The impact of interactive multimedia on improving mathematics learning: A systematic review according to the PRISMA model and an applied analysis of recent studies (2020–2026)

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Abstract:

Global educational research is witnessing a growing interest in developing modern representation techniques and digital educational tools to clarify fundamental mathematical concepts, particularly in the field of e-learning for mathematics. However, there remains a need to develop more effective methods for interactively and practically representing these concepts. This study aims to analyze the impact of interactive multimedia in mathematics education through a systematic literature review (SLR) conducted according to PRISMA guidelines. Studies were collected from various scientific databases, such as Google Scholar, research gate and 18 studies that met the inclusion criteria were identified and analyzed during the period 2020–2026. The study employed qualitative thematic analysis to identify research patterns and trends. The results showed that integrating interactive multimedia into mathematics education significantly contributes to improving academic achievement and developing mathematical problem-solving skills, compared to traditional methods.

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Furthermore, the studies demonstrated that these media not only enhance performance but also play a therapeutic role in addressing mathematical misconceptions and reducing "mathematical phobia" through strategies such as cognitive dissonance and contextual learning (CTL). The results also confirmed that the effectiveness of these technologies depends largely on the quality of the engineering and technical design, especially when integrating two-dimensional and three-dimensional graphics and interactive simulations. However, the study revealed a research gap: the absence of a unified methodological framework that integrates interactive media, contextual learning, and misconception correction within a comprehensive educational model.

Therefore, the study proposes a conceptual framework that can contribute to improving the design and implementation of mathematics education and guide teachers and curriculum developers toward more effective integration of digital technologies in modern learning environments.

Keywords: Interactive multimedia, mathematics education, e-learning, academic achievement, mathematical problem solving.

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أثر الوسائط المتعددة التفاعلية على تحسين تعلم الرياضيات: مراجعة منهجية وفقًا لنموذج PRISMA وتحليل تطبيقي للدراسات الحديثة (2020-2026)

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المستخلص:

يشهد البحث التربوي العالمي اهتمامًا متزايدًا بتطوير تقنيات تمثيل حديثة وأدوات تعليمية رقمية لتوضيح المفاهيم الرياضية الأساسية، لا سيما في مجال التعلم الإلكتروني للرياضيات. ومع ذلك، لا تزال هناك حاجة لتطوير أساليب أكثر فعالية لتمثيل هذه المفاهيم بشكل تفاعلي وعملي. تهدف هذه الدراسة إلى تحليل أثر الوسائط المتعددة التفاعلية في تعليم الرياضيات من خلال مراجعة منهجية للأدبيات (SLR) وفقًا لإرشادات PRISMA. جُمعت الدراسات من قواعد بيانات علمية متنوعة، مثل Google Scholar وResearchGate، وتم تحديد 18 دراسة استوفت معايير الإدراج وتحليلها خلال الفترة 2020-2026. استخدمت الدراسة التحليل الموضوعي النوعي لتحديد أنماط البحث واتجاهاته. أظهرت النتائج أن دمج الوسائط المتعددة التفاعلية في تعليم الرياضيات يُسهم بشكل كبير في تحسين التحصيل الدراسي وتنمية مهارات حل المسائل الرياضية، مقارنةً بالأساليب التقليدية. علاوة على ذلك، أوضحت الدراسات أن هذه الوسائط لا تُحسّن الأداء فحسب، بل تلعب أيضًا دورًا علاجيًا في معالجة المفاهيم الخاطئة في الرياضيات والحد من "رهاب الرياضيات" من خلال استراتيجيات مثل التنافر المعرفي والتعلم السياقي (CTL). أكدت النتائج أيضًا أن فعالية هذه التقنيات تعتمد بشكل كبير على جودة التصميم الهندسي والتقني، لا سيما عند دمج الرسومات ثنائية وثلاثية الأبعاد والمحاكاة التفاعلية. ومع ذلك، كشفت الدراسة عن ثغرة بحثية تتمثل في غياب إطار منهجي موحد يدمج الوسائط التفاعلية والتعلم السياقي وتصحيح المفاهيم الخاطئة ضمن نموذج تعليمي شامل.

