Research Trends in Digital Media Development for Mathematics Subjects in Primary Schools Between 2015-2025

Leni Yulianti[1*]; Trimurtini[2]; Bambang Subali[3]; Ellianawati[4]

[1]*Primary Education, Universitas Negeri Semarang, Indonesia*
[2,3,4]*Physics Education, Universitas Negeri Semarang, Indonesia*
[1*]*Corresponding Email: leniyulianti@students.unnes.ac.id*

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Abstract: This study aims to identify trends in digital media development in mathematics learning in elementary schools during the period 2015-2025. The method employed is a systematic review using the PRISMA approach, which involves 25 selected articles from relevant national and international journals. Article selection is based on specific inclusion and exclusion criteria. A bibliometric analysis was conducted using VOSviewer software to map the relationships between keywords, authors, and topics. The results of the analysis indicate an increase in research trends over the last decade, with a primary focus on interactive digital media, including Android applications, educational games, and augmented reality. The dominant keywords that emerge are digital media, mathematics, and elementary schools, which are often associated with increased motivation and student learning outcomes. Visualization from VOSviewer reveals the main clusters that connect learning technology, media effectiveness, and curriculum innovation. These findings provide a comprehensive overview of the direction of digital media development in elementary mathematics education. They can serve as an important reference for researchers and practitioners in developing innovative and relevant learning strategies to meet the needs of the 21st century.

Abstrak: Penelitian ini bertujuan mengidentifikasi tren pengembangan media digital dalam pembelajaran matematika di sekolah dasar selama periode 2015–2025. Metode yang digunakan adalah tinjauan sistematis dengan pendekatan PRISMA, melibatkan 25 artikel terpilih dari jurnal nasional dan internasional yang relevan. Seleksi artikel didasarkan pada kriteria inklusi dan eksklusi tertentu. Analisis bibliometrik dilakukan menggunakan perangkat lunak VOSviewer untuk memetakan keterkaitan antara kata kunci, penulis, dan topik. Hasil analisis menunjukkan adanya peningkatan tren penelitian dalam satu dekade terakhir, dengan fokus utama pada media digital interaktif seperti aplikasi Android, game edukatif, dan augmented reality. Kata kunci dominan yang muncul adalah media digital, matematika, dan sekolah dasar, yang sering dikaitkan dengan peningkatan motivasi serta hasil belajar siswa. Visualisasi dari VOSviewer mengungkapkan klaster utama yang menghubungkan teknologi pembelajaran, efektivitas media, dan inovasi kurikulum. Temuan ini memberikan gambaran menyeluruh mengenai arah pengembangan media digital dalam pendidikan matematika dasar dan dapat dijadikan referensi penting bagi peneliti maupun praktisi dalam mengembangkan strategi pembelajaran yang inovatif dan relevan dengan kebutuhan abad ke-21.

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A. Introduction

The development of digital technology in the 21st century has had a significant impact on various aspects of life, including education. This transformation is characterized by the increasing use of digital devices, internet-based applications, and various interactive media in the teaching and learning process. Basic education, particularly mathematics learning, is one area that has received special attention regarding the use of digital technology. Mathematics, a subject known for its abstract and challenging nature, is often a source of difficulty for students at the elementary school level. This challenge is exacerbated by conventional teaching methods that are less effective in accommodating students' diverse learning styles, particularly in conveying concepts that require visual and contextual understanding.

Digital media development in Mathematics subjects in elementary schools has shown a significant increase, marked by the emergence of various technology-based interactive media designed to adapt to the learning characteristics of 21st-century students. Digital media, such as Wordwall applications, Google Slides, and Android-based media, have been proven to effectively increase motivation and understanding of mathematical concepts (Mutmainnah & Andika, 2024). Research also indicates that interactive media can enhance students' interest in learning, as it is visually appealing and facilitates direct interaction during the learning process (Paseleng & Arfiyani, 2015). Additionally, digital media enables learning to occur without spatial or temporal limitations, making it flexible and adaptable to students' needs (Dilson et al., 2022). Another trend shows that media such as Google Slides with interactive evaluation features have a positive impact on understanding simple fraction material (Purnama & Pramudiani, 2021). Interactive digital media is also considered to play a role in improving overall student learning outcomes (Simorangkir et al., 2024).

Over the last decade, the development of digital technology has had a profound impact on education, particularly in the learning of mathematics at the primary school level. 21st-century education demands the integration of information technology into the teaching and learning process to create an interactive, engaging, and meaningful learning experience. Digital media is considered capable of overcoming the limitations of conventional methods that tend to be less attractive to students in understanding abstract mathematical concepts (Ayuni et al., 2023).

Mathematics is often perceived as a challenging and unengaging subject, particularly among elementary school students. This is due to the traditional teaching approach, which emphasizes memorisation, and the lack of visual media that support conceptual understanding. Therefore, the use of digital learning media, including videos, comics, interactive applications, and digital scrapbooks, has been developed to help students visualize the material and increase their interest in learning (Suari et al., 2024).

Various studies have shown that the use of digital media in elementary school mathematics learning not only increases students' motivation but also has a positive impact on their learning outcomes and critical thinking skills. For example, digital comic media based on the local wisdom of jejaitan and jaranan dance has been developed as a contextual tool that

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brings math material closer to local culture, while enriching students' understanding of geometry concepts (Fajri, 2024; Ayuni et al., 2023).

