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Development trends in interactive mathematics learning media in deep learning: a systematic literature review

Siti Zulaikah[*,1,a], Dian Septi Nur Afifah[a], Noraniza Bahrotul Ilmi[a]

[a] *Department of Mathematics Education, Faculty of Social Sciences and Humanities, Universitas Bhinneka PGRI, East Java 66229, Indonesia*

A R T I C L E I N F O

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A B S T R A C T

The development of educational technology has increased the importance of interactive mathematics learning media in supporting meaningful, engaging, and effective learning experiences aligned with the Deep Learning instructional approach. Although numerous studies have reported the effectiveness of interactive learning media in improving mathematics learning outcomes, existing research remains fragmented and is generally limited to specific educational levels, mathematical topics, and instructional contexts. study employed a Systematic Literature Review (SLR) following the PRISMA guidelines. Data were collected through the Publish or Perish application using Google Scholar as the primary source. From an initial pool of 200 articles, 61 studies met the inclusion criteria and were analyzed using descriptive quantitative analysis and narrative synthesis. The findings revealed that research on interactive mathematics learning media experienced substantial growth, reaching its highest publication rate in 2025 with 20 articles (32.79%). Research and Development (R&D) was the dominant method (49.18%), with the ADDIE model being the most frequently used development framework. Most studies were conducted at the elementary school level (40.98%) and focused on interactive multimedia (40.98%) as the primary research variable. The reviewed studies generally reported positive effects on learning outcomes, higher-order thinking skills, problem-solving abilities, and learning motivation. However, significant gaps remain, including limited longitudinal studies, insufficient attention to affective outcomes, underrepresentation of senior secondary and higher education contexts, and limited integration of Artificial Intelligence technologies. These findings provide a comprehensive overview of current research trends and offer directions for future studies aimed at developing more innovative, inclusive, and sustainable mathematics learning media.

1. Introduction

The rapid development of educational technology over the past decade has brought significant changes to mathematics teaching and learning practices. The results of the *Programme for International Student Assessment* (PISA) 2022, published by the Organisation for Economic Co-operation and Development (OECD), revealed that Indonesian students achieved an average mathematics literacy score of 366, declining from 379 in 2018 and remaining below the OECD average of 472 [1]. These

* Corresponding author.
E-mail address: zulaikahsiti572@gmail.com (S. Zulaikah).

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findings indicate that improving students' mathematical literacy remains a major educational challenge.

Therefore, innovative learning media are needed to make mathematics learning more interactive, meaningful, and aligned with the implementation of the Deep Learning approach. In this study, the Deep Learning approach refers to the pedagogical approach adopted in the Indonesian education system that emphasizes mindful, meaningful, and joyful learning rather than an artificial intelligence-based approach.

Interactive learning media represent an innovative solution for transforming abstract mathematical concepts into more concrete learning experiences through visualization, simulations, and learning activities that actively engage students. Numerous studies have demonstrated the positive impact of interactive learning media on mathematics learning. From the cognitive perspective, interactive learning media have been shown to improve students' learning achievement and conceptual understanding [2, 3], while also fostering higher-order thinking skills by strengthening students' abilities in analysis, evaluation, and creation [4]. In terms of learning skills, interactive learning media contribute to the improvement of students' critical thinking [5] and mathematical communication skills [6]. Furthermore, they have been found to enhance students' learning motivation and engagement throughout the instructional process [7], as well as their interest in the subject matter being taught [8]. The development of such media has become increasingly important because the Deep Learning approach emphasizes mindful, meaningful, and joyful learning experiences, enabling students not only to develop a conceptual understanding of mathematics but also to relate mathematical concepts to real-life contexts.

Despite these advantages, research on interactive mathematics learning media still presents several limitations. Most studies have been conducted within limited contexts, both in terms of sample size and research setting, and have focused only on specific mathematics topics, such as fractions, geometry, or algebra [2, 3, 4]. Furthermore, the implementation of interactive learning media continues to face challenges related to teachers' readiness to utilize educational technology [9, 10, 11] and the limited integration of learning media with instructional approaches that support the Deep Learning approach, such as Discovery Learning [12], Design Thinking [13], and STEM education [3]. These conditions indicate a gap between the potential of interactive learning media and their implementation in mathematics classrooms.

