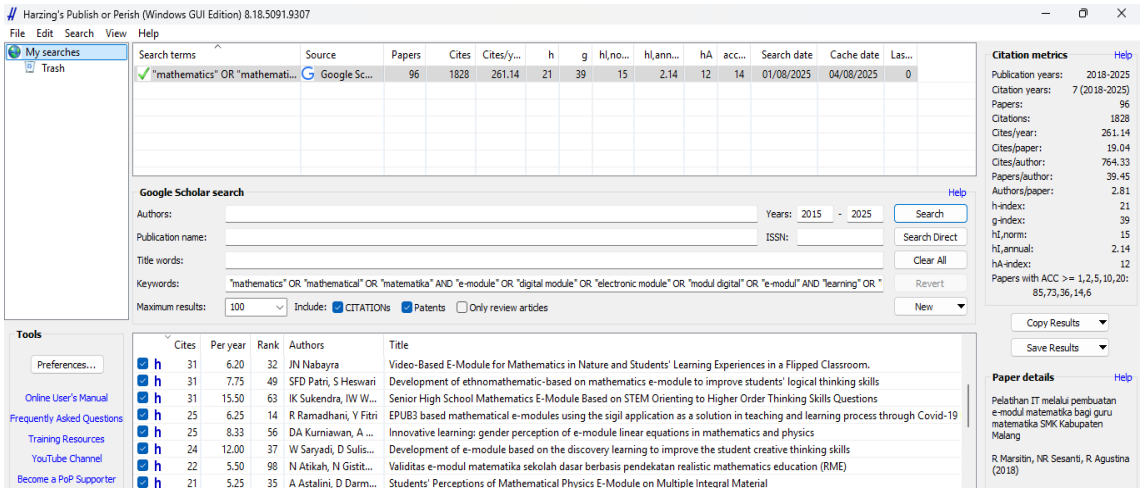
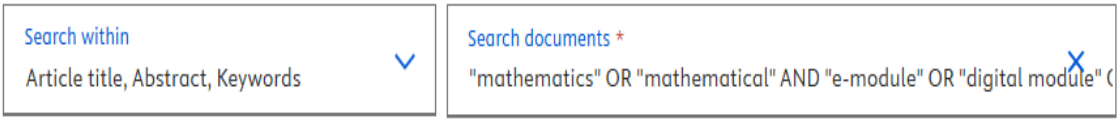
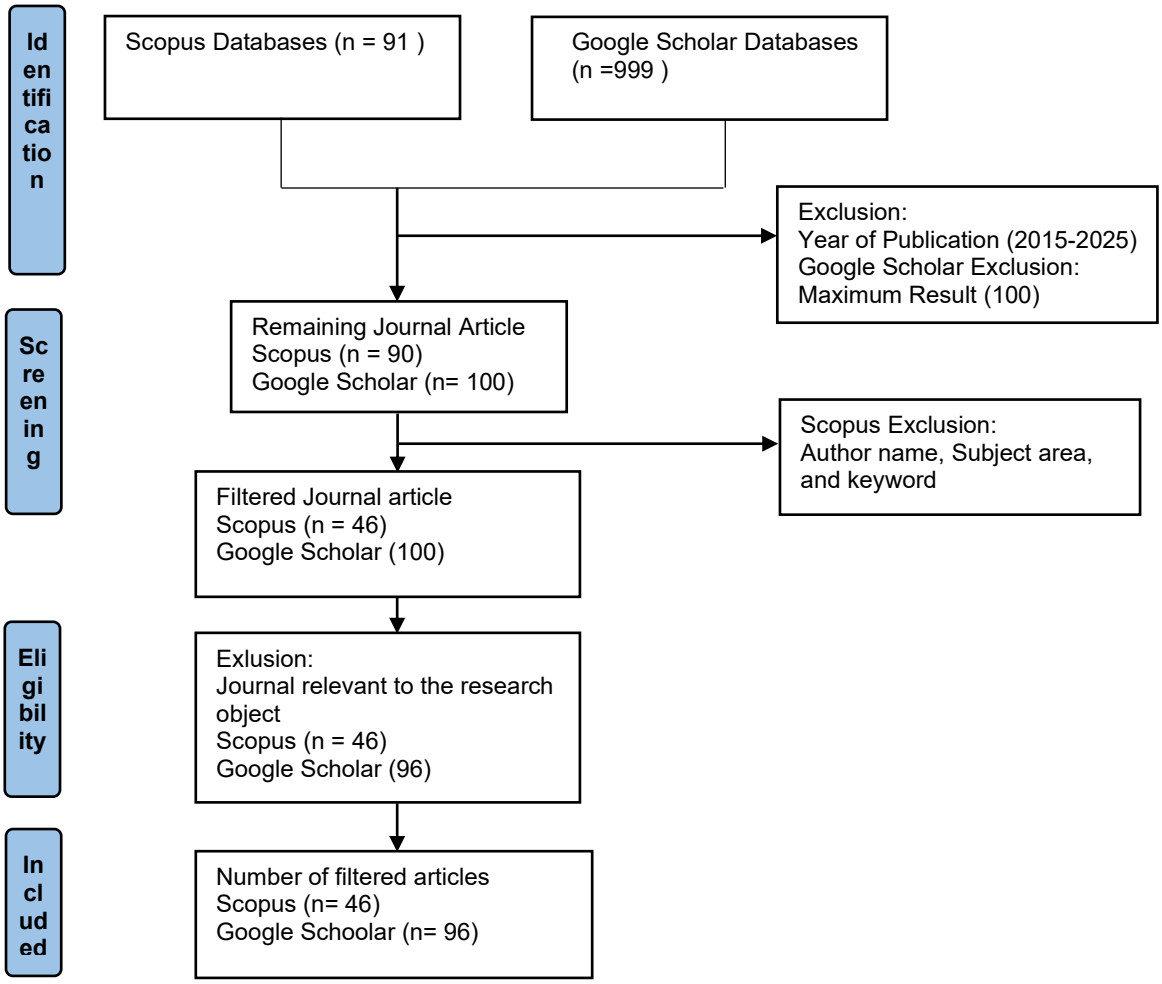


Figure 2. Journal search display on the Scopus page



The second step of PRISMA is the screening stage. In Publish or Perish (PoP), the screening process is carried out by limiting the publication year to 2015–2025 (the last decade) and setting the maximum search to 100. In Scopus, the screening process excludes unknown authors and 11 subject areas: art and humanities, chemical engineering, chemistry, economics, econometrics and finance, energy, health professions, medicine, earth and planetary sciences, business, management, and accounting, and engineering. It also excludes 17 keywords: engineering education, education competing, chemistry education, chemistry teacher, clean energy, computer science, convolution, dynamics, educational robots, general biology, energy materials, renewable energy, dynamic fluids, learning physics, physics, physics education, and physics learning. The screening process yielded 100 articles from Google Scholar and 46 articles from Scopus. The third stage is eligibility, which involves determining the suitability of articles. Researchers assess this suitability by checking whether the title and abstract of the article are relevant to the research objectives. During this stage, metadata from Scopus and Google Scholar is obtained. The included stage is the final stage of the PRISMA flow diagram. The researcher obtained 46 articles from Scopus and 96 articles from Google Scholar that met the requirements for further processing. Data collection was conducted on July 15, 2025, and the data were saved in CSV and RIS formats.

Figure 3. Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)



The data collected from the Scopus and Google Scholar databases will be processed and visualized using the VOSviewer software. VOSviewer generates network visualizations of frequently used terms in a given field (Orduña-Malea & Costas, 2021; Oyewola & Dada, 2022; van Eck & Waltman, 2017). It is a popular and helpful application for bibliometric analysis (Shah et al., 2020; van Eck & Waltman, 2010). VOSviewer can generate bibliometric maps in three forms: density visualization, network visualization, and overlay visualization based on co-citation networks among recent publications.

RESULT AND DISCUSSION

Articles found in Scopus and Google Scholar are often cited in research. The more citations an article receives, the more it is used as a reference in other studies. After collecting and processing data and conducting bibliometric mapping of publication data using VOSViewer software based on the determined research method, the researcher analyzes and interprets the results of the previous stages.

Based on the collected Scopus data, it is evident that research related to e-modules has been trending since 2019 and continues to increase, despite the fact that the number of articles published in 2021 was the same as in 2020. In 2024, 13 articles were published. However, it appears that the annual number of publications related to e-modules returned to a downward trend in 2025 (see Table 1). E-module research began trending in 2019, peaking in 2024, which indicates an intensification of e-module adoption during or after the pandemic. Based on the authors' names, the top ten authors who published e-module articles each published two to three articles. The first six authors—Pebriana, Rahman, Setiaji, Setiyani, Supahar, and Yerizon—each published three articles. The next four authors, Cahyono, Gistituati, Jamaan, and Junaedi, each published three articles (see Table 2).

Of the countries conducting e-module research, three are actively involved: Indonesia, Malaysia, and the Philippines. Indonesia ranks first, having published around 75% of the total e-module documents. This shows that e-module innovation stems from local initiatives and domestic universities. Malaysia and the Philippines have emerged as regional actors but remain far behind Indonesia. Although research related to e-modules is dominated by Southeast Asia, no developed countries are conducting research in this field. This indicates that the potential of e-modules has not yet been recognized as a global topic (see Table 3). The top e-module research trends, based on affiliation, all originate from Indonesia and Malaysia. This reflects Southeast Asia's regional focus on digital transformation in mathematics education. It also indicates high interest among mathematics education faculty in developing digital learning media based on e-modules. However, there are no contributions from major international research universities, suggesting that there are ample opportunities for global collaboration (see Table 4).

The majority of publications are conference proceedings (32 articles, 68.9%) and journal articles (14 articles, 31.1%). This suggests that the peer review process may not be as rigorous as that of Scopus Q1–Q2 journals. Additionally, e-module research is still in its early stages, as evidenced by the limited number of comprehensive studies published in high-impact journals. Given the limited number of documents published in Scopus-indexed articles, Indonesian researchers have an opportunity to focus on more substantial, theoretical Scopus journal articles. The following is a list of the ten articles with the most citations, based on the journal's h-index (see Table 5).