Additionally, digital media based on video and animation has been proven to maintain student attention and create a pleasant and conducive learning environment. In a study by Magdalena et al (2023), the use of digital teaching materials, specifically learning videos, can help students understand geometry and flat shapes more effectively than conventional methods. Similar research support is also found in the development of digital scrapbook media, which has great potential in helping students gradually and independently construct an understanding of mathematical concepts (Juwita et al., 2025).

Research trends in digital media development for mathematics subjects in elementary schools reveal a strong focus on enhancing students' critical thinking skills. This aligns with the needs of 21st-century skills, which require students to analyze, evaluate, and create solutions. Various studies, such as the one conducted by Nurmala & Maulina (2023), underline the low critical thinking skills in elementary school students as a problem that requires innovative solutions.

Therefore, the development of interactive e-modules that integrate visual, audio, and project-based question exercises is crucial to overcome this challenge. Furthermore, Tinambunan et al (2023) also emphasised that technological developments have transformed the form of books from print to electronic, making them more accessible and allowing for reading at any time and place. This shift encourages research to produce digital teaching materials that improve students' critical thinking skills.

The development of digital teaching materials for mathematics in elementary schools focuses not only on improving critical thinking skills but also on adapting to technological advancements and student needs. As stated by Siloto (2021), the development of mathematical logic e-modules based on *Higher Order Thinking Skills* (HOTS) with the aid of a *flipbook maker* is highly relevant to meeting the learning needs of students in the digital era. The use of *flipbook maker software* has proven effective in attracting students' interest in learning, as well as in placing titles, subtitles, and features that do not interfere with comprehension. Adjusting learning media to the development of science and technology is a priority, ensuring the alignment of features with HOTS-based materials, so that students' learning understanding can increase significantly. This indicates that effective digital media must be designed comprehensively, encompassing not only content but also interactivity and attractiveness (Maulida, 2023).

Research trends also show the diversity of models and approaches used in the development of mathematics digital media in elementary schools. Thiagarajan's 4-D development model, which includes the stages of defining, planning, developing, and disseminating, is widely applied in interactive e-module development studies (Rahmani & Hikmawan, 2025). In addition, the *Analysis, Design, Development, Implementation, and Evaluation* (ADDIE) model is also widely used, such as in the development of mathematics e-books aimed at improving students' critical thinking skills (Yulanda & Darwis, 2023; Auliah et al., 2020), as well as digital modules for mathematics learning based on an *open-ended*

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approach to improve mathematical creative thinking skills. The *Research and Development* (R&D) approach is also the dominant method, allowing researchers to systematically develop and test the feasibility of digital media products.

Improving higher-order thinking skills (HOTS) and 21st-century skills, such as critical, creative, and collaborative thinking, are the primary focus in the development of mathematics digital media. Research by Yunita et al (2023) showed that HOTS-based assessment tools can improve mathematics critical thinking skills in elementary school students. Additionally, the use of educational technology, such as the STEM approach, in mathematics learning has been demonstrated to enhance students' critical, creative, and collaborative thinking skills (Fajri, 2024). This indicates that digital media not only serves as a means of delivering information, but also as a platform to train and hone more complex cognitive abilities, preparing students for future challenges.

Innovation in the form of digital media is also evident in the development of *board games* and animations for learning mathematics. Dela (2023) researched the development of *board game* media in math lessons to improve critical thinking skills in elementary schools. Similarly, Nurafifah et al (2024) also developed a *board game* math learning media, "*Guess the Number*", which proved to be valid, practical, and effective in improving students' critical thinking skills. In addition to *board games*, the use of *whiteboard animation* in digital math teaching materials is also a concern, as it presents material in an engaging and interactive manner, as developed by Rijal & Azimi (2020) for PGSD students. This type of media offers a fun and practical learning experience for students.

This skill is crucial in facing the challenges of the 21st century, where the ability to analyze, evaluate, and find solutions to problems is essential. As revealed by Rahmani & Hikmawan (2025), the low critical thinking ability of elementary school students remains an obstacle that requires innovative learning approaches. Therefore, the development of interactive e-modules designed with visual elements, audio, and project-based exercises is a relevant solution. In line with this, Maulida (2023) also emphasized that the evolution of books from printed to electronic forms presents an opportunity to develop digital teaching materials that can be accessed anytime and anywhere, ultimately aiming to hone students' critical thinking skills.

The digital media developed, such as e-modules and e-books, have been tested for their validity, practicality and effectiveness in improving various student abilities, including critical thinking and learning independence (Suprayitno, 2023; Arjudin et al., 2022). The pilot test results showed excellent responses from students and teachers, as well as significant improvements in learning outcomes. This confirms the position of digital media as a powerful tool for transforming mathematics education at the primary level, encouraging learning that is more engaging, interactive, and oriented towards developing students' holistic skills.

One of the dominant approaches in the development of mathematics learning tools is the integration of active learning models with the use of digital media based on learning *theories*, as demonstrated by Yeni (2015), who developed an active learning tool *model*led after Bruner's theory. This strategy is designed to increase student involvement in the teaching and

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learning process through active learning, which is divided into three stages: enactive, iconic, and symbolic. It utilizes digital-based presentation media, such as Microsoft PowerPoint, equipped with animation and interactive menu systems.

The use of digital media has been proven to improve the understanding of abstract concepts in mathematics, as it can present concept visualization systematically and interactively, which supports constructivist-based learning. The results showed that the learning tools developed were considered very valid (with a score of 4.24), practical (with an experimental score of 88.1, higher than the control score of 75.3), and practical in classroom implementation.