لذا، تقترح الدراسة إطارًا مفاهيميًا يُسهم في تحسين تصميم وتنفيذ تعليم الرياضيات، ويرشد المعلمين ومطوري المناهج نحو دمج أكثر فعالية للتقنيات الرقمية في بيئات التعلم الحديثة.

كلمات المفتاحية: الوسائط المتعددة التفاعلية، تعليم الرياضيات، التعلم الإلكتروني، التحصيل الأكاديمي، حل المسائل الرياضية.

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1. Introduction:

The contemporary education system has undergone a radical transformation towards adopting digital learning strategies, driven by the clear shortcomings of traditional teaching methods in addressing the individual differences of learners and meeting the demands of the technological age [Suleiman (2023), Butri et al., (2022)]. These transformations are doubly important in the context of mathematics education, as mathematics is among the subjects where students struggle to grasp abstract concepts, leading to low academic achievement and a traditional aversion to the subject [Windhyastuti et al, (2026), Nurmawati et al., (2020)]. Educational literature based on quasi-experimental studies and systematic reviews confirms that addressing this academic weakness requires a shift towards interactive technology-based learning environments, which have demonstrated high statistical efficacy in improving higher-order thinking skills and problem-solving abilities [Adeyele (2024), Sherif, (2025)].

In this context, interactive multimedia emerges as an integrated educational and engineering tool capable of bridging the knowledge gap. It allows learners to interact directly with content through multiple sensory channels, including text, animation, and visual simulations [Angraini, Fitri (2023), Abdulrahaman, et al. (2020)]. The impact of these media extends beyond simply presenting content in an engaging way. They also increase students' motivation for self-directed and home-based learning, transforming their role from passive recipients to active participants in knowledge construction [Wasi'ah, Cahyono (2025), Amelia and Harahap (2021)]. Cumulative research in mathematics indicates that employing these digital systems contributes to significant leaps in academic achievement, particularly when compared to control groups taught through traditional lectures [Herrera et al, 2024].

The central challenge in mathematics education lies not only in academic achievement but also in the cognitive structure itself. Students often develop what are known as "mathematical misconceptions," which are cognitive obstacles that hinder their understanding of more complex laws [Winarso et al., (2023)]. This is where the protective power of interactive media, supported by advanced strategies such as "cognitive contradiction," becomes apparent. In this approach, software provides a visually challenging environment that compels students to re-evaluate their misconceptions and develop sounder

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understandings [Winarso et al., (2023)]. When these tools are integrated with the contextual teaching and learning approach, technology can connect mathematics to the learner's real-world environment, giving abstract concepts tangible, practical dimensions that enhance the depth of strategic understanding [Pratiwi et al, 2024].

This study is an extension of research efforts seeking the optimal use of educational technology. It aims to measure the actual impact of interactive multimedia in addressing conceptual gaps and improving mathematical abilities, ultimately leading to the development of a comprehensive methodological framework that helps teachers and curriculum designers effectively integrate two-dimensional and three-dimensional components within classrooms.

2. Research objective:

1- Evaluate the effectiveness of interactive media in improving students' mathematical problem-solving skills.

2- Exploring the role of interactive multimedia in reducing misconceptions in mathematics and increasing student engagement.

3- Provide a methodological framework for integrating multidimensional technologies (such as animation and 3D technologies) into mathematics teaching.

3. Research question:

1- What is the impact of interactive media on improving mathematical problem-solving skills?

2- How does interactive multimedia contribute to reducing mathematical misconceptions and increasing engagement?

3- What is an effective methodological framework for integrating multidimensional technologies into mathematics teaching?