Based on subject area, the majority of publications (59.3%) originated from the fields of physics and astronomy. This is likely because the term "mathematical" is used in the context of theoretical physics rather than mathematics education. Only 9.3% of articles originated from the field of mathematics, indicating that explicit research on e-modules in mathematics education is still scarce. Meanwhile, the Social Sciences rank second at 20.4%, making it the most relevant field because it covers education, pedagogy, and learning technology. Computer science (5.6%) contributes significantly to the technical development of e-modules, including application-based design and learning management systems (LMS). Psychology (3.7%) plays a role in exploring affective aspects, such as motivation and learning anxiety. Multidisciplinary studies

(1.9%) show potential for cross-disciplinary collaboration. Overall, this distribution indicates that, although e-module research in mathematics education continues to grow, stricter topic screening and deeper exploration within the mathematics education domain itself are needed.

Table 1. E-module research trends by year

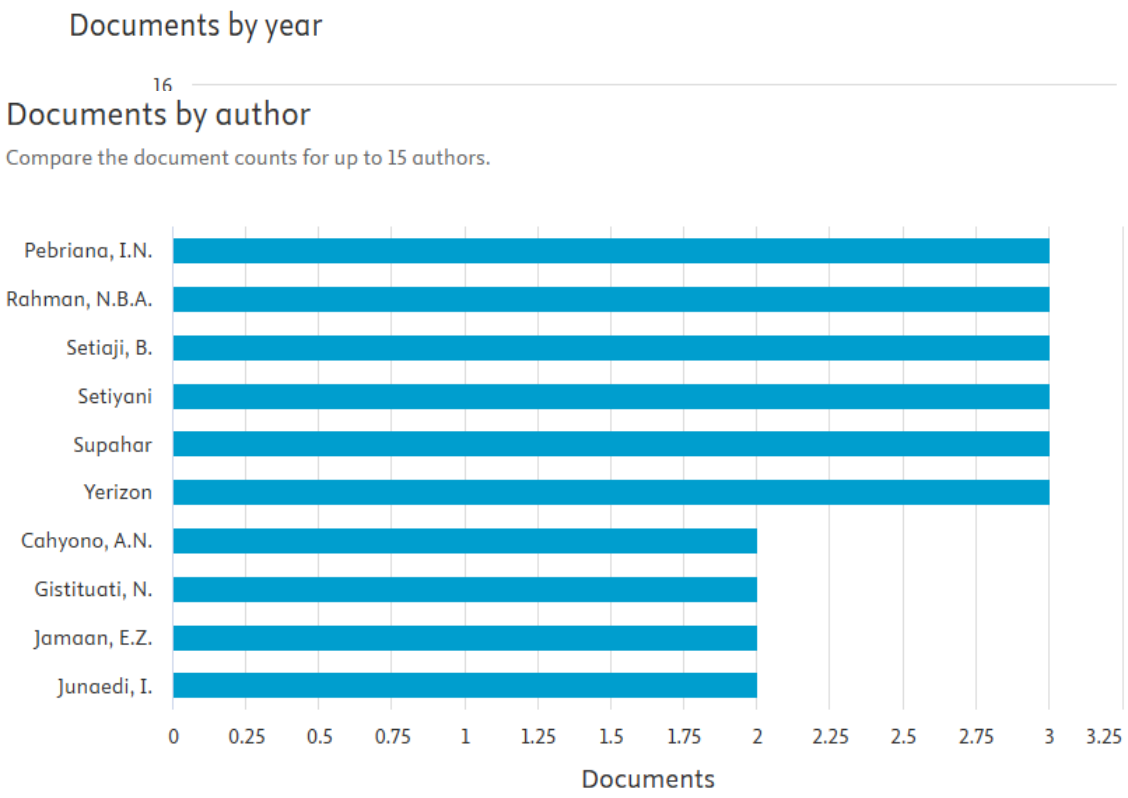


Table 3. Research e-module based on country

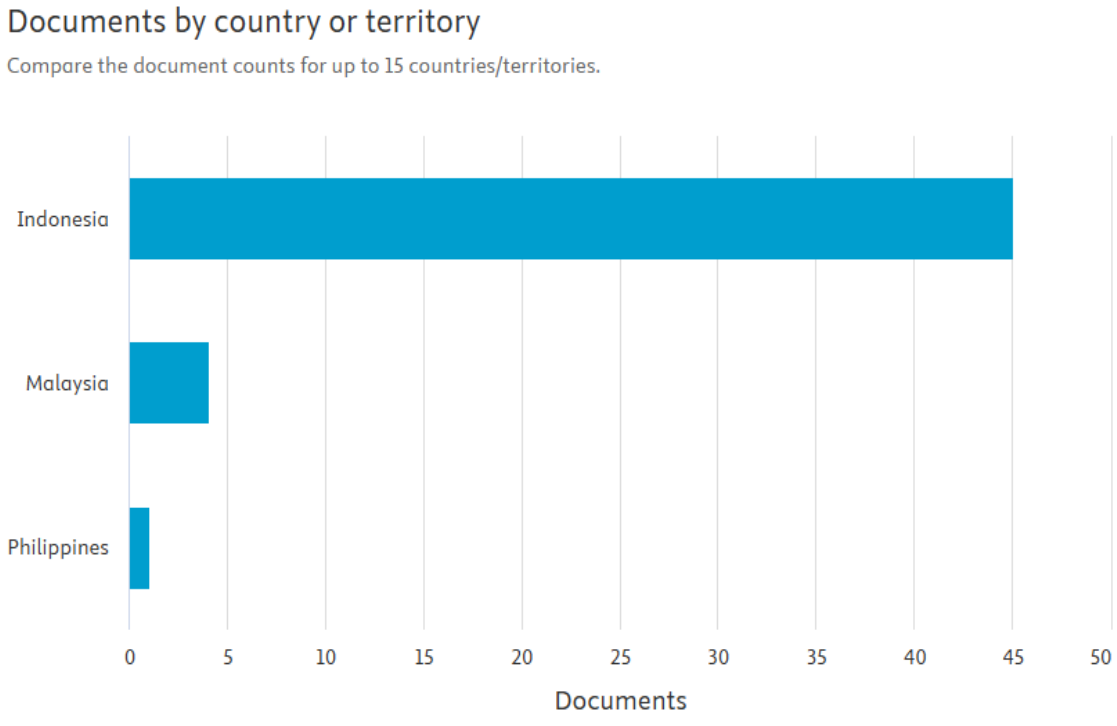


Table 4. Research on the E-module based on affiliation

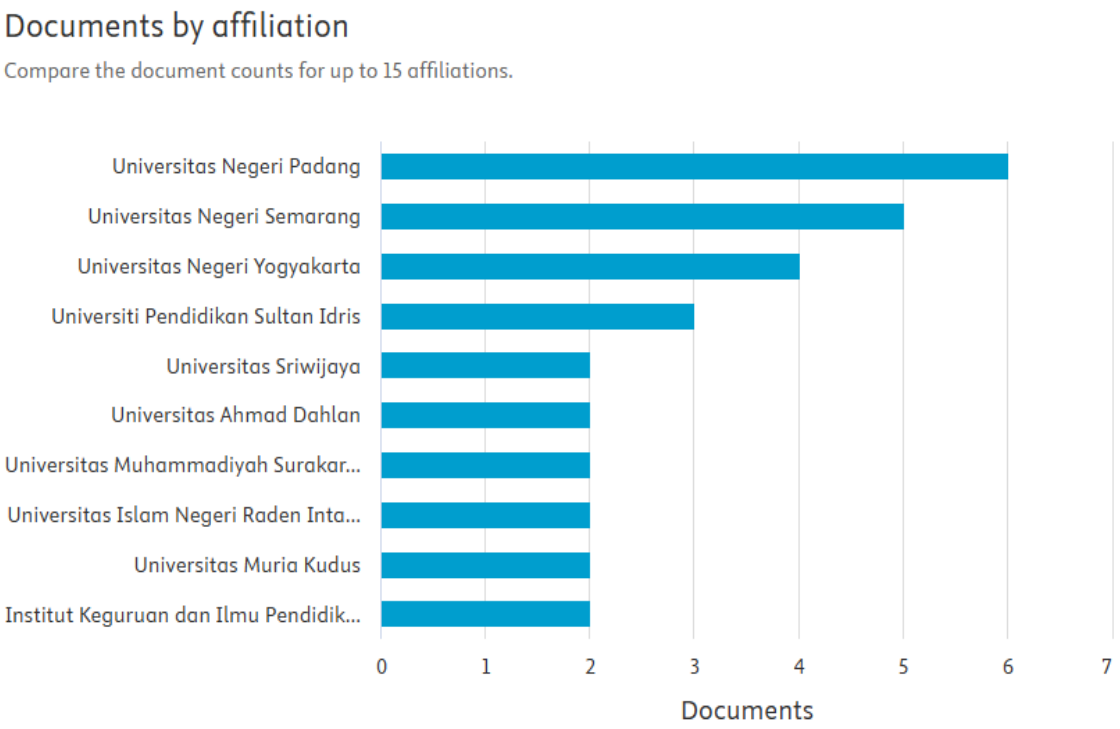


Table 5. Research on e-modules based on document type

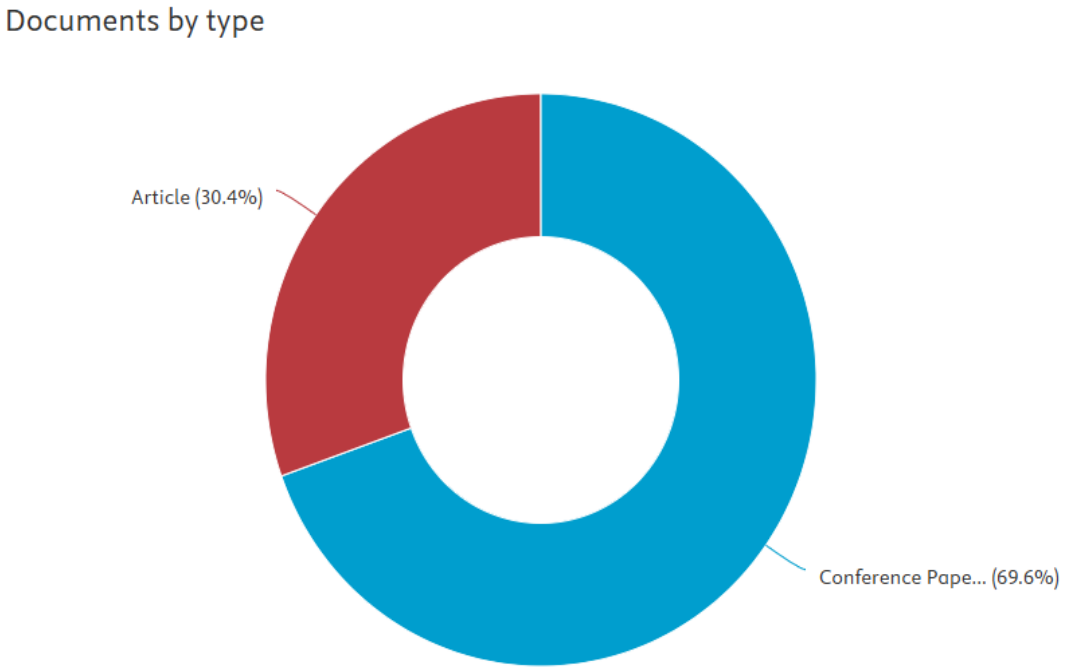
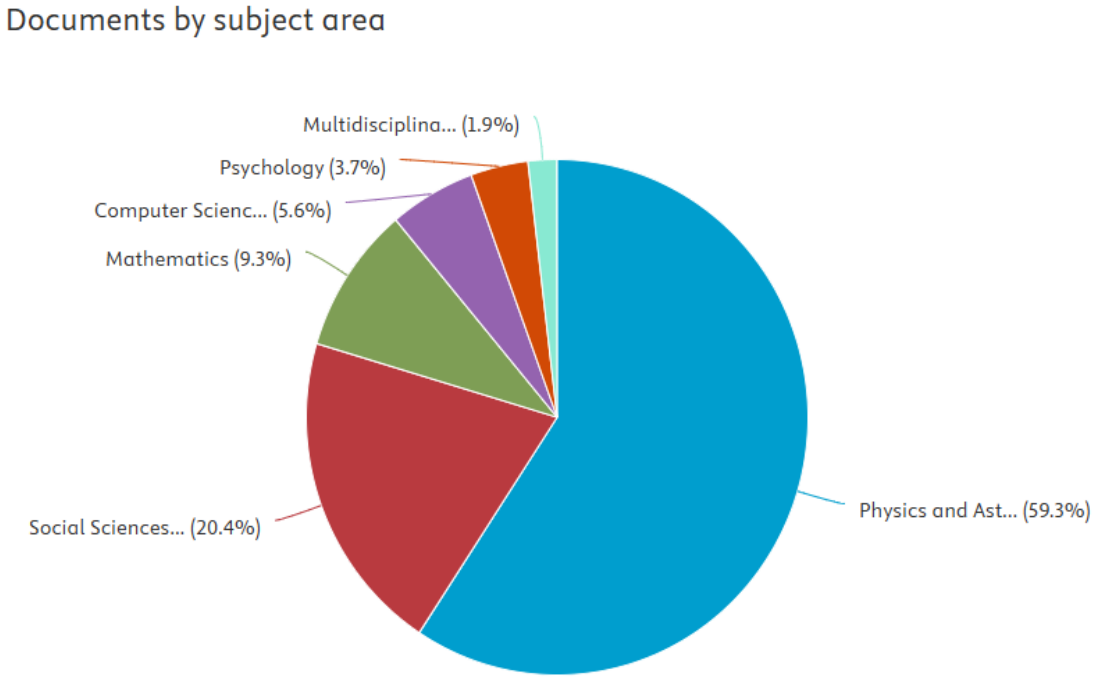


Table 6. Research on e-modules based on subject area

Dari 46 artikel scopus yang dianalisis, terdapat 10 artikel dengan sitasi terbanyak yang



peneliti sajikan pada tabel berikut.

Table 7. Scopus Publication Data with the Most Citations

No	Number of Citations	Aouthor name	Title of Article	year	Journal Name
1	26	Setiyani, Putri, D.P., Ferdianto, F., Fauji, S.H.	Designing a digital teaching module based on mathematical communication in relation and function	2020	Journal on Mathematics Education
2	20	Hidayat, W., Rohaeti, E.E., Ginanjar, A., Putri, R.I.I.	An epub learning module and students' mathematical reasoning ability: a development study	2022	Journal on Mathematics Education
3	19	Setiyani, Waluya, S.B., Sukestiyarno, Y.L., Cahyono, A.N.	E-module design using kvisoft flipbook application based on mathematics creative thingking ability for juniaor High Schools	2022	International Journal of Interactive Mobile Technologies
4	16	Hikayat, C., Suparman, Hairun, Y., Suharna, H.	Design of realistic mathematics education approach to improve critical thinking skills	2020	Universal Journal of Educational Research
5	10	Fahmi, S., Priwantoro, S.W., Cahdriyana, R.a.,	Interactive learning media using kvisoft flipbook maker for mathematics	2019	Journal of physics conference

		Rohmah, S.N., Nisa, L.C.	learning		series
6	6	Astalini, Darmaji, Kurniawan, D.A., Simamora, N.N., Ramadhanti, A.	A study for Student perception of mathematical physics e-module based on gender	2022	Journal of Turkish Science Education