Furthermore, research by Wijayanti et al (2016) reinforced the trend of utilizing digital media in mathematics learning, employing a *Project-Based Learning* (PBL) approach combined with a realistic mathematics approach. In this study, learning tools, including syllabi, lesson plans, worksheets, digital teaching materials, and problem-solving ability tests, were developed and evaluated using the Borg and Gall model. Digital media not only serve as a means of delivering material, but also encourage students to think critically, solve problems, and develop entrepreneurial potential through simulated buying and selling activities. The device's validity reached the "outstanding" category, with an average validation value of all components above 3.4. The level of practicality was demonstrated by the positive response from 93% of students and the teacher's ability to manage learning, with an average score of 3.48. The effectiveness of digital media in this device is reflected in the students' learning completeness, which reached 81.25% and the *N-Gain* value of 0.64, indicating an increase in problem-solving skills in the moderate category.

Through this study, a deeper understanding of the types of digital media that are most widely developed, the mathematics topics that often focus development, and the most effective development models will emerge. Thus, this study not only has academic value in enriching the scientific literature but also practical value in helping various parties develop mathematics learning tools that are more relevant, contextual, and have a positive impact on student learning outcomes in today's digital era.

B. Method

In responding to the challenges of the ever-evolving world of education, particularly in the context of learning mathematics at the primary school level, a thorough review of previous studies related to digital media innovation is necessary. One of the most effective ways to achieve this goal is to conduct a systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. PRISMA is an internationally recognized framework used in many disciplines to improve the rigour, transparency, and quality of scientific literature synthesis.

The application of PRISMA in this study provides a methodological foundation to ensure that the process of selecting and analyzing articles is objective and structured. This approach not only enables researchers to carefully trace previous research but also facilitates the filtering of relevant information from the large number of publications available online. A

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PRISMA-based systematic review consists of four main stages, which are interconnected and play a crucial role in producing a robust and reliable knowledge synthesis: identification, screening, complete content eligibility assessment, and inclusion.

The first stage begins with the article identification process. In this context, we used the Publish or Perish (PoP) software, which is integrated with the Google Scholar database, one of the most comprehensive and accessible sources of scientific literature. The literature search was conducted using strategically designed keywords, namely "digital media", "mathematics learning" and "primary school". These keywords were not only applied in Indonesian but also in their English translations to reach international publications. This strategy aimed to gather a broad range of data that was not limited to a single language or a specific geographical context. This process yielded thousands of articles, which served as the starting material for further analysis.

However, as is common in systematic reviews, not all articles found through the identification process were relevant to the research focus. Therefore, the next step was to screen the articles. This screening was an initial process of elimination based on the information available in the titles and abstracts. The aim was to remove articles that did not align with the core topic, such as those that did not discuss digital media, focused on mathematics learning, or were not conducted at the primary school level. In addition, articles that were opinion pieces, editorials, or not based on empirical research were also eliminated at this stage. Only articles that met the basic requirements and showed direct relevance to the research topic proceeded to the next stage.

After the abstract-based screening process, the remaining articles were then read thoroughly to assess their full content eligibility. At this stage, the researcher examined each part of the article in depth, from background, objectives, methodology, to results and discussion. This process was a critical point in the systematic review, as the researcher had to assess not only the relevance of the topic but also the methodological quality and academic contribution of each article. The inclusion criteria applied in this study included several important aspects, including: the article must explicitly discuss the development or use of digital media in the context of mathematics learning; the learning focus must be at the primary school level; and the research methods used must be transparent, structured, and academically accountable, whether in the form of Research and Development (R&D), experiments, qualitative approaches, or mixed methods.

Many articles failed at this stage because they did not meet one or more of these criteria. For example, some articles discussed digital media in general without specifically linking it to math learning. Others have examined math learning, but not the direct use of digital media in this context. Some even focused on secondary or higher education, which is beyond the scope of this study. Therefore, only articles that met all the inclusion criteria and demonstrated appropriate academic quality were allowed to proceed to the final stage.

After the comprehensive content assessment process, several articles were identified as worthy and met all the criteria. These articles were then included in the inclusion stage and formed the primary basis for analysis in this systematic review. Each article was qualitatively

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analyzed and classified based on several important dimensions, such as the grade level that was the subject of the study (low grade, high grade, or not mentioned), the mathematics topics covered (geometry, fractions, measurement, etc.), the type of digital media developed (Android apps, digital comics, e-modules, interactive videos, etc.), and the development approach or model used (such as ADDIE, 4D, or R&D). This classification is crucial for understanding the patterns and trends that have emerged in mathematics digital media development research in primary schools over the past decade.

To enrich and deepen the analysis, this study also included data visualization using VOSviewer software. Through bibliometric analysis, researchers were able to map the relationships between keywords that frequently appear in the selected articles and identify dominant thematic clusters. This visualization provides a more comprehensive picture of the direction of the research development, showing how concepts such as "digital media", "learning motivation", "interactive", and "critical thinking skills" are interrelated and become the primary focus in the development of mathematics learning innovations at the elementary level.

Overall, the application of the PRISMA flow in this systematic review not only ensures the accuracy and consistency of the article selection process but also ensures that the analysis conducted truly reflects the actual and relevant research conditions and trends. By following the stages of PRISMA carefully, from literature identification to final selection, researchers can compile a valid and functional map of research development, both for learning media developers, educators, policy makers, and other researchers who want to continue similar studies. Thus, PRISMA is not just a technical framework, but an instrument that supports the scientific validity and academic integrity of the entire research process.