Previous studies have demonstrated the effectiveness of interactive learning media in improving the quality of mathematics learning [2, 7, 14]. However, these studies have generally focused on evaluating the effectiveness of learning media in specific mathematics topics, educational levels, or instructional approaches [2, 9, 14]. Consequently, a comprehensive understanding of research trends in interactive mathematics learning media across educational levels, research methodologies, investigated variables, and the extent to which these media have been integrated with the principles of the Deep Learning approach is still lacking.

The novelty of this study lies in comprehensively mapping research trends in the development of interactive mathematics learning media across educational levels, ranging from elementary schools to higher education institutions, during the period from 2020 to 2026. This study presents a systematic synthesis of publication trends, research methods, educational levels, research variables, and the extent to which interactive mathematics learning media have been integrated with the principles of the Deep Learning approach. Therefore, this study not only describes the development of research on interactive mathematics learning media but also identifies research gaps and potential directions for future studies to support the development of more effective and relevant mathematics learning media.

These research gaps indicate that studies on interactive mathematics learning media remain fragmented and have yet to provide a comprehensive understanding of research trends and future opportunities for developing learning media that support the Deep Learning approach. Therefore, a systematic mapping through a Systematic Literature Review is required to integrate existing research findings and provide a comprehensive overview of trends in the development of interactive mathematics learning media.

Based on these research gaps, this study aims to analyze trends in the development of interactive mathematics learning media during the period of 2020–2026 by identifying publication trends, dominant research methods, educational levels that have received the greatest research attention, the most frequently investigated research variables, and research gaps related to the integration of interactive learning media with the principles of the Deep Learning approach. The findings are expected to provide a comprehensive overview of research trends, dominant methodological approaches, and future research opportunities to support the implementation of the Deep Learning approach.

Based on the literature review, this study employs five main indicators for data analysis: (1) publication trends, (2) research methods and development models, (3) educational levels, (4) research variables investigated, and (5) the level of integration between interactive learning media and the principles of the Deep Learning approach. These indicators form the basis for data extraction, classification, and synthesis, enabling a systematic analysis of research trends in interactive mathematics learning media.

The primary contribution of this study is the development of a comprehensive map of research trends based on an analysis of 61 articles that met the

selection criteria. This study not only identifies publication trends, dominant research methods, educational levels, and frequently investigated variables but also highlights research areas that require further exploration, particularly regarding the integration of interactive learning media with the principles of the Deep Learning approach. Therefore, the findings are expected to serve as a valuable reference for researchers, teachers, and instructional media developers in determining future research directions and developing more innovative, effective, and contextually relevant mathematics learning media to meet the demands of twenty-first-century education.

2. Method

2.1. Research Design

This study employed Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The SLR approach was selected because it enables the identification, selection, evaluation, and synthesis of previous studies in a systematic, transparent, and reproducible manner [15]. This study aims to analyze research trends in the development of interactive mathematics learning media published between 2020-2026 by examining publication trends, research methods and development models, educational levels, research variables, and the extent to which interactive learning media have been integrated with the principles of the Deep Learning approach.

2.2. Data Sources and Unit of Analysis

The unit of analysis in this study was scientific journal articles rather than human participants. The data sources were obtained through a literature search using the Publish or Perish (PoP) application, which retrieves bibliographic data from Google Scholar. The articles analyzed were published between 2020 and 2026. After the selection process, the 61 eligible articles were further identified according to their indexing databases, including SINTA, Scopus, Garuda, and other indexing platforms, as part of the publication characteristics analysis.

2.3. Research Procedure

The literature search was conducted using the Publish or Perish (PoP) application with the Boolean search technique in four search sessions. The search employed the following keyword combinations: "interactive learning media" AND "mathematics" AND "deep learning", "interactive multimedia" AND "mathematics education", "interactive media" AND "mathematics" AND "critical thinking", and "multimedia learning" AND "mathematics".

Each search session was limited to 50 articles, resulting in 200 articles at the initial identification stage. Limiting the number of articles in each search session helped ensure that the retrieved articles were highly relevant to the search keywords while facilitating a systematic screening process. The article selection process was subsequently conducted based on the inclusion and exclusion criteria presented in Table 1 and followed the PRISMA procedure illustrated in Fig. 1.