4. Research problem:

The research problem lies in the continued reliance of mathematics teaching on traditional and rote methods, which has led to weak student motivation and a significant decline in their mathematical problem-solving skills [Nurmawati, (2020)]. This problem is exacerbated by the emergence of knowledge gaps

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that lead to the development of alternative perceptions and erroneous mathematical concepts among learners, a challenge that is difficult to address through conventional learning environments [Winarso et al, (2023)]. Despite the rapid development of information technology and the availability of multidimensional digital tools such as 3D applications and animation, the educational field still lacks clear methodological frameworks that explain how to effectively integrate these technologies into contextual learning environments [Pratiwi et al., (2024), Abdulrahaman et al., (2020)]. Consequently, the current deficiency is manifested in the absence of integrated technological use to bridge conceptual gaps and increase academic interaction, which necessitates studying the impact of interactive media in addressing these problems and developing a practical framework for integrating them into mathematics teaching.

5. Research method:

This study employed the Systematic Literature Review (SLR) methodology to collect and analyze scientific studies addressing the impact of using interactive multimedia in mathematics education. SLR is considered one of the most rigorous and objective research methods for analyzing scientific literature, enabling researchers to systematically gather and analyze available research evidence to arrive at reliable and reproducible conclusions.

To ensure transparency and methodological rigor, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart was used. This flowchart provides a clear methodological framework for identifying, selecting, sorting, and evaluating studies before their inclusion in the final analysis.

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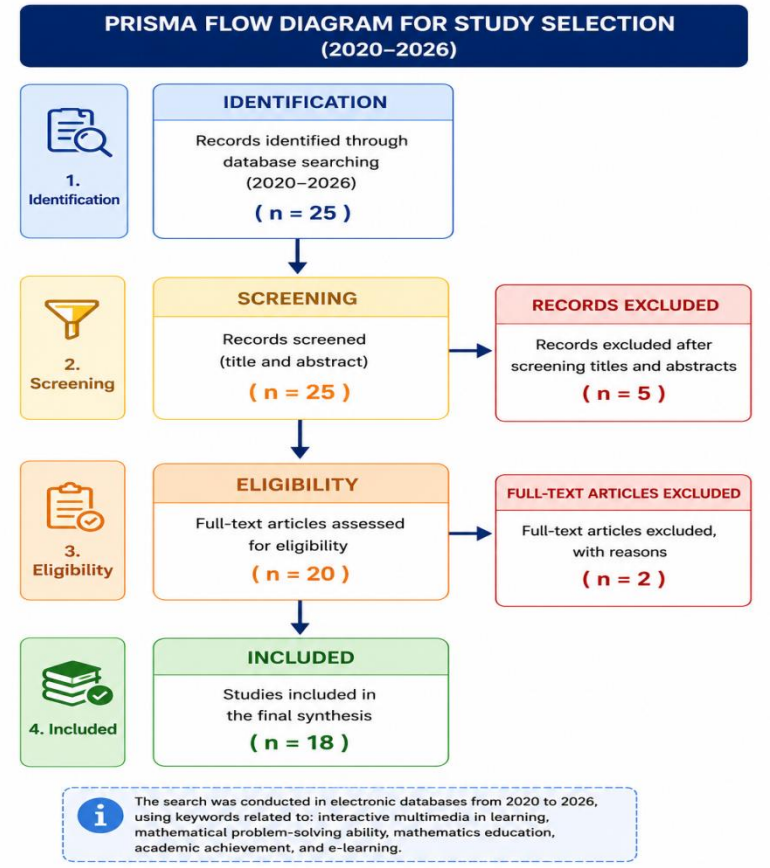


Figure 1 PRISMA Flow Diagram For Study Selection (2020-2026)

1. In the identification phase, a comprehensive search was conducted in electronic scientific databases covering the period from 2020 to 2026, using a set of keywords related to the study topic, such as "interactive multimedia," "mathematics education," "academic achievement," and "e-learning." The initial search resulted in the discovery of 25 scientific articles published in peer-reviewed journals.
2. During the screening phase, the titles and abstracts of the retrieved studies were reviewed to verify their relevance to the research topic and objectives. Five articles were excluded for failing to meet the selection criteria or for not being directly related to the use of interactive multimedia in mathematics education, leaving 20 studies eligible for the next stage.