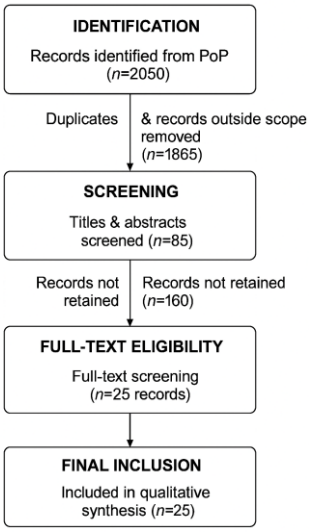

Figure 1. PRISMA Diagram

The accompanying PRISMA flowchart illustrates the systematic process used to select articles for in-depth analysis in this study. The flow is divided into four main stages: Identification, Screening, Full Content Eligibility, and Inclusion. Each stage is shown vertically

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from top to bottom, and each box includes a number reflecting the number of articles that made it through or were eliminated at that particular stage.

At the Identification stage, it was noted that a total of 2,050 articles were found through search results using Publish or Perish (PoP) software, which retrieves data from Google Scholar. The search keywords used were "digital media", "mathematics learning" and "primary school", both in Indonesian and English. This indicates the breadth of literature available that is generally relevant to the research topic.

From this initial number, an initial screening process was conducted to remove inappropriate articles. Articles that were duplicates, opinion pieces, editorials, or did not address the topic in a relevant manner were eliminated. This resulted in 185 articles that were deemed suitable for abstract reading. Thus, a total of 1,865 articles were eliminated at an early stage because they did not meet the basic selection criteria. This process is listed in the Screening stage in the PRISMA image (Figure 1).

Next, the Full-Text Eligibility stage was conducted by thoroughly reading 185 articles. At this stage, researchers assessed the substance of the articles to ensure that each article truly addressed the development or use of digital media in mathematics learning at the primary school level, included valid research methods, and delivered evaluable results. After a thorough evaluation, 160 articles were eliminated for reasons such as not focusing on mathematics learning, not involving the elementary level, digital media not being the primary focus, or not employing scientific methods that could be accounted for.

Finally, 25 articles met all selection criteria and were included in the Inclusion stage. These articles were analyzed systematically and in-depth in this study, examining topics, types of digital media, levels of education, and approaches to development methods used. These articles were also further analyzed using VOSviewer software for bibliometric visualisation purposes. This explains the stages of conducting a study, starting from (1) research design; (2) population and sample (research targets); (3) data collection techniques and instrument development; (4) data analysis techniques. If a study uses tools and materials, it is necessary to write the specifications of the tools and materials used. These articles were also further analyzed using VOSviewer software for bibliometric visualisation purposes.

C. Result

1. Data Analysis

Data analysis in this study is based on 25 selected articles from a total of 2,050 articles identified through searches using the *Publish or Perish* (PoP) application linked to Google Scholar. The search was conducted using the keywords: "digital media", "mathematics learning", and "primary school", in both Indonesian and English, to cover both national and international sources.

After a rigorous screening process based on the PRISMA approach, 25 articles that met all the inclusion criteria were analyzed in depth to identify patterns and trends in the development of digital media for learning mathematics at the primary school level. The data were analyzed

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qualitatively by classifying the articles based on several important dimensions, namely: grade level, mathematics learning topic, type of digital media developed, and research method used.

a) Grade Level

Based on the classification of grade levels, the majority of the research focused on high school students (grades IV-VI), with a total of 15 articles. Meanwhile, six articles explicitly targeted lower grades (grades I-III), and four articles did not specify the grade level that was the subject of their research. The dominance of higher grades suggests that the abstract and complex thinking skills that begin to develop at this age are the primary focus of math-based digital media development.

b) Mathematics Learning Topics

In terms of math learning topics, geometry and flat shapes are the most frequently researched topics, as evidenced by eight articles. Other topics include fractions, basic arithmetic operations, measurement, and ethnomathematics. The selection of these topics demonstrates that digital media have been developed to help students understand visual, abstract, and conceptual math concepts, which are generally difficult to grasp through conventional methods.

c) Types of Digital Media Developed

The types of digital media developed in the research are very diverse, reflecting the creativity and adaptation of technology by the researchers. The most dominant media type was Android-based applications, which appeared in 7 articles. Other media include educational games, digital comics, digital scrapbooks or e-modules, and augmented reality (AR). These media generally have interactive and visual characteristics, which are designed to attract students' interest and increase their involvement in the mathematics learning process.

d) Research Methods Used

In terms of methodological approach, the Research and Development (R&D) method was the most dominant, used in 14 articles. R&D was used to develop, test the feasibility, and assess the effectiveness of the designed digital media products. In addition, there were also articles that employed pure or quasi-experimental methods, qualitative approaches, and mixed methods. As shown in Figure 2.

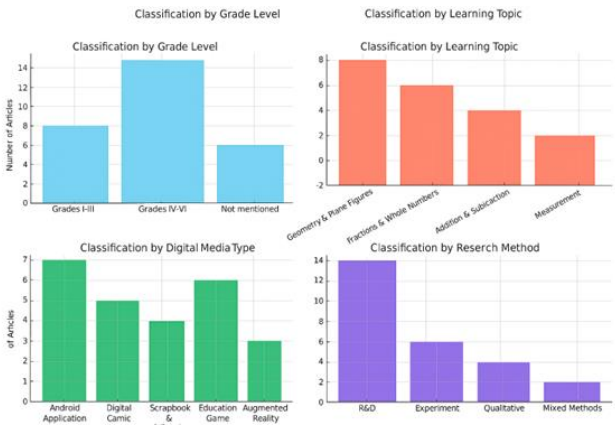

Figure 2. Trend Analysis Of 25 Selected Articles

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e) Bibliometric Visualization

As part of the data analysis, this study also employed bibliometric analysis using VOSviewer software, as shown in Figure 3.