7	5	Hidayah, N., Komikesari, H., Pratiwi, W.O., Asyhari, A., Yusandika, A.D.	STEM-based science E-module: is it sufficent to improve students' creative thinking skills?	2023	Aip Conference Proceedings
8	4	Patri, S.F.D., Heswari, S.	Development of ethnomathematic-based on mathematics e-module to improve students' logical thinking skills	2021	Aip Conference Proceedings
9	3	Dio, R.V.	Utization of digital module for asynchronous online independent learning in advanced mathematics education	2022	Mathematics teaching research Journal
10	2	Alyusfitri, R., Gistituati, N., Yerizon, Fauzan, A., Yarman	The Effectiveness and Relationship of Student Responses toward Learning Outcomes using interactive Multimedia-Based-E-Modules in Elementary Schools	2024	International Electronic Journal of Elementary Education

As shown in Table 7, of the ten articles with the highest number of citations, one article published in the Journal of Mathematics Education in 2020, titled "Designing a Digital Teaching Module Based on Mathematical Communication in Relation and Function" (Setiyani, 2020), has the highest number of citations, at 26.

Vosviewer mapping of 46 Scopus articles yielded 49 word items, which were divided into seven clusters. The clusters are distributed as follows: each contains a group of word items related to the research topic. In addition to items divided into clusters, the visual analysis of Vosviewer mapping results of Scopus data is divided into three categories: network visualization, overlay visualization, and density visualization. The 10 keywords with the highest frequency of occurrence in e-module research trends are listed below.

Table 8. Item with the most repetitions

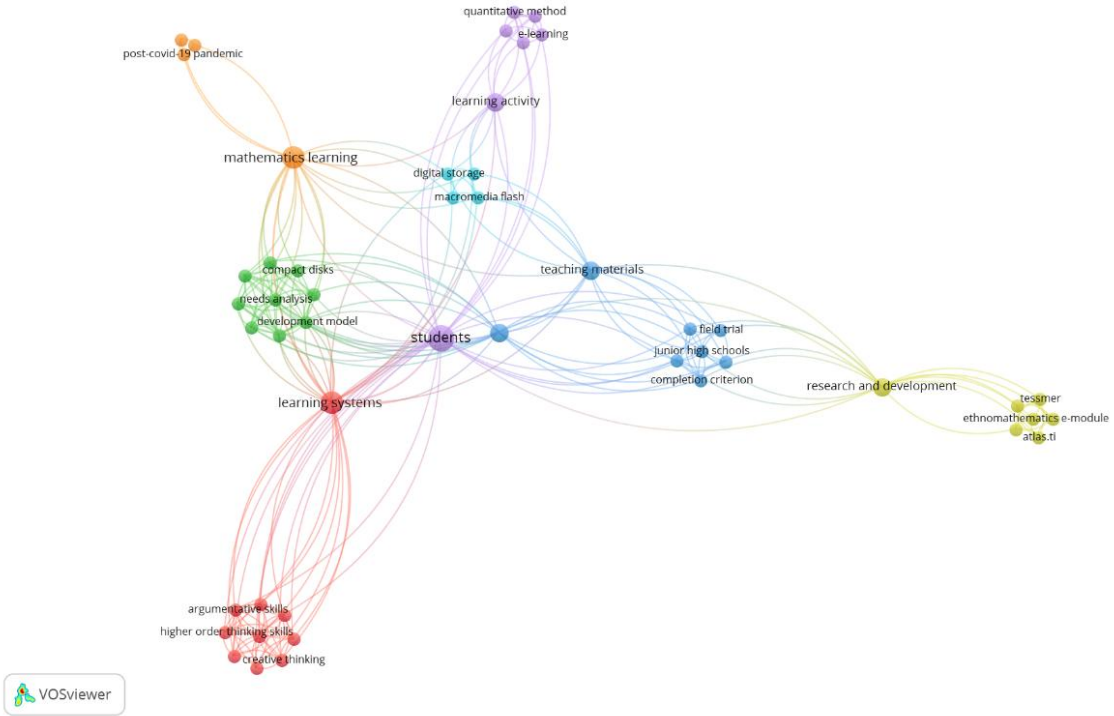
No.	Keyword	Total link strength
1.	Student	8
2.	Learning system	7
3.	e-module	6
4.	Learning media	6
5.	Mathematics learning	6
6.	Teaching materials	6
7.	Learning activity	4
8.	Realistic mathematics education	4
9.	Addie	3
10.	Gender	3

The network visualization results generated by VOSviewer show seven main clusters representing interrelated research themes in learning media and educational development.

Cluster 1, marked in red, includes ten main items, such as argumentative skills, critical thinking, creative thinking, learning systems, and STEM (science, technology, engineering, and mathematics). This cluster represents a research focus on developing higher-order thinking skills and learning systems that support 21st-century skills. Cluster 2, marked in green, consists of nine items, including educational technology, interactive learning, development models, and student responses. This cluster reflects research themes surrounding the use of educational technology and interactive approaches in developing learning media. Cluster 3, marked in blue, includes eight items, such as learning media, junior high schools, teaching materials, and visual studios. This cluster focuses on developing relevant teaching media for secondary education levels and testing their effectiveness through field studies and completion criteria.