Table 1
Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2020 and 2026.	Articles published before 2020 or after 2026.
Articles written in Indonesian or English.	Articles written in languages other than Indonesian or English.
Articles discussing interactive learning media in mathematics education.	Articles not related to interactive learning media in mathematics education.
Full-text articles.	Articles without full-text access.

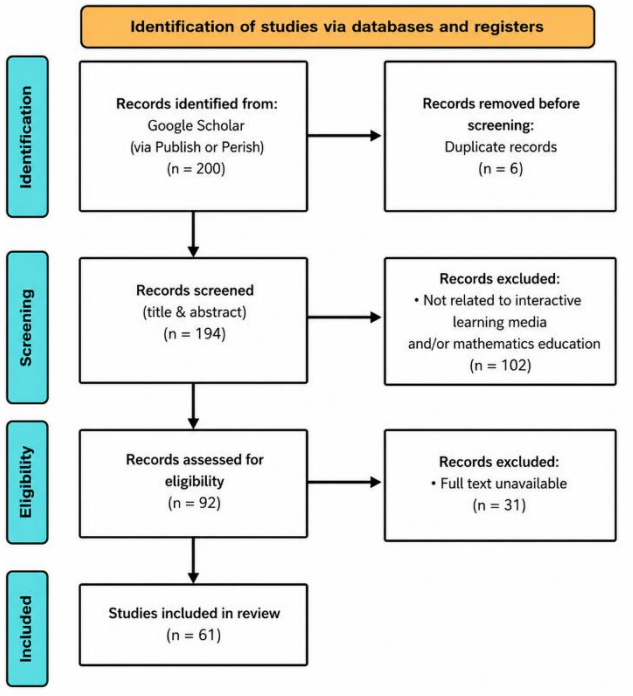


Fig. 1. PRISMA Flow Diagram

At the identification stage, 200 articles were retrieved through the Publish or Perish (PoP) application, which indexes publications from Google

Scholar. Duplicate records were manually identified by comparing article titles, authors, and Digital Object Identifiers (DOI), resulting in the removal of six duplicate articles and leaving 194 articles for the screening stage.

During the screening stage, article titles and abstracts were evaluated. A total of 102 articles were excluded because they did not focus on interactive learning media and/or mathematics education, leaving 92 articles for the eligibility assessment.

During the eligibility stage, the full texts of the remaining 92 articles were assessed. Thirty-one articles were excluded because the full texts were unavailable. Consequently, 61 articles met all inclusion criteria and were included in the final analysis. Subsequently, these articles were identified according to their indexing databases, including SINTA, Scopus, Garuda, and other indexing platforms to support the analysis of publication characteristics

2.4. Research Instrument

The research instrument consisted of a data extraction from designed to collect relevant information from each eligible article. The extracted data included the authors, publication year, indexing database, educational level, research method, development model, research variables, and the main findings related to the development of interactive mathematics learning media.

2.5. Data Analysis

The data extracted from the 61 selected articles were analyzed in two stages. The first stage employed descriptive quantitative analysis (frequency analysis) to calculate the frequency and percentage distributions of publication year, indexing database, research method, development model, educational level, and research variables.

The second stage employed narrative synthesis to analyze the research findings in order to identify patterns, trends, and research gaps concerning the development of interactive mathematics learning media. The extracted data were organized into five analytical indicators, namely publication trends, research methods and development models, educational levels, research variables, and the level of integration between interactive learning media and the principles of the Deep Learning approach. The synthesized results were then used to provide a comprehensive overview of research developments and to identify potential directions for future research.

3. Results and Discussion

3.1. Publication Trends

Based on the extraction of 61 articles that met the selection criteria, Fig. 2 presents the publication trends of research on interactive mathematics learning media during the 2020-2026 period.