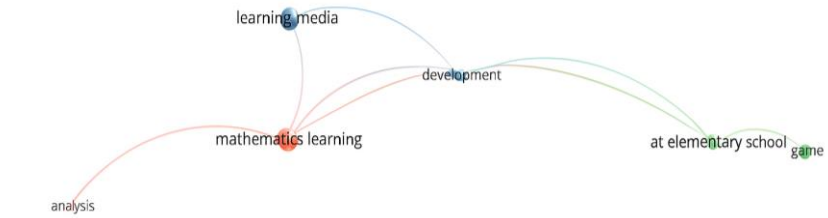

Figure 3. Vosviewer Display for Keyword-Based Analysis

The visualization results show that there are three major clusters in the reviewed literature, namely:

"learning mathematics" cluster - representing the research focus on the analysis and development of learning mathematics;

The "learning media" cluster - showing the exploration of different forms of media and their relationship to learning;

The "gaming in primary school" cluster indicates a trend towards the use of gamification approaches in mathematics learning.

This bibliometric analysis reinforces previous qualitative findings and provides a comprehensive picture of the direction, focus and intensity of research developments in the past decade.

2. Critical Appraisal

A critical appraisal of the 25 articles selected for this review was conducted to ensure that each article was of sufficient scientific quality to warrant analysis. This process is a crucial stage in a systematic review because not all articles that meet the thematic and methodological criteria have a high depth of analysis, strong data, or academic validity.

The critical appraisal was conducted by considering four leading indicators, namely (1) the quality of the research methodology, (2) the strength of the evidence and academic contribution, (3) the relevance and consistency with the focus of the study, and (4) the applicability and usefulness of the media developed in the context of learning mathematics in primary schools.

a) Methodological Quality

Most of the articles employed the Research and Development (R&D) approach, which involves a systematic process encompassing the planning, development, validation, and testing stages of digital media products. Development models such as ADDIE, 4-D, and the Borg and Gall approach were the dominant frameworks in the articles. Good articles contain detailed descriptions of each stage, including expert validation techniques, media

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revisions, and limited and extensive trials that generate both quantitative and qualitative data.

b) Strength of Evidence and Academic Contribution
In terms of strength of evidence, most articles included quantitative data in the form of improvements in pretest-posttest scores, N-Gain scores, or expert validation scores. These articles show that the digital media developed is not only innovative in terms of form, but also proven effective in improving learning outcomes and students' critical thinking skills.

c) Relevance and Consistency of Focus
All articles analyzed have met the relevance criteria, which explicitly discuss the development or application of digital media in mathematics learning at the elementary school level. However, at the appraisal stage, consistency of focus was also highlighted. Some articles, although topically relevant, deviated from the focus of the discussion, for example, overemphasizing technological features without evaluating their impact on students' understanding of mathematical concepts. These articles were categorized as applicable but limited from a pedagogical perspective.

d) Applicability of Media in Real Context
The last aspect assessed in the *critical appraisal* is the extent to which the developed media can be applied in a real primary school setting. Some articles described in-school trials involving teachers and students directly, and included data on user responses to the media. Such articles are highly rated as they demonstrate the practicality and acceptability aspects that are important in real-world learning implementation.

3. Literature Review Results

The literature review of the 25 selected articles showed that the development of digital media for learning mathematics in primary schools has increased significantly from 2015 to 2025. Various forms of digital media have been developed, ranging from Android applications and educational games to digital comics and interactive e-modules. The primary purpose of developing these media is to help students understand math concepts that have been considered difficult and tedious.

Numerous studies have demonstrated that the use of digital media can enhance student learning outcomes, particularly in subjects such as geometry, fractions, and measurement. Visual and interactive media help students visualise abstract concepts that are difficult to grasp using traditional lecture methods. In addition, students' learning motivation also increases when they learn with fun and colourful media such as animated videos or math games.

Not only in terms of understanding and motivation, but several studies have also shown that digital media plays a crucial role in fostering critical and creative thinking. Media designed with open-ended problems, project activities, or real-world problems encourage students to think more deeply, rather than memorize formulas. This aligns with 21st-century learning needs that emphasize Higher-Order Thinking Skills (HOTS).

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Various approaches are used in the development of such media. Among them are the 4D model (Define, Design, Develop, Disseminate), the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), and the Research and Development (R&D) approach. These approaches allow media development to be structured and tested for feasibility before being implemented in the classroom.

4. Data Analysis Matrix

Table 1 below summarises the results of the review of 25 selected articles that discuss the development of digital media in mathematics learning in primary schools. The matrix is organized by title, author, journal and findings of each study.