Next is Cluster 4 (yellow), which consists of seven items, including the Ethnomathematics E-Module, the Sundanese Gamelan, Atlas.ti, and Plomp. This cluster is unique because it employs a qualitative approach to research and development based on local culture and wisdom, particularly ethnomathematics, when developing culture-based e-modules. Cluster 5 (purple) involves themes such as e-learning, project-based learning, virtual meetings, and quantitative methods. This reflects the integration of online learning and project-based approaches in response to the need for flexible learning, especially post-pandemic. Cluster 6, marked in green, consists of four items, such as digital storage, Macromedia Flash, and multimedia-based learning. These items focus on developing multimedia-based digital media technology. This cluster highlights the use of software and digital platforms in developing interactive learning media. Finally, Cluster 7 includes themes such as mathematics learning, the post-pandemic era, and research development outcomes. It highlights the education sector's response to the pandemic, particularly regarding mathematics learning and adapting to new methods of learning development (see Figure 4).

Figure 4. Visualization of Research Trends Network E-module data from Scopus

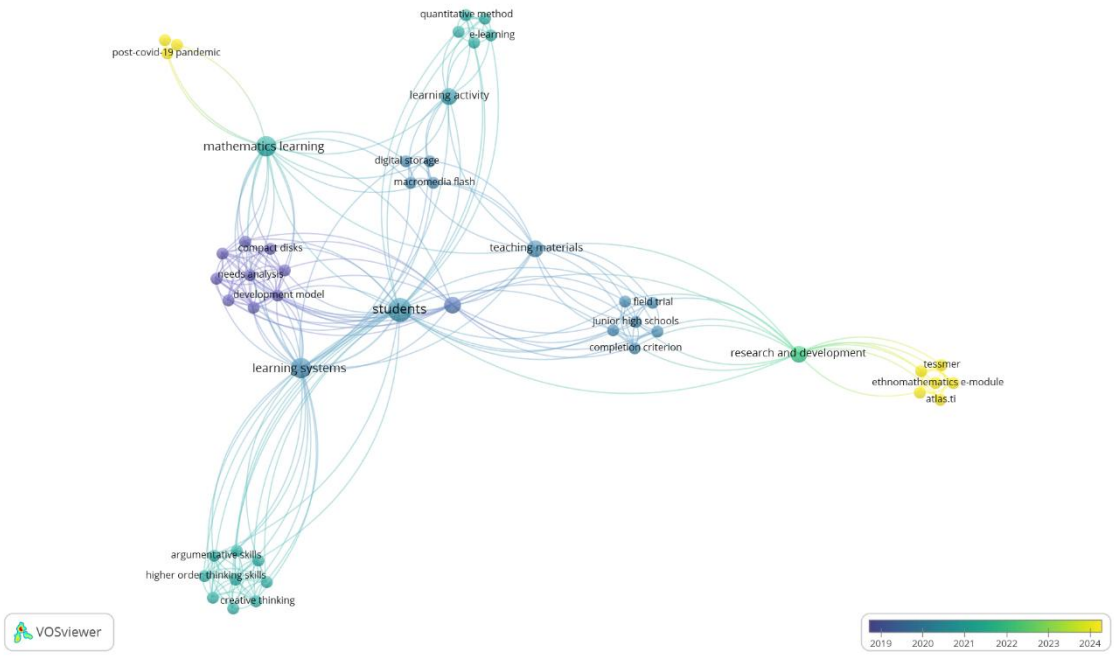


Next is the overlay visualization result from VOSviewer. It displays the temporal dynamics of research keywords related to mathematics learning development, learning systems, and digital innovation in education. The colors in this visualization represent the average year the keywords appeared in literature. Dark blue to purple: Keywords that were

dominant in the early years (around 2019–2020). Green to turquoise: Keywords that emerged or developed in the middle (around 2021–2022). Bright yellow: Keywords that emerged in 2023–2024 and have developed significantly.

In the overlay visualization, researchers should pay attention to five points, namely: 1). Old keywords (2019–2020): Words such as "compact disks," "needs analysis," and "development model" appear in dark purple. This indicates that, in the early period, educational research focused on relatively conventional needs analysis and model development, including CD-based media. This reflects the early phase of technology-based instructional material development before the full transition to online platforms. 2). Core and stable keywords (2020-2022): Elements such as students, learning systems, teaching materials, and junior high schools appear in the light blue to green area. This means these terms have had a consistent and recurring presence over the past few years. Topics such as the effectiveness of teaching materials, the development of learning systems, and a focus on junior high school students are at the core of contemporary educational research and remain primary concerns. 3). Post-Pandemic Development (2022-2023): Terms such as post-pandemic, mathematics learning, e-learning, and quantitative methods appear in yellow or light green, reflecting a surge in attention to these topics after the pandemic. This shows that the pandemic was a catalyst for a major shift toward digital learning, stronger quantitative evaluation methods, and adapting mathematics learning to an online context. 4) New and Cutting-Edge Topics (2023–2024): Keywords such as "ethnomathematics," "e-module," "Tessmer," and "Atlas.ti" appear in bright yellow, indicating that these are very new and rapidly developing research trends. This signifies a shift in focus toward integrating local wisdom into mathematics education (ethnomathematics), using the Tessmer development model for product validation, and adopting digital qualitative analysis tools, such as Atlas.ti, in educational studies (see Figure 5).

Figure 5. Visualization Results of Overlay Trends in Electronic Module Research Scopus Data

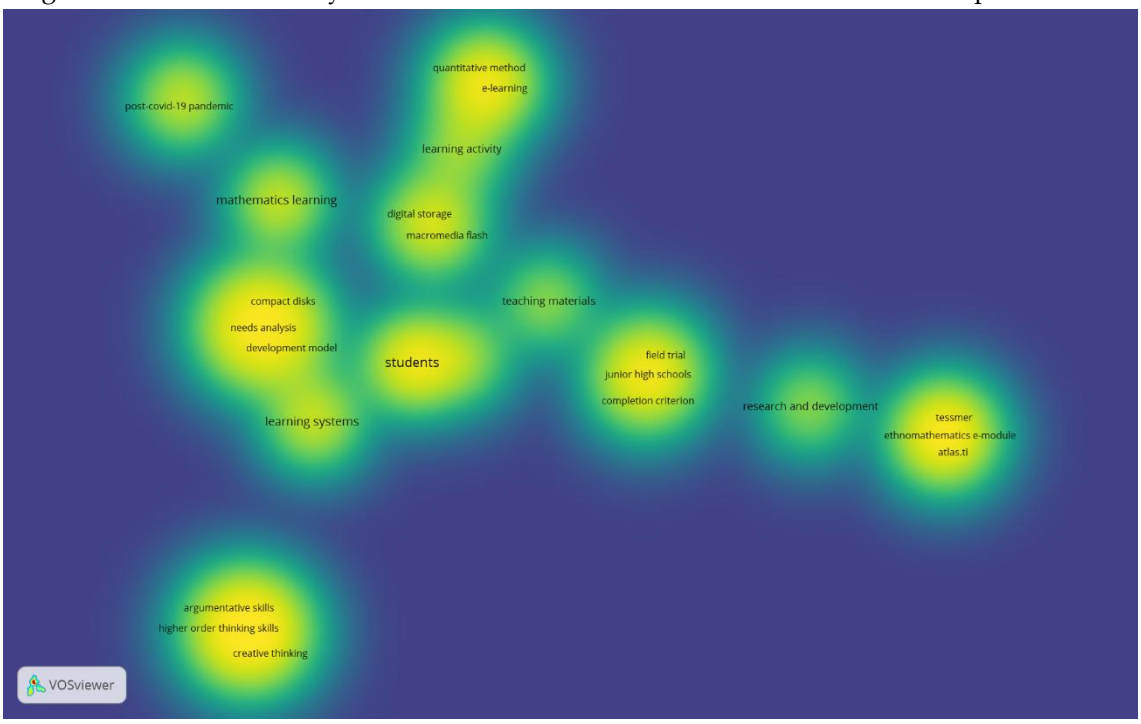


The final analysis in VOSviewer is a density visualization. In this visualization, colors indicate the frequency and connectivity of keywords. Bright yellow indicates keywords that appear frequently and are connected to many other words. Green and blue indicate keywords that appear less frequently and are less connected. Keyword proximity indicates that they frequently appear together in a single document, representing interconnected research themes. The keyword "students" emerges as the primary gravitational center in the network, marked by the most intense shade of yellow. This suggests that nearly all of the research in the dataset

focuses on students as the primary subject, whether in the context of learning, instructional material development, or competency achievement. There is a strong connection between "students," "teaching materials," "field trials," "completion criteria," and "junior high schools." Many studies focus on developing teaching materials, conducting limited trials (field trials), and evaluating student learning outcomes at the junior high school level.

A cluster of keywords, such as e-learning, quantitative method, and learning activity, is at the top. These keywords reflect post-pandemic research trends moving toward online learning and using quantitative approaches to measure the effectiveness of digital learning activities. On the right, there is a cluster of research and development, Tessmer, the ethnomathematics e-module, and Atlas.ti. This reflects the use of the research and development approach, specifically the Tessmer model, in developing context-based e-modules (ethnomathematics), which are supported by qualitative analysis software, such as Atlas.ti. Another prominent cluster includes needs analysis, the development model, and compact disks. This indicates that some research still involves a needs analysis before developing instructional materials and that some research still uses classic digital media, such as CDs or disks. The term "post-pandemic" stands alone but is connected to mathematics learning. This suggests a particular focus on how mathematics learning adapts post-pandemic, though this topic is not yet strongly connected to other clusters. In the lower left corner are clusters related to creative thinking, argumentative skills, and higher-order thinking skills. This suggests that some studies focus on developing higher-order thinking skills, which are learning outcome targets in modern curricula (see Figure 6).

Figure 6. Results of Density Visualization of E-Module Research Trends from Scopus Data



The data collected from the Google Scholar database using Harzing's Publish or Perish (PoP) application was used to extract information from 98 articles that were suitable for research using keywords: "*mathematics*" OR "*mathematical*" OR "matematika" AND "e-*module*" OR "digital module" OR "*electronic module*" OR "modul digital" OR "e-modul" AND "*learning*" OR "*education*" OR "pembelajaran". Metadata collection was carried out by collecting articles, including author names, article titles, number of citations, related URLs, DOIs, year of publication, and number of citations.