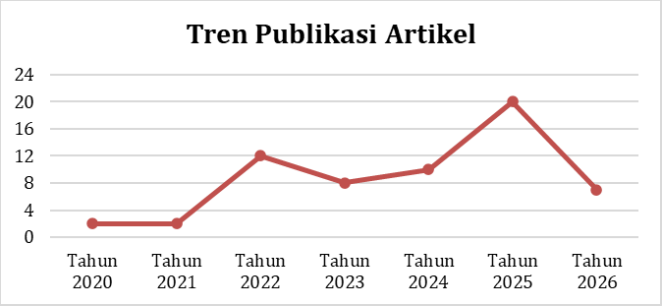


Fig. 2. Publication Trends of Research on Interactive Mathematics Learning Media 2020-2026

The analysis of the 61 selected articles indicates that the number of publications on interactive mathematics learning media exhibited a fluctuating trend throughout the 2020–2026 period. In 2020 and 2021, the number of publications remained relatively low, with only 2 articles (3.28%) published in each year. This study was not designed to identify the factors influencing publication trends, as the analyzed data were limited to the characteristics of articles that satisfied the inclusion criteria. Therefore, the causes of the observed changes in publication trends cannot be inferred from this review.

The number of publications increased to 12 articles (19.67%) in 2022. Most studies published during this period focused on the development of platform-based learning media, such as interactive websites and digital comics [16, 17]. This increase in publications coincided with the introduction of the Merdeka Curriculum by the Indonesian Ministry of Education, Culture, Research, and Technology in February 2022, which began to be implemented in the 2022/2023 academic year [18]. However, this temporal correspondence is presented solely as a policy context and should not be interpreted as evidence of a causal relationship, since this study did not examine the determinants of publication trends.

In 2023, the number of publications declined to 8 articles (13.11%), with a greater emphasis on evaluating the effectiveness of learning media in improving specific mathematical competencies [4, 19]. Subsequently, the number of publications increased again to 10 articles (16.39%) in 2024, accompanied by a growing number of studies integrating Problem-Based Learning (PBL) and Discovery Learning into the development of interactive learning media [20, 21].

The highest number of publications was recorded in

2025, with 20 articles (32.79%). Studies published during this period demonstrated broader research themes, including the application of Augmented Reality (AR), Artificial Intelligence (AI), and Deep Learning instructional approach in the development of learning media [22, 23, 24]. This increase coincided with the formalization of the Deep Learning instructional approach through Indonesia's Ministerial Regulation No. 13 of 2025, which was implementation beginning in the 2025/2026 academic year [25]. Similar to the observation for 2022, this temporal correspondence is provided only as a policy context and should not be interpreted as evidence of causality. Meanwhile, 7 articles (11.48%) were identified for 2026. This figure does not represent the total number of publications for 2026 because the data collection process was completed before the end of the publication year [3, 23].

3.2. *Research Methods*

The research methods employed in the 61 analyzed articles are presented in Fig. 3.

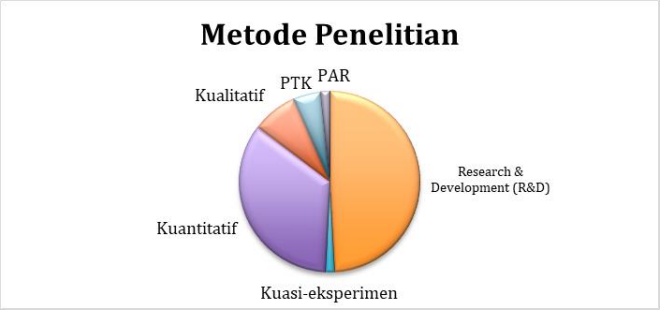


Fig. 3. Distribution of Research in the Analyzed Articles

The analysis of the 61 selected articles revealed that the Research and Development (R&D) was the most frequently employed research approach, accounting for 30 studies (49.18). This predominance indicates that most studies focused on the development and validation of learning media rather than on evaluating their instruction effectiveness. Among the development models, ADDIE was the most widely adopted, followed by the 4D model and the Borg and Gall model [17, 26, 27].

The predominance of the R&D approach suggests that research conducted during the 2020-2026 period primarily emphasized product development, validation, and practicality testing. Studies investigating the implementation of learning media in broader educational settings or evaluating their long-term effectiveness remained relatively limited among the analyzed articles. This finding highlights opportunities for future research to replicate learning media across diverse learning contexts and to examine their long-term impact on educational outcomes.