Table 1. Data Analysis Matrix

No	Title	Authors	Journal	Research Result
1	Mathematics Learning Strategy Assisted by Digital Book Creator Media	1. Alfi Maulida	Journal of Mathematics Learning and Development (PEMANTIK)	This research develops learning media using Book Creator Digital to increase interest in learning mathematics in vocational schools, which is also relevant for elementary schools. This media presents math materials with an attractive visual design, enabling students to interact with text, images, and audio. The results showed that the use of this media increased students' interest and attention, clarified the material, and created a pleasant learning atmosphere. Expert validation scores also show that this media is suitable for use.
2	Development of Open-Ended Based Digital Module	1. L. Auliah 2. S. Syaiful 3. S. Syamsurizal	Journal of Mathematics Education	This study developed an open-ended digital module to improve the creative thinking skills of fifth-grade elementary school students. This module contains open-ended problems, interactive simulations, and explorative activities that allow students to find various solutions. The pilot test results showed a significant increase in mathematical creative thinking ability, with a high N-Gain value. The module was declared valid by experts and practical for use in the classroom.
3	Multimedia-Infused Math Digital Comic	1. Bhujangga Ayuningrat P.S.	Journal of Science and Humanities	The research developed multimedia-laden digital comics for fraction materials in grade IV SD. This media combines illustrated

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No	Title	Authors	Journal	Research Result
		2. Gusti N.S. Agustika 3. I Wayan Sujana	Research and Development	stories with contextual narratives and illustrations. This digital comic effectively captured students' attention and helped them understand the concept of fractions through both visual and contextual representations. Students' learning outcomes improved, and the comics were considered very effective by teachers and students.
4	Development of Math Board Game Media	1. Dela Tri Wulandari	Journal of Innovative Education	The board game media was developed for the topic of arithmetic operations, designed as an educational game with simple rules, game boards, and question cards. The results showed that this board game improved critical thinking skills, strengthened students' social interaction, and made the learning atmosphere more fun. Experts tested the validity of the media, and the results of classroom implementation showed significant effectiveness.
5	Mobile-based Interactive Math Learning Media	1. D. Dilson 2. R. Yunita 3. S. Arimadona	SIMTIKA Journal	An Android-based interactive mobile application for the measurement topic in Grade III has been developed. This media facilitates independent exploration of material through animations, interactive simulations, and online quizzes. This application provides flexible learning, can be accessed anytime, and is effective in increasing student understanding and participation. Student and teacher responses to this media were very positive.
6	HOTS Assessment for Whole and Mixed Numbers	1. Irma Yunita	Journal of Elementary Mathematics Education	The research focuses on the development of HOTS-based assessment tools to improve the critical thinking skills of grade VI students. The assessment tool includes open-ended and reflective questions. The results demonstrated an improvement in critical thinking skills and an enhanced understanding of mathematical concepts. Teachers are also helped

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No	Title	Authors	Journal	Research Result
				in assessing students' thinking process, not just the final result.
7	Digital Scrapbook for Measurement Materials	1. Juwita 2. D.B. Maritasari 3. I.U. Wardani	JP2M (Journal of Mathematics Education and Learning)	The media developed is a digital scrapbook that displays measurement materials with images, videos, and interactive instructions. The scrapbook encourages gradual and independent knowledge construction, greatly helping students understand concepts such as length, weight, and volume. The study showed significant improvement in concept understanding and enthusiasm for learning.
8	Digital Literacy Media "Lotika"	1. R. Nurmala 2. H. Maulina	Proximal Journal	The media, in the form of the Android application "Lotika," is designed for PGSD students but is also relevant for elementary schools, featuring digital literacy-based math simulations. This application improves understanding of math concepts through visual content, audio, and interactive exercises. The pilot test showed an increase in concept mastery and digital literacy.
9	Wordwall Media Utilisation	1. A. Mutmainnah 2. R. Andika	Sinar Dunia: Journal of Social Humanities and Education Research	Wordwall is used as an interactive evaluation medium in mathematics learning for grade V elementary school students. The research shows that Wordwall is effective in online evaluation, motivates students because it is game-like, accelerates teacher feedback, and enriches the variety of question forms.
10	Impact of Educational Technology on 21st Century Skills	1. N. Fajri 2. M. Nursalim 3. S. Masitoh	EdTech Review Indonesia	Through a systematic literature review approach, this study examines the role of educational technology, including digital mathematics media, in enhancing critical, creative, and collaborative thinking skills. The research confirms that digital media in general has a significant impact on HOTS achievement.
11	Development of Local Wisdom-	1. Ni Made Santi Ayuni	Journal of Educational	This digital comic, based on Jajaitan local culture and Jaranan dance, was developed for the grade IV SD

https://doi.org/10.51276/edu.v6i3.1342

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	Based Math Digital Comics	2. I Made Suarjana 3. Gusti Ayu Putu Sukma Trisna	Media and Technology	students to explore the topic of angles. Comics are organized with local characters and stories that visually and narratively represent the concept of angle. Research indicates that this media enhances understanding of geometry concepts and fosters cultural values. Students are more enthusiastic and feel a closer connection to the learning content.
12	"Guess the Number" Board Game	1. R. Nurafifah 2. I. Rafianti 3. N. Anriani	Linear Journal: Mathematics Education	This board game media is designed to train students in grades IV-V in arithmetic operations and critical thinking. The game consists of boards, number cards, and playing rules that require students to think strategically. Validation showed that this media is valid and practical. Implementation in the classroom demonstrated an increase in students' logical thinking skills, accompanied by a corresponding rise in enthusiasm for learning.
13	Implementation of Interactive Multimedia-based Learning Media	1. M.C. Paseleng 2. R. Arfiyani	Scholaria: Journal of Education and Culture	This media is an interactive multimedia experience that utilizes animation, audio, and video, commonly found in basic math materials used in elementary school education. The results showed that this media increased student interactivity and understanding, and was suitable for various learning styles (visual, auditory). Teachers also found it helpful in delivering complex materials.
14	Development of Digital Teaching Material Model for Learning Mathematics for Grade VI Elementary School	1. I. Magdalena 2. A. Syafinka 3. S. Mariyam	Masaliq Journal of Education	Media in the form of video-based digital teaching materials was developed for flat building materials. The content consists of geometry animations, interactive simulations, and quiz exercises. This media was deemed valid by experts and is very effective in improving students' spatial understanding. Teachers reported that students were more active and able to explain geometry concepts in their native language.