Table 9. *E-module* Citation Metric (2015-2025)

Description	Result
Publication Years	2018-2025
Citation Years	7 (2018-2025)
Total Publication	96
Citations	1828
Cites/Year	261,14
Cites/Paper	19,04
Cites/Author	764,33
Author/Paper	2,81
h-index	21
g-index	39
hI, norm	15
hI, annual	2,14
hA-index	12

Table 9 shows that over the past 8 years, 96 documents have been published. Of the 96 documents, there have been 1,828 citations, with an average of 261.14 citations per year and 19.04 citations per paper. The H-index for all articles is 21, while the g-index is 39. Below is a list of the top 10 articles with the most citations, as compiled by the researcher based on the journal's H-index results.

Table 10. Publication data for e-module articles with the most citations

No	Number of Citations	Author Name	Title of Articel	Year	Journal Name
1	184	A Fonda, S Sumargiyani	The developing math electronic module with scientific approach using kvisoft flipbook maker pro for xi grade of senior high school students	2018	Infinity Journal
2	177	DP Putri, F Ferdianto, SH Fauji	Designing a digital teaching module based on mathematical communication in relation and function.	2020	Journal on Mathematics Education
3	111	NFD Hadiyanti, AC Prihandoko, dkk	Development of mathematics e-module with STEM-collaborative project based learning to improve mathematical literacy ability of vocational high school students	2021	Journal of Physics: Conference Series
4	82	I Islahiyah, H Pujiastuti, A Mutaqin	Pengembangan e-modul dengan model pembelajaran berbasis masalah untuk meningkatkan kemampuan pemecahan masalah matematis siswa	2021	AKSIOMA: Jurnal Program Studi Pendidikan Matematika
5	82	F Ramadanti, A Mutaqin, dkk	Pengembangan E-Modul Matematika Berbasis PBL (Problem Based Learning) pada Materi Penyajian Data	2021	Jurnal Cendekia : Jurnal Pendidikan Matematika

			untuk Siswa SMP		
6	70	S Hendri, R Handika, AK Kenedi, D Ramadhani	Pengembangan modul digital pembelajaran matematika berbasis science, technology, enginiring, mathematic untuk calon guru sekolah dasar	2021	Jurnal Basicedu
7	68	R Ilmi, IM Arnawa, NN Bakar	Development of an android-based for math e-module by using Adobe Flash Professional Cs6 for grade X students of senior high school	2021	Journal of Physics: Conference Series
8	63	NK Erawati, NKR Purwati, dkk	Pengembangan e-modul logika matematika dengan heyzine untuk menunjang pembelajaran di smk	2022	JPM: Jurnal Pendidikan Matematika
9	50	ET Aulia, RCI Prahmana	Developing interactive e-module based on realistic mathematics education approach and mathematical literacy ability	2022	Jurnal Elemen
10	49	D Wahyudi	Pengembangan e-modul dalam pembelajaran matematika SMA berbasis Android	2019	Gauss: Jurnal Pendidikan Matematika

As shown in Table 10, the article "The Developing Math Electronic Module with Scientific Approach Using Kvisoft Flipbook Maker Pro for XI Grade of Senior High School Students" (Fonda & Sumargiyani, 2018) is the most cited article among the top 10 articles, with 184 citations. Refer to the table to see how the publication of research articles on e-modules in mathematics education increased from 2015 to 2025.

Table 11. Development of E-Module Research

Tahun Publikasi	Jumlah Publikasi	Persentase
2016	0	0 %
2017	0	0 %
2018	1	1,04
2019	2	2,08
2020	4	4,17
2021	21	21,875
2022	27	28, 125
2023	25	26,04
2024	11	11,46
2025	5	5,21
Total	**96**	**100%**

Table 11 shows that the number of publications on e-modules in mathematics education increased significantly from 2020 to 2021, with 17 additional documents published. This increase began in 2019 and continued until 2022 due to the global impact of the pandemic, which made the use of e-modules in online mathematics education particularly helpful. Over the past ten years, research on e-modules in mathematics education published in the Google Scholar database shows a positive trend. The highest number of e-module publications in

mathematics education occurred in 2022, with 27 publications. After 2022, however, the number decreased, indicating a decline in researchers' interest in developing e-modules.

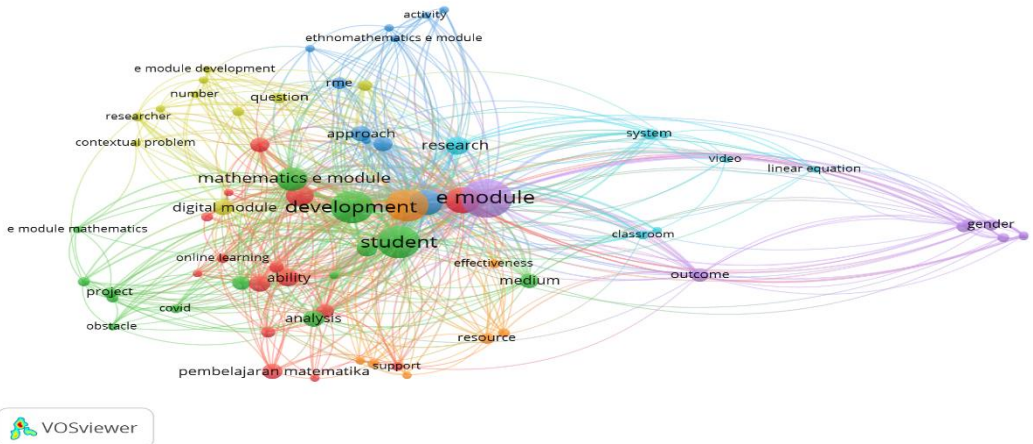
VOSViewer mapped 96 articles and yielded 79 keyword items, each of which occurred at least twice. Synonymous terms were then removed, resulting in 71 items divided into seven clusters. In addition to the items in the seven clusters, the mapping results from the VOSViewer software on Google Scholar data were divided into three categories: network visualization, overlay visualization, and density visualization. The network visualization results from the bibliometric analysis of scientific studies about e-modules using VOSViewer illustrate the interconnectedness and different research focuses that complement each other by clustering keywords into seven differently colored clusters.

Cluster 1 (purple) focuses on the term "e-module" and includes related keywords such as "system," "video," "classroom," "outcome," and "linear equation." This cluster emphasizes the technical and implementation aspects of e-module use, particularly in video-based learning systems and student learning outcomes. It also highlights the application of e-modules in specific subjects, such as mathematics and linear equations. The relationships among the keywords in this cluster demonstrate that research on e-modules extends beyond their development to include their integration into comprehensive digital learning systems. Cluster 2 (orange) groups keywords such as "development," "resource," "support," and "mathematics learning." This cluster emphasizes the development and implementation support of e-modules for learning, particularly in mathematics. Research in this cluster tends to explore how resources, such as media and teaching materials, and development strategies contribute to the effectiveness of e-modules in improving learning quality. Cluster 3 (green) addresses issues related to students, abilities, projects, obstacles, and online learning. This cluster focuses on how students respond to using e-modules, including their abilities, challenges, and online learning experiences. The keyword "project" indicates a trend toward integrating project-based learning approaches in e-module use.

Cluster 4 (red) contains keywords such as "mathematics e-module," "digital module," "online learning," "researcher," and "contextual problem." The main focus of this cluster is developing e-modules for mathematical contexts and contextual approaches. This reflects researchers' efforts to develop relevant teaching tools for students' needs and real-world situations. Cluster 5 (light blue), with keywords such as "research," "approach," "RME," and "ethnomathematics e-module," emphasizes research methodology and pedagogical approaches in the development of e-modules, including Realistic Mathematics Education (RME) and ethnomathematics. This cluster reveals how learning theories are incorporated into culturally based digital content. Cluster 6 (dark blue) is more technical and contains keywords such as "activity" and "question." This cluster focuses on the technical details of measurement, the design of learning activities within e-modules, and evaluation strategies for learning. Cluster 7 (light purple) consists solely of the word "gender" and its association with several elements. This reflects an interest in how gender influences the effectiveness of e-module use. For example, there may be differences in achievement or preferences between male and female learners (see Figure 7).

Figure 7: Visualization of E-Module Research Trends Network Using Google Scholar Data

Figure 7 above, Overall this visualization shows that research on e-modules in



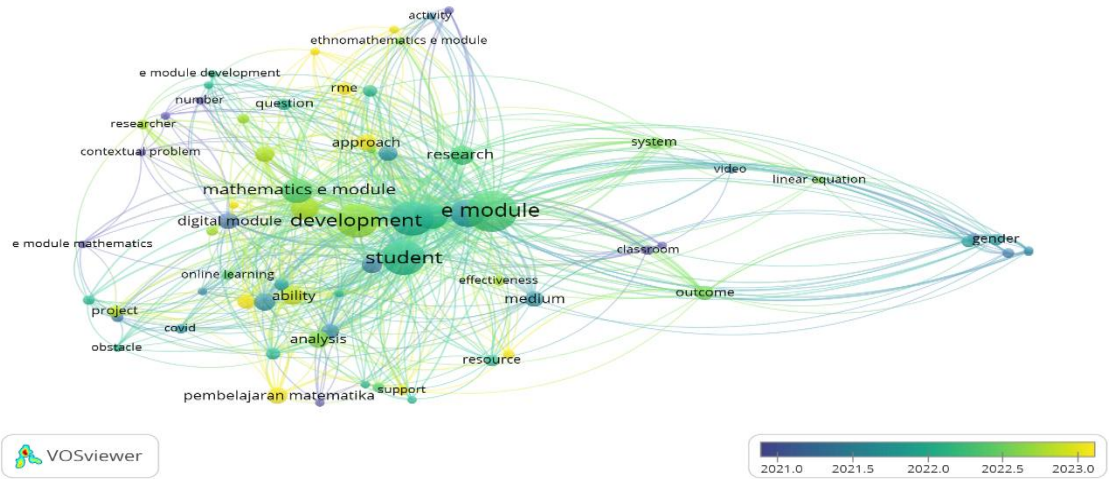
education has developed into a multidimensional field. This field focuses on content development, pedagogical implementation, cultural context, system effectiveness, and learner characteristics. The relationships between keywords demonstrate that e-module research is inextricably linked to the broader dynamics of digital learning. The closer the lines between two items, the stronger the connection between them (Van Eck & Waltman, 2017). Based on the mapping results in Figure 7, the keyword "e-module" is the most frequently used, appearing 47 times as indicated by its large circle. The table below presents the 10 items with the highest usage frequency.