Quantitative research ranked second, comprising 21 studies (34.43%), most of which employed quasi-experimental designs with pretest-posttest instruments, t-test and normalized gain (N-gain) analyses to assess the effectiveness of learning media in improving students' learning outcomes and critical thinking skills [3, 5, 28]. Meanwhile, qualitative methods were employed in 5 studies (8.20%), Classroom Action Research (CAR) was used in 3 studies (4.92%), while non-R&D quasi-experimental and Participatory Action Research (PAR) approaches were each adopted in 1 study (1.64%). Collectively, these six methodological categories encompassed all 61 analyzed articles. The limited adoption of mixed-methods and longitudinal research designs indicates an important opportunity for future studies to provide more comprehensive and robust empirical evidence.

3.3. *Educational Level*

The educational levels of the research participants represented in the 61 analyzed articles are presented in Fig. 4.

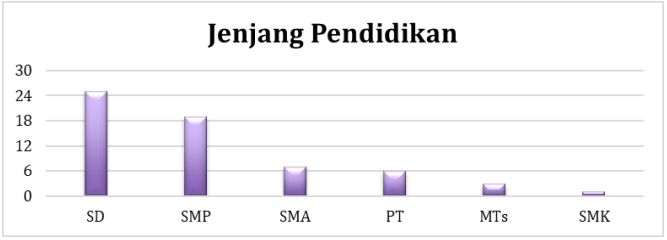


Fig. 4. Distribution of Educational Levels is the Analyzed Articles

The analysis of the 61 selected articles revealed that research on interactive mathematics learning media was conducted predominantly at the elementary school level, accounting for 25 studies (40.98%). At this level, the developed learning media included various forms, such as PowerPoint-based interactive multimedia, Augmented Reality (AR) applications, educational games, and Artificial Intelligence (AI)-based media. The instructional content primarily focused on geometry, number operations, and fractions [14, 22, 24].

The junior secondary school level ranked second, with 19 studies (31.15%). Most of these studies developed learning media for geometry, algebra, and social arithmetic using various digital platforms, including Wordwall, Scratch, and GeoGebra [4, 29, 30].

Meanwhile, 7 studies (11.48%) were conducted at the senior secondary school level, primarily focusing on calculus and trigonometry. At the higher education level, 6 studies (9.84%) were identified, most of which concerned the development of learning media for Algebraic Structures courses [5]. In addition, Islamic junior secondary school (MTs) and vocational high schools (SMK) were represented by 3 studies (4.92%) and 1 study (1.64%), respectively.

Overall, the distribution indicates that research on interactive mathematics learning media remains concentrated at the elementary and junior secondary school levels. In contrast, relatively fewer studies have been conducted at the senior secondary, vocational high school, and higher education levels among the analyzed articles. These findings suggest that research on interactive mathematics learning media at these educational levels remains limited, highlighting opportunities for future studies to expand investigations across a broader range of educational settings.

3.4. Research Variables

The distribution of research variable categories in the 61 analyzed articles is presented in Fig. 5.

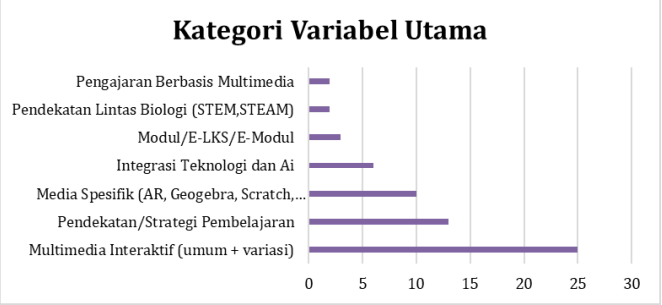


Fig. 5. Distribution of Research Variable Categories in the Analyzed Articles

The analysis of the 61 selected articles revealed that interactive multimedia was the most dominant research variable category, accounting for 25 articles (40.98%). Within this category, the most frequently investigated dependent variables included learning outcomes, conceptual understanding, learning motivation, and problem-solving skills [2, 31]. These findings indicate that most studies focused on developing interactive learning media to enhance students' learning achievement.

The second most common category was the integration of interactive learning media with various instructional approaches, including Realistic Mathematics Education (RME), Discovery Learning, Problem-Based Learning (PBL), and the Deep Learning instructional approach, which was identified in 13 articles (21.31%) [29, 32]. This finding suggests that a considerable number of studies emphasized not only the technological aspects of learning media but also their integration with specific pedagogical approaches to support the teaching and learning process.