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15	Assistance in Developing HOTS Mathematics Problems	1. Arjudin 2. S. Prayitno 3. R. Yulis Tyaningsih 4. N. Humaira Salsabila	Rengganis Journal of Community Service	The focus is on training junior high school teachers, but the approach is relevant for elementary schools. The HOTS-based questions developed help teachers structure assessments that encourage analytical and reflective thinking. Teachers reported a shift in their learning approach from memorization to concept-based discussions.
16	Development of TAI Model Mathematics Learning Module	1. S. Suprayitno 2. Y. L. Sukestiyarno 3. I. Isfarudi	Journal of Teaching Profession	The Team Assisted Individualisation (TAI) based module was developed for grade IV elementary school. The media is equipped with collaborative activities, visual simulation, and individual reflection. This module increases students' learning independence and critical thinking, as evidenced by the increase in post-test scores and active involvement during group learning.
17	Interactive Google Slides Media Development	1. S.J. Purnama 2. P. Pramudiani	Basicedu Journal	Media in the form of interactive Google Slides for simple fractions. The slides are equipped with animation and automatic evaluation. The research shows that students understand the concept of fractions more quickly, due to the direct visualization between fraction form and image representation. Teachers can also evaluate students' understanding directly.
18	Development of Interactive E-Modules for Mathematics	1. Z. Rahmani 2. R. Hikmawan	Didaktika Journal	E-modules based on the 4D model (Define, Design, Develop, Disseminate) were developed to train critical thinking. The module contains learning videos, project exercises, and written reflections. Expert validation was perfect, and the pilot test showed an increase in N-Gain scores in the aspects of analysis and evaluation of mathematical concepts.
19	Whiteboard Animation for PGSD Students	1. A. Rijal 2. A. Azimi	Basicedu Journal	Whiteboard animation media was developed as a basic mathematics teaching material for prospective teachers. This animation video simplifies complex geometry

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				concepts and presents them in a sequential, visual format. As a result, PGSD students gain a deeper understanding of how to teach the material to elementary students and feel more prepared to utilize visual media in the classroom.
20	Development of HOTS-based Math Logic E-Modules	1. Siloto	Journal of Innovative Learning	Media in the form of HOTS flipbook-based e-modules for grade V math logic material. The module presents logical material with visual simulations, logic flow animations, and HOTS exercises. As a result, students' interest and understanding increased significantly, and they became more enthusiastic about engaging in higher-order thinking exercises.
21	Analysis of the Use of Interactive Digital Media	1. R. Simorangkir 2. R. Sinaga 3. R. Limbong 4. Z. Nazwa	Trapsila: Journal of Basic Education	The study analysed various interactive digital media used by Grade 5 students. The media included e-books, animations, digital quizzes and simulations. The research demonstrated that these media enhanced students' motivation and learning outcomes, particularly in geometry and arithmetic operations. Teachers stated that the media helped them to be more efficient in teaching.
22	Improving Critical Thinking Skills in the Digital Age	1. R.R. Tinambunan 2. S. Pratiwi 3. N. Ulandari 4. N.T.A. Ni'mah	Journal of Elementary School Teacher Education	This study emphasizes the importance of teacher and student digital literacy in supporting critical thinking skills. Although it does not mention specific media, this study suggests that project-based e-modules can be a solution. This study highlights the importance of human resources and facilities in supporting digital media.
23	Implementation of Science Learning with Fotonovela Media	1. S. Wijayanti 2. I. Isnarto 3. M. Masrukan	Journal of Primary Education	The fotonovela was developed as a contextualized learning medium. Although the focus is on science, this media increases students' learning motivation and entrepreneurial skills, and can be adapted to contextual math materials, such as buying and selling. The media were deemed valid and practical for application in

https://doi.org/10.51276/edu.v6i3.1342

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				elementary/middle school classrooms.
24	Math Learning Difficulties in Elementary School	1. E.M. Yeni	JUPENDAS	This article does not develop media, but identifies mathematics learning difficulties in primary school, such as difficulties in understanding symbols and abstract concepts. This article provides a basis for designing customized digital learning interventions.
25	Contextualized Digital Scrapbook Development	1. E. Yulanda 2. U. Darwis	Journal of Research on Mathematics and Natural Sciences Education	A digital scrapbook was developed to facilitate learning about flat shapes. Using a contextual approach, this media contains illustrations of shapes in everyday life. As a result, students can more easily identify and understand geometry concepts and show improvement in their ability to relate the material to real-world situations.

D. Discussion

The findings of the 25 articles reviewed support the hypothesis with concrete data and evidence. The dominance of media types such as Android applications, digital comics, e-modules, board games, augmented reality, and whiteboard animation shows that the focus of learning media development is no longer limited to content delivery, but has shifted towards creating a fun, active, and meaningful learning experience. For example, studies by Nurafifah et al (2024) and Dela (2023) have demonstrated that math board game media is effective in enhancing the critical thinking skills of elementary school students, which is a key indicator of 21st-century learning achievement.

The suitability of the results of this study is also evident in comparison with previous studies in the same field. For example, Simorangkir et al (2024) showed that interactive digital media not only increased learning motivation but also directly impacted student learning outcomes. This reinforces the findings of this study, which suggest that digitizing learning not only makes learning more engaging but also enhances cognitive effectiveness. Juwita et al (2025) even demonstrated that digital scrapbook media makes a significant contribution to enhancing concept understanding in measurement materials, which are often considered challenging for students to comprehend without concrete visualization.