Table 12. Items with the most repetitions

No.	Kata Kunci	Banyak Pengulangan
1.	e module	47
2.	development	35
3.	student	35
4.	mathematics	35
5.	study	22
6.	learning	21
7.	Mathematics e module	18
8.	problem	14
9.	research	11
10.	ability	10

Next is the result of the overlay visualization analysis from VOSviewer. This visualization shows the dynamics of e-module research development year over year based on the keywords used. The darker the yellow, the higher the novelty level of the item, and vice versa (Van Eck & Waltman, 2017). Keywords such as "e-module," "development," "student," and "mathematics e-module" are at the center of the green network, indicating that these topics have long been the main focus and remain relevant today. The emergence of yellow keywords, such as "ethnomathematics e-module," "RME," "approach," "question," and "obstacle," signifies new trends in e-module development, including contextual approaches, locally based cultures, and an emphasis on evaluation and learning obstacles. Keywords such as gender and linear equation, located in a slightly separate area and colored blue-green, reflect that these issues are beginning to be explored but have not yet become main topics. Keywords such as ability, effectiveness, analysis, and online learning are in a transitional color and indicate a shift in research focus from product development to evaluating the impact and effectiveness of digital learning. Overall, this visualization shows that e-module research is becoming more complex and interdisciplinary, with a focus on social context and specific student needs. This makes it a fertile ground for further research (see Figure 8).

Figure 8. Visualization of Overlay Trend of E-Module Data from Google Scholar



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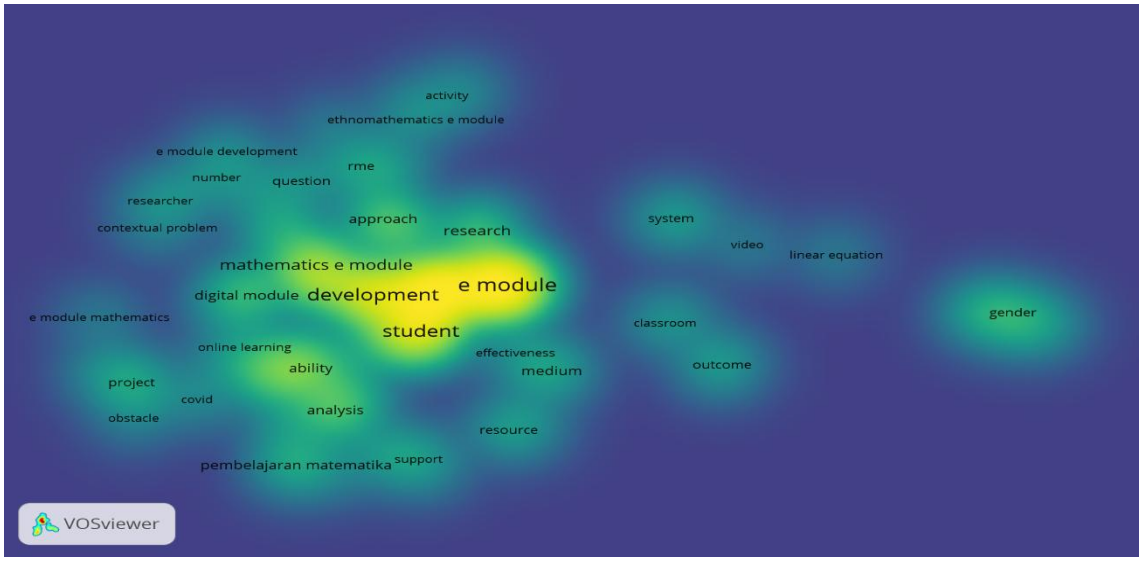
The final Vosviewer analysis is a density visualization. The density of research themes is shown in bright yellow. The more faded the yellow, or the closer it is to green or blue, the less common the theme is as a research topic. This makes it a useful reference for future research (Van Eck & Waltman, 2017) The density visualization of the e-module research map above provides an overview of the intensity and frequency with which keywords appear in the analyzed literature. The keywords "e-module," "development," and "student" are at the core of the research, as indicated by their bright yellow color and central position on the map. This indicates that the primary focus of research in this field is the development of e-modules and their relationship with students. Keywords such as "mathematics e-module," "digital module," "online learning," and "effectiveness" are located around the center and colored light green. This indicates that these issues are also frequently discussed and closely related to the main theme.

Conversely, keywords such as "ethnomathematics," "e-module," "RME" (Realistic Mathematics Education), "contextual problem," and "question" are in the green-blue area. This indicates that contextual and culture-based approaches are beginning to receive attention but have not yet become the dominant focus. Keywords far from the center that are colored blue, such as "video," "linear equation," "system," "gender," and "classroom," reflect that these aspects are still peripheral and have only been discussed in a few studies.

Overall, this visualization shows that e-module research remains highly focused on development and use with general student populations. However, there is already a shift toward contextual, culture-based approaches and social issues, such as gender differences and the impact of the pandemic. This shift is still in the early stages of exploration. This visualization is useful for identifying research gaps and future directions for developing topics (see Figure 9).

Figure 9. Visualization of Density Trends in E-module Data Research on Google Scholar



DISCUSSION

Based on the results of data analysis from Scopus and Google Scholar regarding research trends on e-modules in mathematics education, it was found that a surge in e-module research began in 2019, coinciding with the COVID-19 pandemic that affected all countries, including Indonesia. This indicates that all researchers were seeking effective learning alternatives that could be implemented simply and quickly by applying e-module-assisted mathematics education. This finding confirms studies (Sundari et al., 2024; S. R. Putri & Syafriani, 2020) stating that e-modules are an effective tool in transforming conventional

learning models into more active, innovative, and contextual learning. The development of mathematics e-modules over the past ten years has been dominated by problem-based learning (PBL) models, realistic mathematics education (RME) approaches, ethnomathematics, and STEM approaches. The integration of mathematics e-modules using the PBL, PjBL, RME, or STEM learning models is considered effective in improving students' mathematical problem-solving skills (Widya et al., 2023) critical thinking skills, and learning independence (Seruni et al., 2020), as well as creative thinking skills (Achmad, 2020; Sari et al., 2022) and students' mathematical representation (Putra et al., 2023).

Another finding from the analysis related to e-module research trends is that most research is aimed at junior high school students (Aprilia et al., 2024; Benitha & Novaliyosi, 2022; Fahmi et al., 2022; Heswari & Patri, 2021; Kasih & Siregar, 2024; Lestiana et al., 2025; Mampouw et al., 2023; Maulana et al., 2022; Nasir et al., 2022; Purwoko et al., 2023; Raharjo et al., 2023; Rahman, 2022; Wandani, Setyansah, & ..., 2023; Widya et al., 2023; Yunianta et al., 2023), high school student (Fonda & Sumargiyani, 2018; Ilmi et al., 2021; Lutfiyah et al., 2023; Madu, 2025; Maghfiroh et al., 2024; Ramadhani & Fitri, 2020; Saputri et al., 2025; Sinurat & Firdaus, 2024; Tobing et al., 2021; Wahyudi, 2019) with a little exploration of basic or higher education, you will see that the ADDIE model is very suitable for developing instructional and systematic teaching materials. Most research designs use the ADDIE model in Research and Development (R&D), showing that the ADDIE model is well-suited for developing systematic and instructional teaching materials (Fitriyah et al., 2021; Vivien Pitriani et al., 2021).

Although progress has been made in the development of e-modules, a number of significant challenges remain. First, most studies employ research and development (R&D) designs with limited validation and have not yet undergone long-term or cross-context effectiveness testing. Second, the use of software or learning management systems (LMS) in e-module development is often not clearly explained. Third, few articles investigate the long-term impact of e-module use on learning outcomes or 21st-century skills. Fourth, little research has been conducted on how students with special needs or in contexts with technological limitations can access e-modules. Fifth, quantitative approaches dominate without sufficient balance from in-depth qualitative studies, such as explorations of user experiences or phenomenological studies of students and teachers.

This research implies the need for a standardized, adaptive instructional design model to guide e-module development across subjects and educational levels. Technological advances provide an opportunity to integrate artificial intelligence into e-modules to offer personalized learning paths and automatic feedback. Teachers require intensive training to effectively develop and utilize e-modules, necessitating research-based policies for teacher professional development.

Future research could focus on adapting e-modules for students with disabilities or from 3T areas (frontier, remote, and disadvantaged). Another focus could be the development of e-modules based on innovative technologies, such as augmented reality (AR), artificial intelligence (AI), and game-based learning. A long-term quasi-experimental design could be used to assess the extent to which e-modules impact students' higher-order thinking skills. Another area of research could be a comparison of the effectiveness and cost-efficiency of various e-module development platforms. Qualitative phenomenological or case studies could explore perceptions, challenges, and adaptation strategies when using e-modules in real classroom settings. This research has limitations in that the data sources were taken from Scopus and Google Scholar, so processing was done separately. Further research on this topic can use data sources from other databases, such as Web of Science (WoS), and the publication year restrictions should be reviewed until the end of 2025.

CONCLUSION

Based on the results and discussions, it can be concluded that publications related to e-modules for basic mathematics education have great potential to improve the learning process. A bibliometric analysis reveals emerging research trends and patterns, showing a significant increase in publications, especially in recent years — particularly from 2019 to 2024. Based on

keywords, the latest research topics related to e-modules in mathematics education include interactive e-modules, realistic mathematics education, ethnomathematics, and mathematics literacy. Topics that have not been extensively explored in relation to e-modules in mathematics education include computational thinking, mathematical reasoning, mathematical literacy, augmented reality (AR), artificial intelligence (AI), game-based learning, and higher-order thinking skills (HOTS).