Furthermore, learning media developed using specific platforms, such as GeoGebra, Augmented Reality (AR), Scratch, and mobile learning, were identified in 10 articles (16.39%). Meanwhile, the integration of Artificial Intelligence (AI) into learning media emerged in 6 articles (9.84%) of the total analyzed studies [24, 33]. These four major categories accounted for 54 of the 61 analyzed articles, whereas the remaining seven articles were distributed across three less frequently represented categories, namely Modules/E-Worksheets/E-Modules, Cross-Disciplinary Approaches (STEM/STEAM), and Multimedia-Based Instruction. Owing to their relatively low frequency, these categories are not discussed separately.

Overall, the dependent variables examined in the analyzed articles encompassed both cognitive and affective domains. The cognitive domain included learning outcomes, Higher-Order Thinking Skills (HOTS), and numeracy literacy, whereas the affective domain included learning motivation, learning interest, and mathematics anxiety. The findings indicate that the reviewed studies placed greater emphasis on assessing cognitive outcomes than on affective aspects or students' digital literacy [23, 34].

Overall, these findings suggest that research on interactive mathematics learning media remains predominantly oriented toward improving students' cognitive performance. In contrast, affective, social, and digital literacy dimensions have received comparatively less attention in the analyzed studies. Therefore, future research has the opportunity to develop learning media that not only evaluate cognitive achievement but also comprehensively assess the development of affective outcomes and digital competencies.

3.5.Key Findings and Research Gaps

The synthesis of the 61 articles that met the selection criteria indicates that research on interactive mathematics learning media has developed substantially during the 2020–2026 period, as reflected in publication trends, research methods, educational levels, and the diversity of learning media developed. Overall, the majority of the reviewed studies reported positive contributions of interactive learning media to mathematics education within their respective research contexts, particularly in improving students' learning outcomes, Higher-Order Thinking Skills (HOTS), problem-solving skills, and learning motivation compared with conventional instructional approaches.

In the cognitive domain, STEM-based learning media achieved a normalized gain (*N*-gain) score of 0.77 [3], the Si-GEMAS serious game improved students' critical thinking scores by 22.61 points [19], while Scratch-based learning media attained an *N*-gain score of 0.80 with a classical mastery level of 91% [30]. In the affective domain, several studies also reported improvements in students' learning motivation and reductions in mathematics anxiety following the implementation of interactive learning media [11, 28]. Nevertheless, these findings were obtained from different research contexts in terms of educational level, student characteristics,

instructional content, and implementation duration. Therefore, they should not be generalized directly to all educational settings.

When the findings presented in Sections 3.1 – 3.4 are considered collectively, they reveal that the increasing number of publications during the 2020–2026 period was accompanied by the predominance of Research and Development (R&D) studies [29-35]. Most of these studies were conducted at the elementary and junior secondary school levels and primarily focused on developing interactive learning media while using learning outcomes as the principal evaluation variable. In addition, many studies integrated interactive multimedia with various instructional approaches, including Realistic Mathematics Education (RME), Problem-Based Learning (PBL), Discovery Learning, and the Deep Learning instructional approach. This pattern indicates that research on interactive mathematics learning media during the reviewed period has remained largely concentrated on product development and the evaluation of cognitive learning outcomes [36-40].

From a theoretical perspective, the findings suggest that the development of interactive mathematics learning media has evolved beyond the mere adoption of educational technology toward the integration of pedagogical approaches that promote more meaningful learning experiences. From a practical perspective, these findings provide useful guidance for researchers and instructional media developers in designing learning media that are not only valid and practical but also capable of fostering multiple dimensions of students' competencies. These implications highlight that the successful development of interactive learning media requires not only technological innovation but also the integration of instructional approaches that align with students' characteristics and mathematics learning objectives [41-46].

Unlike previous studies, which generally reported either the development process or the effectiveness of learning media within specific contexts, this review provides a comprehensive synthesis by integrating publication trends, research methods, educational levels, and research variable categories while simultaneously identifying existing research gaps. Consequently, this study offers a broader understanding of the development of interactive mathematics learning media research during the 2020–2026 period and provides a valuable foundation for establishing future research agendas [47-55].