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3. In the eligibility assessment phase, the full texts of the 20 studies were read and analyzed according to a set of predefined inclusion criteria. These criteria included that the study be published in a peer-reviewed scientific journal, directly address the application of interactive multimedia in mathematics education, and demonstrate clear results related to academic achievement, the development of mathematical skills, or the improvement of the learning process. This stage resulted in the exclusion of two studies for failing to meet the eligibility requirements.
4. In the final inclusion phase, 18 scientific studies were selected to form the final database for the systematic review. Data were extracted regarding authors, publication years, study objectives, methodologies, sample characteristics, research instruments, and key findings.

Subsequently, the data were analyzed using descriptive and thematic approaches to identify common trends and main findings across the selected studies. The use of the PRISMA flowchart helped to systematically and clearly document the study selection process, thus enhancing the reliability and scientific rigor of the study results.

6. Literature review:

1. S. M. A. Suleiman, 2023: The application of multimedia technologies as educational tools for mathematics teaching was examined in [Suleiman (2023)]. It adopted the descriptive approach, whereby a questionnaire was distributed as a random sample to (50) male and female teachers in the Jabal Awliya locality. The results showed that the use of multimedia, from the teachers' point of view, raised the level of academic achievement in mathematics, and the results were positive. However, there are obstacles from the administrations in terms of providing the necessary capabilities, as well as the adoption of the traditional system in the educational process. The researcher recommended adopting the use of multimedia in the educational process.

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2. S. Putri, Abdurrahman, D. Andrian, L. M. Angraini, and L. A. Effendi, 2022: The mean aims of this study are to produce educational media products based on Macromedia Flash 8 mathematics, focusing on the similarity and congruence of materials for ninth-grade students, was addressed in [Putri et al., (2022)]. This research outlines the development of ADDIE, which comprises five phases: analysis, design, development, implementation, and evaluation. The tools used were media validation sheets and student response questionnaires. The results of the analysis showed an average validity rate of 86.57%, indicating "very valid," while the average practicality rate of the learning media was 89.53%, indicating "very practical." Based on the research and development findings, it can be concluded that the developed educational media is suitable for use in mathematics education.

3. E. K. Windhyastuti, R. Kariadinata, and A. D. Susandi, 2026: This study aimed to develop interactive multimedia in mathematics, supported by the Articulate Storyline software, which was evaluated [Windhyastuti et al., (2026)] and would be practical and effective in improving problem-solving and self-learning skills among fourth-grade students. The study sample consisted of fourth-grade students. Data were analyzed descriptively, quantitatively, and qualitatively. The study concluded that interactive multimedia in mathematics, supported by the Articulate Storyline software, is a practical and effective educational tool for improving problem-solving and self-learning skills among elementary school students.

4. V. O. Adeyele, 2024: This study aimed to determine the relative effectiveness of simulation games, blended learning, and interactive multimedia in improving basic science learning outcomes for students with diverse abilities was evaluated in [Adeyele (2024**)**]. The goal was to provide information on the most effective strategy for teaching basic science to these students. The study employed a quasi-experimental design, with the experiment conducted in six schools and two schools serving as a control group. Descriptive and inferential statistical analysis was used. The results indicate that interactive multimedia was more effective with students in mainstream schools, while blended learning proved most effective with students in special education schools. These findings suggest the need for teachers to use strategies to capture and maintain student attention during basic science instruction.

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5. K. M. Sherif, 2025: The study employed a mixed methodology was employed in [Sherif (2025], including a pre-test and post-test to assess academic achievement, and a questionnaire to evaluate students' academic behavior. The collected data were analyzed using SPSS version 26, employing t-tests, means, and standard deviations. The results demonstrated that interactive multimedia tools, such as Canva, Powtoon, and educational games, can significantly impact the learning process. These tools effectively improve the academic achievement of young learners, as evidenced by the marked improvement in post-test scores compared to pre-test scores. Furthermore, interactive multimedia enhances students' cognitive interaction and self-regulation. The study's recommendations emphasized the importance of utilizing multimedia tools and training teachers in the use of information and communication technologies in education.