REFERENCES

Achmad, S. R. (2020). Design of e-module with RME approach to improve the creative thinking ability of students. *International Journal of Scientific and Technology Research*, *9*(3), 5228–5233. https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85082711127&origin=inward

Annisa, D., Khairunnisak, C., Fadhiliani, D., & Zubaidah, T. (2025). The Role of Interactive e-Modules Based on Realistic Mathematics Education to Improve Mathematical Representation Ability. *Mathema: Jurnal Pendidikan Matematika*, *7*(1), 220. https://doi.org/10.33365/jm.v7i1.4844

Aprilia, V. A., Effendi, M., & ... (2024). Development of Project-Based E-Module to Facilitate Student's Mathematics Collaboration and Communication in Boarding School. *… , Jurnal Matematika …*. https://eprints.umm.ac.id/id/eprint/9109/

Ariani, D., Rahmi, Alqansa, P., Rufaida, & Revita, R. (2025). Tantangan Dan Solusi Dalam Pembelajaran Matematika Di Era Digital. *Aljabar: Jurnal Ilmu Pendidikan, Matematika Dan Kebumian*, *1*. https://doi.org/https://doi.org/10.62383/aljabar.v1i2.543

Arruda, H., Silva, E. R., Lessa, M., Proença, D., & Bartholo, R. (2022). VOSviewer and Bibliometrix. *Journal of the Medical Library Association : JMLA*, *110*(3), 392–395. https://doi.org/10.5195/jmla.2022.1434

Arya Udayana, N. N., Wirawan, I. M. A., & Divayana, D. G. H. (2017). Pengembangan E-Modul Pada Mata Pelajaran Pemrograman Berorientasi Objek Dengan Model Pembelajaran Project Based Learning Kelas XII Rekayasa Perangkat Lunak Di SMK Negeri 2 Tabanan. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *6*(2), 128. https://doi.org/10.23887/janapati.v6i2.9373

Aulia, E. T., & Prahmana, R. C. I. (2022). Developing interactive e-module based on realistic mathematics education approach and mathematical literacy ability. In *Jurnal Elemen*. researchgate.net. https://www.researchgate.net/profile/Rully-Prahmana/publication/357605533_Developing_interactive_e-module_based_on_realistic_mathematics_education_approach_and_mathematical_literacy_ability/links/61d5fcf5da5d105e551fcd1b/Developing-interactive-e-module-ba

Benitha, A., & Novaliyosi, N. (2022). Development of an e-Module Based on Realistic Mathematics Education (RME) on Algebra Material for Class VII SMP/MTS Students. In *… Journal: Scientific Journal of Mathematics, Mathematics …*.

Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. *Journal of Business Research*, *109*, 1–14. https://doi.org/10.1016/j.jbusres.2019.10.039

Elaby, M. F., Elwishy, H. M., Moatamed, S. F., Abdelwahed, M. A., & Rashiedy, A. E. (2022). Does design-build concept improve problem-solving skills? An analysis of first-year engineering students. *Ain Shams Engineering Journal*, *13*(6), 101780. https://doi.org/10.1016/j.asej.2022.101780

Erita, S. (2022). Development of an e-modules for learning mathematics based on a scientific approach to help the online learning process. *International Journal of Trends in Mathematics …*. http://ijtmer.saintispub.com/ijtmer/article/view/170

Fadilah, R. T., & Dj, L. (2023). Perbandingan Hasil Belajar Siswa Menggunakan Modul Elektronik dengan Modul Konvensional Melalui Model Guided Discovery Learning pada Materi Senyawa Hidrokarbon. *Jurnal Ilmiah Universitas Batanghari Jambi*, *23*(1), 736. https://doi.org/10.33087/jiubj.v23i1.3074

Fahmi, S., Rahmawati, R. Y., & ... (2022). Two-variables linear system: A smartphone-based-e-

module with a realistic mathematic education approach. … *Jurnal Matematika Kreatif* …. https://journal.unnes.ac.id/nju/kreano/article/view/31661

Fitriyah, I., Wiyokusumo, I., & Leksono, I. P. (2021). Pengembangan media pembelajaran Prezi dengan model ADDIE simulasi dan komunikasi digital. *Jurnal Inovasi Teknologi Pendidikan*, *8*(1), 84–97. https://doi.org/10.21831/jitp.v8i1.42221

Fonda, A., & Sumargiyani, S. (2018). The developing math electronic module with scientific approach using kvisoft flipbook maker pro for xi grade of senior high school students. *Infinity Journal*. http://www.e-journal.stkipsiliwangi.ac.id/index.php/infinity/article/view/520

Herawati, N. S., & Muhtadi, A. (2018). Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran Kimia kelas XI SMA. *Jurnal Inovasi Teknologi Pendidikan*, *5*(2), 180–191. https://doi.org/10.21831/jitp.v5i2.15424

Heswari, S., & Patri, S. F. D. (2021). EFEKTIFITAS PENGEMBANGAN E-MODUL MATEMATIKA BERBASIS ETNOMATEMATIKA UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR LOGIS. *Jurnal Muara Pendidikan*. http://ejournal.stkip-mmb.ac.id/index.php/mp/article/view/416

Hikayat, S. C., Hairun, Y., & ... (2020). Design of realistic mathematics education approach to improve critical thinking skills. In *Universal Journal of* …. researchgate.net. https://www.researchgate.net/profile/S-Suparman/publication/341822511_Design_of_Realistic_Mathematics_Education_Approach_to_Improve_Critical_Thinking_Skills/links/5ed62c62299bf1c67d329bae/Design-of-Realistic-Mathematics-Education-Approach-to-Improve-Criti

Ilmi, R., Arnawa, I. M., & Bakar, N. N. (2021). Development of an Android-Based for Math E-Module by using Adobe Flash Professional CS6 for Grade X Students of Senior High School. *Journal of Physics: Conference* …. https://doi.org/10.1088/1742-6596/1742/1/012026

Indrawati, F. (2023). Matematika dalam Menghadapi Tantangan Abad Ke-21. *Prosiding Diskusi Panel Nasional Pendidikan Matematika*, *80*, 411–418.

Islahiyah, I., Pujiastuti, H., & Mutaqin, A. (2021). Analisis kebutuhan e-modul dengan model pembelajaran berbasis masalah pada materi barisan dan deret kelas XI SMA. In *Tirtamath: Jurnal Penelitian dan* …. academia.edu. https://www.academia.edu/download/92773261/pdf_14.pdf

Izzah, A., Kusmaharti, D., & Yustitia, V. (2023). Pengembangan E-Modul Matematika Berbasis Problem Based Learning Untuk Memecahkan Masalah Matematika Materi Kecepatan Dan Debit Di Sekolah Dasar. *Jurnal Lebesgue : Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika*, *4*(2), 1139–1147. https://doi.org/10.46306/lb.v4i2.382

Jia, K., Wang, P., Li, Y., Chen, Z., Jiang, X., Lin, C. L., & Chin, T. (2022). Research Landscape of Artificial Intelligence and e-Learning: A Bibliometric Research. *Frontiers in Psychology*, *13*(February), 1–14. https://doi.org/10.3389/fpsyg.2022.795039

Kasih, A. C., & Siregar, T. J. (2024). Development of Mathematics Learning e-Modules to Improve Students' Mathematical Communication Skills. … *of Trends in Mathematics Education* …. http://ijtmer.saintispub.com/ijtmer/article/view/334

Lestari, S. D., & Wijayanti, P. S. (2021). Developing Digital Module Using Flip Pdf Professional. *Jurnal Matematika Dan Pembelajaran*, *9*(2), 242–259.

Lestiana, H. T., Rohmah, A., Putri, E., & ... (2025). Development of Interactive Mathematics E-Module Designed by Canva and Fliphtml5. In … *Matematika*. journal.institutpendidikan.ac.id. https://journal.institutpendidikan.ac.id/index.php/plusminus/article/download/2537/1852

Lutfiyah, L., Buchori, A., & Indiati, I. (2023). Desain media pembelajaran berbasis e modul pada materi logika matematika. In … *: Jurnal Ilmiah Pendidikan Matematika, Matematika* ….

Madu, A. (2025). Development of ethnomathematics-based e-modules to improve student learning outcomes on circle material. *International Journal of Innovative Research and Scientific Studies*, *8*(4), 1347–1362. https://doi.org/10.53894/ijirss.v8i4.8069

Maghfiroh, K., Dwijanto, D., & ... (2024). Development of Mathematics E-Module to Improve Students' Mathematical Problem Solving Skills in Problem Based Learning Models. *… of Mathematics Education*. https://journal.unnes.ac.id/journals/ujme/article/view/2112

Mampouw, H. L., Pawestri, Y. I., & ... (2023). Development of Flip PDF And Video Based E-Modules to Improve Mathematics Learning Outcomes. *Numerical …*. https://journal.iaimnumetrolampung.ac.id/index.php/numerical/article/view/3296

Maryam, M., Masykur, R., & Andriani, S. (2019). Pengembangan e-modul matematika berbasis Open Ended pada materi sistem persamaan linear dua variabel kelas VIII. *AKSIOMA : Jurnal Matematika Dan Pendidikan Matematika*, *10*(1), 1–12. https://doi.org/10.26877/aks.v10i1.3059

Maulana, M. N., Muslim, S., & ... (2022). The effectiveness of using electronic modules in mathematics subjects in the material of constructing flat sided space. *Journal of Education …*. https://ejournal.undiksha.ac.id/index.php/JERE/article/view/38785

Mutiara Sakinah, & Dori Lukman Hakim. (2023). Respons Siswa Terhadap Penggunaan E-Modul Interaktif Barsil Dalam Kemandirian Belajar Matematika. *Koordinat Jurnal MIPA*, *4*(2), 54–65. https://doi.org/10.24239/koordinat.v4i2.71

Nasir, M., Sunarno, W., & Rahmawati, F. (2022). Flipped classroom using e-module to improve understanding of light concepts: needs analysis of e-module development to empower scientific explanation. *Journal of Physics …*. https://doi.org/10.1088/1742-6596/2165/1/012040

Ningrum, S. S. (2023). Analisis bibliometrik e-modul berbasis project based learning di sekolah dasar menggunakan vosviewer. *COLLASE (Creative of Learning Students …*. https://journal.ikipsiliwangi.ac.id/index.php/collase/article/view/17638

Nuranisa, U. D., Indiati, I., & ... (2023). Pengembangan E-Modul Matematika Berbasis Pendekatan Saintifik Untuk Siswa SMP Kelas VIII. *… : Jurnal Matematika Dan …*. http://journal.upgris.ac.id/index.php/imajiner/article/view/15815

Orduña-Malea, E., & Costas, R. (2021). Link-based approach to study scientific software usage: the case of VOSviewer. In *Scientometrics* (Vol. 126, Issue 9). Springer International Publishing. https://doi.org/10.1007/s11192-021-04082-y