Based on this synthesis, several research gaps were identified. First, most studies employed samples drawn from a single school, limiting the generalizability of their findings to broader educational contexts [35]. Second, no longitudinal studies were identified that examined the long-term effects of interactive learning media on knowledge retention or students' competency development [36]. Third, existing research remains predominantly focused on cognitive outcomes, whereas affective dimensions, such as self-efficacy, mathematical disposition, and self-regulated learning, have received comparatively limited attention [34]. Fourth, the integration of Artificial Intelligence (AI) into interactive learning media remains limited, with only 6 of the 61 analyzed studies addressing this topic [24, 33]. Finally, relatively few studies have been conducted at the senior secondary school, vocational high school, and higher education levels, as well as in special education settings and geographically diverse educational contexts, compared with research conducted at the elementary and junior secondary school levels [37, 38].

Based on these identified research gaps, future studies are encouraged to expand the implementation of interactive learning media across a wider range of educational levels and school contexts, employ longitudinal and mixed-methods research designs, examine cognitive and affective outcomes in a more balanced manner, and conduct more comprehensive evaluations of emerging technologies, including Artificial Intelligence (AI), in mathematics education. Such efforts are expected to strengthen the empirical evidence regarding the effectiveness of interactive learning media while supporting the development of more innovative, inclusive, and sustainable mathematics learning practices [56-59].

4. Conclusion

Based on the findings of the Systematic Literature Review of 61 articles that met the selection criteria during the 2020–2026 period, it can be concluded that research on interactive mathematics learning media has experienced considerable growth in terms of publication trends, research methods, educational levels, and the diversity of learning media developed. The number of publications reached its highest level in 2025, with 20 articles (32.79%), indicating increasing scholarly interest in the development of interactive learning media for mathematics education.

From a methodological perspective, Research and Development (R&D) was the predominant research approach (49.18%), with the ADDIE model being the most frequently employed. This finding indicates that existing studies have primarily focused on the development, validation, and practicality evaluation of learning media rather than on their long-term implementation and effectiveness. Regarding educational levels, most studies were conducted at the elementary school (40.98%) and junior secondary school (31.15%) levels, whereas research involving senior secondary schools, vocational high schools, and higher education institutions remains relatively limited. In terms of research variables, interactive multimedia constituted the most dominant category (40.98%), with learning outcomes, Higher-Order

Thinking Skills (HOTS), problem-solving skills, and learning motivation being the most frequently investigated dependent variables.

The synthesis of the reviewed studies indicates that interactive learning media generally make positive contributions to mathematics learning across various educational contexts. However, these findings are predominantly based on the assessment of cognitive outcomes and are derived from studies with relatively limited implementation contexts. Consequently, this review provides a comprehensive overview of the current development of research on interactive mathematics learning media while identifying areas that require further investigation.

This review also has several limitations. First, it included only articles that satisfied the predefined inclusion and exclusion criteria and, therefore, does not represent the entirety of the literature on interactive mathematics learning media. Second, the synthesis was based on the characteristics of the selected studies without examining causal relationships among variables or calculating effect sizes, as is typically conducted in a meta-analysis. Accordingly, the findings should be interpreted within the scope and methodological boundaries of a Systematic Literature Review.

Based on these findings, future research is recommended to expand the implementation of interactive mathematics learning media at the senior secondary school, vocational high school, higher education, and special education levels, which remain underrepresented in the existing literature. Future studies are also encouraged to employ mixed-methods and longitudinal research designs to generate stronger empirical evidence regarding the long-term impact of interactive learning media. Furthermore, the development of learning media should extend beyond improving cognitive achievement to include the assessment of affective outcomes, such as learning motivation, self-efficacy, mathematical disposition, and self-regulated learning. Finally, the integration of emerging technologies, including Artificial Intelligence (AI) and adaptive technologies, represents a promising direction for developing more innovative, personalized, and sustainable mathematics learning media.

CRediT authorship contribution statement

Siti Zulaikah: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing – original draft. Dian Septi Nur Afifah: Supervision, Validation, Methodology, Writing – review & editing, Project administration. Noraniza Bahrotul Ilmi: Validation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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