6. L. M. Angraini and Y. C. Fitri, 2023: This study focused on students' weak mathematical problem-solving abilities was investigated in **[**Angraini and Fitri (2023)]. And it aimed to improve these abilities through the use of interactive multimedia learning materials to support e-learning. This quantitative (quasi-experimental) study was conducted at the Islamic University of Riau (UIR) and Pasir Panjarayan University (UPP). The sample consisted of mathematics education students at URI (the experimental group) and mathematics education students at UPP during the 2021/2022 academic year. The t-test results showed a statistical significance value of 0.025, which is less than 0.05. This indicates an increase in the mathematical problem-solving abilities of students who benefit from using interactive multimedia learning materials.

7. N. Wasi'ah and A. N. Cahyono,2025: A systematic literature review was conducted in [Wasi'ah and Cahyono (2025)] to investigate the impact of interactive multimedia in learning on students' mathematical problem-solving skills. Twenty research papers were reviewed, employing a literature review methodology. Fifteen of these papers were selected from nationally recognized journals (Sinta 1-5) indexed in Scopus and Google Scholar databases, with a particular focus on "interactive multimedia in learning" and "mathematical problem-solving ability." The results demonstrated that interactive multimedia in learning significantly improves students' mathematical problem-solving abilities. Furthermore, the findings showed that integrating interactive multimedia, especially within a problem-based

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learning framework, is considerably more effective than traditional training that does not utilize such media. In conclusion, interactive multimedia in learning is a crucial tool for enhancing mathematics teaching and developing students' critical problem-solving skills.

8. L. Herrera, S. Ordóñez, and S. Ruiz-Loza,2024: Enhancing mathematical education with spatial visualization tools [Herrera et al., (2024)] investigated the integration of spatial visualization tools, virtual environments, and 3D printing into mathematics classes using a sample of 255 students. Using the modified Purdue Spatial Visualization Test (PSVT:R) in a pre- and post-test design, the researchers compared an experimental group with a control group. Their statistical analysis showed that while the control group achieved consistent results ($p = 0.163$, $g = 0.035$), the experimental group demonstrated a significant 25% increase in spatial visualization efficiency ($p < 0.05$, $g = 0.325$). Based on the results of analysis of variance (ANOVA) at a 95% confidence level, the study concluded that utilizing 3D printing and virtual tools significantly improves students' spatial reasoning and mathematical understanding.

9. W. Winarso, Toheri, and T. Udin, 2023: This study aims to analyze the problem of misconceptions in mathematics [Winarso and Udin (2023**)**] by developing interactive multimedia based on the cognitive contradiction strategy. The study employed a design-based research and development methodology, combining qualitative and quantitative data collection methods. The results indicated that the interactive multimedia intervention based on the cognitive contradiction strategy effectively reduced students' misconceptions in mathematics. The findings also demonstrated improved conceptual understanding and increased engagement with the learning process. This research contributes to mathematics education by offering innovative and practical solutions for addressing students' misconceptions. The results suggest the potential of using interactive multimedia based on the cognitive contradiction strategy as an educational approach to enhance conceptual understanding and reduce misconceptions in mathematics.

10. K. H. Pratiwi, R. Situmorang, and T. Iriani, 2024: This study aims to identify the potential and characteristics of interactive multimedia combined with contextual learning (CTL) in teaching mathematics to elementary school students, through a systematic literature review (SLR). The results of the

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analysis show that interactive multimedia combined with CTL has significant potential to improve learning outcomes, motivation, engagement, and understanding of mathematical concepts among elementary school students. CTL also enables students to see how mathematical concepts are applied in everyday life, making the learning process more relevant and engaging. However, the application of interactive multimedia with cooperative learning faces challenges, such as the availability of technological infrastructure and teacher competency. This study suggests that teachers and researchers should recognize that designing and using interactive multimedia with cooperative learning can effectively improve the quality of mathematics learning in elementary school.

11. N. Nurmawati, L. R. Masduki, E. Prayitno, and M. Y. R. Dartani, 2020: The use of interactive multimedia to enhance mathematics learning outcomes and alleviate the limitations of traditional teaching methods was evaluated in [Nurmawati et al., (2020)]. The study included a comparative analysis of fourth-grade students, comparing those taught using interactive multimedia with a control group taught using traditional methods. The experimental results showed a statistically significant difference between the two educational environments, confirming that integrating interactive multimedia—using text, images, animation, and sound—effectively improves students' conceptual understanding and learning outcomes in mathematics.