Oyewola, D. O., & Dada, E. G. (2022). Exploring machine learning: a scientometrics approach using bibliometrix and VOSviewer. *SN Applied Sciences*, *4*(5). https://doi.org/10.1007/s42452-022-05027-7

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1), 1–11. https://doi.org/10.1186/s13643-021-01626-4

Pasaribu, E. (2024). Development of Mathematics Learning E-Modules with the PQ4R Strategy to Improve Students' Creative Thinking Abilities and Learning Independence. *Prima: Jurnal Pendidikan Matematika*. https://jurnal.umt.ac.id/index.php/prima/article/view/11862/0

Purwoko, R. Y., Kusumaningrum, B., & ... (2023). Development of Open Ended Based Mathematics E-Modules to Enhance Students' Critical Thinking Ability. *Mathline: Jurnal …*. https://mathline.unwir.ac.id/index.php/Mathline/article/view/337

Putra, I. S., Aswirna, P., & Asrar, A. (2023). DEVELOPMENT OF E-MODULE ON ETHNO STEM PHYSICS FOR THE CREATdddION OF JAMBI BATIK AND ITS IMPACT ON STUDENTS'CREATIVE THINKING …. *Imam Bonjol International …*. https://ibicie.uinib.ac.id/index.php/ibicie/article/view/123

Putri, D. P., Ferdianto, F., & Fauji, S. H. (2020). Designing a digital teaching module based on mathematical communication in relation and function. *Journal on Mathematics Education*. https://eric.ed.gov/?id=EJ1251981

Putri, S. R., & Syafriani, S. (2020). Analysis development of guided inquiry based physics e-module to improve critical thinking ability of students high school. *Journal of Physics:*

Conference Series. https://doi.org/10.1088/1742-6596/1481/1/012063
Putri, V. J., & Hasanuddin, H. (2025). Penggunaan E-modul Interaktif berbantuan Geogebra dalam pembelajaran Matematika: Analisis Bibliometrik. *Algoritma: Jurnal Matematika, Ilmu …*, *3*. https://journal.arimsi.or.id/index.php/Algoritma/article/view/506
Raharjo, H., Haqq, A. A., & Larsari, V. N. (2023). Empowering Students in the Digital Era: An Analysis of Interactive E-Modules' Effect on Digital Mathematical Communication. *… Journal of Mathematics …*. https://journals.eduped.org/index.php/IJMME/article/view/401
Rahman, S. A. (2022). The development of mathematics e-modules by using flip pdf professional software on algebraic forms of material. In *Annual International COnference on Islamic Education …*
Ramadhani, R., & Fitri, Y. (2020). A Project-based learning into flipped classroom for ePUB3 electronic mathematics learning module (eMLM)-based on course design and implementation. In *Universal Journal of Educational Research*. academia.edu. https://www.academia.edu/download/91656929/UJER40-19591244.pdf
Rumansyah, M. (2016). The Differences of Effect of Teaching by Using Interactive Module and Conventional Module on the Understanding of Science Concept. *Jurnal Pendidikan Matematika Dan Sains*, *4*(1), 54–62.
Sagita, M., & Mulyani, P. K. (2023). Numeracy E-Module with Edugame As A Support For Mathematics Learning for Sixth-Grade Elementary School Students. *Journal of Education Technology*. https://ejournal.undiksha.ac.id/index.php/JET/article/view/65920
Saputri, S. E., Ramalisa, Y., Pasaribu, F. T., & ... (2025). Pengembangan E-Modul Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Literasi Matematis Siswa. *… Pendidikan Matematika*. https://etdci.org/journal/kognitif/article/view/3351
Sari, M., Andra, D., Distrik, I. W., & ... (2022). Problem-based e-module integrated with stem and assisted by lms to foster creative thinking ability. *… and Mathematics …*. https://ejournal.radenintan.ac.id/index.php/IJSME/article/view/13087
Seruni, R., Munawaroh, S., Kurniadewi, F., & Nurjayadi, M. (2020). Implementation of e-module flip PDF professional to improve students' critical thinking skills through problem based learning. *Journal of Physics: Conference Series*, *1521*(4), 8–13. https://doi.org/10.1088/1742-6596/1521/4/042085
Setiyani. (2020). Designing a digital teaching module based on mathematical communication in relation and function. *Journal on Mathematics Education*, *11*(2), 223–236. https://doi.org/10.22342/jme.11.2.7320.223-236
Shah, S. H. H., Lei, S., Ali, M., Doronin, D., & Hussain, S. T. (2020). Prosumption: bibliometric analysis using HistCite and VOSviewer. *Kybernetes*, *49*(3), 1020–1045. https://doi.org/10.1108/K-12-2018-0696
Simbolon, A. (2024). Tren penelitian e-modul dalam pendidikan matematika dalam satu dekade terakhir (2014-2024): Analisis bibliometrik. *JPMI (Jurnal Pembelajaran Matematika …*. https://journal.ikipsiliwangi.ac.id/index.php/jpmi/article/view/22840
Sinurat, H. B., & Firdaus, M. (2024). Pengembangan e-modul kontekstual dengan flip pdf untuk peningkatan kemampuan pemahaman konsep matematika siswa SMA. *J-CEKI: Jurnal Cendekia Ilmiah*. https://ulilalbabinstitute.co.id/index.php/J-CEKI/article/view/5629
Sridana, N., & Sarjana, K. (2020). *The Implementation of Mathematics Learning in the Context of 21st Century Skill Competencies in Junior High Schools*. *465*(Access 2019), 283–285. https://doi.org/10.2991/assehr.k.200827.071
Sulistiawati, Cipta, E. S., & Muchlis, E. E. (2022). SIGMA DIDAKTIKA : Jurnal Pendidikan Matematika Analisis bibliomterik perkembangan penelitian R & D model ADDIE pada pembelajaran matematika dengan vosviewer tahun. *SIGMA DIDAKTIKA: Jurnal Pendidikan Matematika*, *10*(2), 107–129.
Sundari, P. D., Saputra, D., Sari, S. Y., & ... (2024). Analysis of Teaching Materials Needs for Digital Module Development in Physics Learning: Teachers Perception. In *Jurnal Penelitian …*. researchgate.net. https://www.researchgate.net/profile/Putri-Sundari-3/publication/378698887_Analysis_of_Teaching_Materials_Needs_for_Digital_Module_D

evelopment_in_Physics_Learning_Teachers_Perception/links/65f27559286738732d3e4ec3/Analysis-of-Teaching-Materials-Needs-for-

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J. M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3). https://doi.org/10.3390/jintelligence11030054

Tobing, H. E. L., Somakim, S., & Susanti, E. (2021). Development of E-Module Based on HOTS Questions on Distance Material for High School Students. In *Jurnal Pendidikan Matematika*. academia.edu. https://www.academia.edu/download/90289945/pdf.pdf

Utami, S., Firmansah, D., & Yanti, Y. (2025). Analysis of Electronic Modules in Enhancing Mathematics Learning Motivation in Elementary Schools. *Pedagogik Journal of Islamic Elementary School*, *8*(1), 108–131. https://doi.org/10.24256/pijies.v8i1.6395

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

van Eck, N. J., & Waltman, L. (2017). Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics*, *111*(2), 1053–1070. https://doi.org/10.1007/s11192-017-2300-7

Vivien Pitriani, N. R., Wahyuni, I. G. A. D., & Gunawan, I. K. P. (2021). Penerapan Model Addie Dalam Pengembangan Media Pembelajaran Interaktif Menggunakan Lectora Inspire Pada Program Studi Pendidikan Agama Hindu. *Cetta: Jurnal Ilmu Pendidikan*, *4*(3), 515–532. https://doi.org/10.37329/cetta.v4i3.1417

Wahyudi, D. (2019). Pengembangan E-Modul dalam Pembelajaran Matematika SMA Berbasis Android. In *GAUSS: Jurnal Pendidikan Matematika*. core.ac.uk. https://core.ac.uk/download/pdf/327233517.pdf

Wandani, S., Setyansah, R. K., & ... (2023). Development of mathematics e-modules based on PjBL STEM on materials constructing flat side spaces to improve mathematical communication ability of junior high …. *AL-ISHLAH: Jurnal …*. http://journal.staihubbulwathan.id/index.php/alishlah/article/view/2497

Wandani, S., Setyansah, R. K., & Masfingatin, T. (2023). Development of Mathematics e-Modules based on PjBL STEM on Materials Constructing Flat Side Spaces to Improve Mathematical Communication Ability of Junior High School Students. *AL-ISHLAH: Jurnal Pendidikan*, *15*(1), 533–548. https://doi.org/10.35445/alishlah.v15i1.2497

Widya, W., Andriani, R., Sudirman, S., Hidayat, A. T., & Elisyah, N. (2023). The Effectiveness of Physics E-Modules Based on Creative Problem-Solving Learning Model Integrated with 21st-Century Skills. *Indonesian Journal of Science and Mathematics Education*, *6*(1), 48–58. https://doi.org/10.24042/ijsme.v6i1.14584

Winata, K. R., Naswan, S., & Agustini, K. (2018). Pengembangan E-modul Interaktif Berbasis Proyek Pada Mata Pelajaran Simulasi Digital Kelas X di SMK TI Bali Global Singaraja. *Jurnal Teknologi Pembelajaran Indonesia*, *8*(1). https://doi.org/10.23887/jtpi.v8i1.2238

Wulandari, S., Febrini, D., & Syafri, F. S. (2020). Pengembangan Modul Matematika yang Terintegrasi Nilai--nilai Islam Berbasis Pendekatan Saintifik pada Materi Himpunan. *Jurnal Equation*, *3*(2), 206–219.

Yasin, M., Fakhri, J., Siswadi, Faelasofi, R., Safi'i, A., Supriadi, N., Syazali, M., & Wekke, I. S. (2020). The effect of SSCS learning model on reflective thinking skills and problem solving ability. *European Journal of Educational Research*, *9*(2), 743–752. https://doi.org/10.12973/eu-jer.9.2.743

Yunianta, T. N. H., Herman, T., Wizhar, B. Al, & Kurniawan, M. A. F. (2023). Development of mathematics e-module using kodular and flipbook for junior high school students: Differences. In *Jurnal Didaktik Matematika*.