However, not all studies show uniform success. Some articles emphasise that the effectiveness of digital media is significantly influenced by contextual factors, including teacher competence in utilizing the media, school technology infrastructure, and students' readiness in using digital devices. For example, an article by Tinambunan et al (2023) notes that although interactive e-modules have great potential, there are still constraints in terms of

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accessibility and digital literacy of teachers and students, especially in areas with limited facilities.

These findings also align with global trends in digital education. STEM, HOTS-based learning and project-based learning (PjBL) approaches are the foundation of digital media development that not only aims to convey information, but also build higher-order thinking skills. This is evident in the development of media, such as Auliah et al (2020) open-ended math e-book and Siloto (2021) HOTS-based e-modules, each of which has shown positive results in improving students' critical and creative thinking skills.

Overall, there are no fundamental contradictions between the results of this study and other studies. On the contrary, there is strong coherence between the initial hypothesis, the empirical findings, and the existing literature. However, this study also revealed that the effectiveness of digital media can only be optimally achieved if teacher training, a flexible curriculum, and adequate infrastructure support are provided. Without these supporting factors, digital media development may be an innovative project that lacks practical impact.

E. Implication

The findings of this study have important implications for educational practice and policy in the digital age. First, the results indicate that integrating digital media into mathematics learning in primary schools can effectively address students' diverse learning needs and support the development of 21st-century skills, such as critical, creative, and collaborative thinking. Therefore, teachers need to be trained and supported to develop and implement digital media effectively in the classroom.

Secondly, the trend of developing digital media that is interactive, contextual and adaptive shows the importance of a more flexible pedagogical approach. This implies that educational institutions and the government must support the provision of technological infrastructure and access to training in digital-based media development.

Thirdly, scientifically, this study expands the field of technology education research by highlighting the role of digital media as a crucial component of innovative mathematics learning strategies. It also provides a strong foundation for further studies in the development of other technology-based media that are more sophisticated and personalized.

F. Limitations and Suggestions for Further Research

As the authors, we acknowledge that this study has certain limitations that need to be openly discussed. First, this study analyzed only 25 articles from a total of 2,050 identified articles; therefore, there is still a possibility that some relevant publications were missed in the selection process because they did not meet our inclusion criteria. This resulted in a limited scope of representation of the overall trend.

Secondly, this study employs a systematic review with a bibliometric approach, which does not directly evaluate the implementation of digital media in the field. This means that the effectiveness of digital media, as found in the literature, has not been empirically tested

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through classroom observations or product trials. We have also not explored the context of using digital media in an educational environment that has limited infrastructure or resources.

Thirdly, in the classification of media types, mathematics topics and development models, we emphasized the frequency and general trends rather than the quality of student learning outcomes produced by each approach. This limitation hinders understanding the advantages and disadvantages of various media types in enhancing math learning outcomes.

G. Conclusion

Based on a systematic review of 25 selected articles from 2015 to 2020, the development of digital media in mathematics learning in primary schools exhibits an increasingly positive and innovative trend. The analyzed studies demonstrate that digital approaches, including Android apps, digital comics, scrapbooks, interactive videos, and augmented reality technology, have been proven to significantly enhance students' motivation, conceptual understanding, and learning outcomes. These media not only make learning more enjoyable but also help overcome classic challenges in learning mathematics, such as the abstract nature of the material and students' lack of interest in the subject. In addition, the integration of local context through ethnomathematics and the application of approaches such as STEM and gamification demonstrate a substantial contribution to the development of 21st-century skills. Bibliometric visualization using VOSviewer also revealed key clusters that support the relationship between digital media, learning effectiveness and curriculum innovation. Thus, digital media is no longer just a supplement; it has become an integral element capable of revolutionising the way mathematics is taught at the primary school level. Therefore, educators and curriculum developers must continue to explore, design, and implement relevant, interactive, and contextualized digital media to promote a more adaptive and meaningful educational transformation.

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Author's Biography

	**Leni Yulianti, S.Pd.** Born in Blora, October 28, 1998. A Bachelor's in elementary school teacher education at Universitas Terbuka (UT) in 2021. Completed PPG Prajabatan at Universitas Negeri Semarang (UNNES) in 2024, and currently pursuing a Master's degree in Primary Education at UNNES. Email: leniyulianti@students.unnes.ac.id
	**Dr. Trimurtini, S.Pd., M.Pd.** Lecturer at Universitas Negeri Semarang (UNNES), Faculty of Education and Psychology, currently teaching in the Curriculum Development Study Program. She completed her Bachelor's degree (S.Pd.) and Master's degree (M.Pd.) in Education, and earned her Doctorate (Ph.D.) in Education as well. Email: trimurtinipgsd@mail.unnes.ac.id
	**Dr. Bambang Subali, M.Pd.** Lecturer at Universitas Negeri Semarang (UNNES). He earned his Doctorate in Science Education from UNNES, along with a Master's degree in Education and a Bachelor's degree in Physics Education. Email: bambangfisika@mail.unnes.ac.id
	**Dr. Ellianawati, M.Si.** Lecturer at Universitas Negeri Semarang (UNNES). Completed her Bachelor's degree in Physics Education at Universitas Negeri Semarang, her Master's degree in Material Physics at Institut Teknologi Bandung, and her Doctorate in Science Education at Universitas Pendidikan Indonesia. Email: ellianawati@mail.unnes.ac.id