12. D. P. Amelia and A. Harahap, 2021: applied a quantitative methodology to assess the impact of interactive multimedia learning on students' engagement with mathematics during the COVID-19 pandemic's remote learning environment [**Amelia and Harahap (2021)**]. Using cluster sampling, the researchers tracked academic changes in pre- and post-test scores. Their results indicated that while the control group's performance increased by only 8.60% (from 66.70% baseline to 75.30%), the group exposed to the interactive multimedia framework achieved a significant increase of 29.95%, with their average post-test performance rising from 56.60% baseline to 86.55%. Based on these statistical findings, the researchers concluded that integrating multimedia is an effective mechanism for significantly enhancing students' interest in and academic performance in mathematics.

13. Abdulrahman et al., 2020: conducted a systematic review to examine the effectiveness of various multimedia tools in modern teaching and learning

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processes [Abdulrahman et al., (2020)]. Through a structured process of selecting and evaluating literature based on predefined criteria, the researchers analyzed how integrated digital media improves student performance. Their findings showed that current tools rely heavily on multimedia components such as interactive audio, video, animation, and 3D technology. The researchers concluded that while most multimedia solutions are tailored to specific subjects and audiences, their educational success depends primarily on the specific technologies and structural components incorporated into their software development.

14. Febblina Daryanes and colleagues (2023): conducted a study aimed at developing interactive learning media using the Articulate Storyline program, based on a case study approach, to enhance students' problem-solving skills. The study employed a research and development (R&D) methodology following the ADDIE model. The results showed that the developed educational media achieved high levels of validity and acceptance among experts and contributed to improving students' problem-solving skills, thus confirming the effectiveness of interactive media in supporting learning and developing higher-order thinking skills.

15. Z. Hafizah and K. Samosir (2023) :This study aimed to develop interactive educational media based on the Canva application to enhance students' mathematical problem-solving skills in the area of number patterns. It employed a research and development methodology based on the ADDIE model. The results demonstrated the high validity and reliability of the developed media, as well as its high level of effectiveness, according to teacher and student feedback. Furthermore, the media proved effective in improving academic achievement and developing mathematical problem-solving skills, as evidenced by increased student mastery and improved scores on problem-solving tests. The study recommends utilizing interactive educational media based on the Canva application in mathematics teaching due to its positive impact on enhancing students' mathematical problem-solving abilities.

16. R. A. Sukmawati, M. Pramita, N. Werinda, N. Mahmudah, and A. A. Putri (2022): This study aimed to develop interactive multimedia for teaching the topic of circles to eighth-grade students and to verify its validity, practicality, and effectiveness in the educational process. The study employed

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a research and development (R&D) methodology using the ADDIE model and was implemented with students at a government junior high school in Banjarmasin. The results showed that the developed interactive multimedia achieved high levels of validity, validity, practicality, and effectiveness, confirming its suitability for use in teaching mathematics and contributing to the development of students' mathematical problem-solving abilities.

17. B. S. Hartanto, (2024): This study aimed to review the literature on the use of interactive multimedia in mathematics and science education in Indonesia. It employed a literature review methodology to analyze previous studies, explore the evolution of interactive multimedia use, its development methods, strengths and weaknesses, and the educational outcomes achieved. The study demonstrated that interactive multimedia is an effective ICT-based tool that contributes to supporting the educational process and enhancing student learning by providing an interactive learning environment that meets learners' needs, particularly in mathematics and science.

18. W. A. B. Sutomo and Turmudi,(2024): This study aimed to provide a systematic review of the literature on the application of interactive multimedia and its impact on mathematics learning outcomes. The researchers employed a systematic literature review methodology, analyzing studies published between 2019 and 2023. The results revealed 188 studies addressing the use of interactive multimedia in mathematics education across various educational levels. The study also demonstrated that the use of interactive elements such as animation, audio, video, and simulations contributes to improving the understanding of mathematical concepts and raising students' academic achievement. Furthermore, the study indicated that the research and development (R&D) approach was the most frequently used methodology in studies related to interactive multimedia.

7. Result and Dissection:

Based on the previously analyzed and reviewed studies, from Sulaiman's (2023) to Sutomo and Tormody's (2024), we can move to the discussion and comparative analysis phase to identify common research patterns, pinpoint prevailing scientific trends, and analyze the impact of interactive multimedia on developing mathematical problem-solving skills and improving learning outcomes.

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The analysis revealed that previous studies can be categorized into three main, interconnected areas. The first area comprises developmental studies that adopted instructional design models, particularly the ADDIE model, such as the studies by Putri et al. (2022), Daryanes et al. (2023), Hafizah and Samosir (2023), and Sukmawati et al. (2022). These studies focused on developing interactive multimedia learning environments and verifying their validity, practicality, and effectiveness. Their results confirmed that designing interactive media based on sound educational and technical principles directly contributes to improving mathematics learning and developing problem-solving skills.

The second axis consists of experimental and quasi-experimental studies, such as those by Adeyele (2024), Angraini and Fitri (2023), Nurmawati et al. (2020), Amelia and Harahap (2021), Herrera et al. (2024), and Windhyastuti et al. (2026). These studies focused on measuring the actual impact of interactive multimedia within the educational environment by comparing experimental and control groups and using various statistical analyses. The results consistently showed the superiority of the groups that used interactive multimedia in terms of academic achievement, conceptual understanding, spatial visualization skills, self-directed learning, and mathematical problem-solving abilities.

The third axis consists of studies based on systematic literature reviews, such as those by Abdulrahaman et al. (2020) and Pratiwi et al. (2024), Wasi'ah and Cahyono (2025), Hartanto (2024), and Sutomo and Turmudi (2024) provided a comprehensive overview of the evolution of interactive multimedia in education. These studies emphasized that the effectiveness of these technologies depends on the quality of their design, their degree of interaction with learners, and their integration with modern educational strategies.

The comparative analysis also demonstrated the evolution of the concept of interactive multimedia from mere tools for displaying text, images, and animations to integrated digital learning environments that support active learner interaction and participation. This is evident in the study by Pratiwi et al. (2024), which integrated multimedia with contextual learning (CTL); the study by Winarso et al. (2023), which employed a cognitive conflict strategy to address misconceptions in mathematics; and the study by Herrera et al.

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(2024), which integrated spatial visualization tools, virtual environments, and 3D printing into mathematics learning.

Despite variations in educational environments, grade levels, and tools, most studies agree that interactive multimedia plays a pivotal role in improving academic achievement, increasing learning motivation, developing mathematical thinking, and enhancing problem-solving skills. The results also indicate that integrating multimedia with modern teaching strategies such as problem-based learning, contextual learning, and self-directed learning yields better results than using interactive media in isolation.

Therefore, it can be concluded that interactive multimedia represents one of the most effective trends in developing mathematics education, and its success depends not only on the technical aspects but also on appropriate instructional design, its integration within effective teaching strategies, and the provision of a supportive learning environment that allows learners to interact, participate, and actively construct knowledge.

7.1 Table of systematic comparison between pivotal studies

Based on the studies included in the systematic review of the literature, the following table shows a structured comparison between the selected studies according to a set of key criteria, including the study's objective, the methodology used, the target sample, the educational tool or technology used, and the most important findings, which contributes to forming a comprehensive view of research trends in the field of interactive multimedia and mathematics education

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Table (1): Systematic Comparison of Previous Studies on Interactive Multimedia in Mathematics Education

Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
Suleiman (2023)	Investigate the possibility of using multimedia in mathematics teaching	Descriptive	50 teachers	Questionnaire	Multimedia improved academic achievement; administrative and technical barriers existed.
Putri et al. (2022)	Develop mathematics learning media using Macromedia Flash 8	ADDIE Development Model	Grade 9 students	Macromedia Flash 8	High validity (86.57%) and practicality (89.53%).
Windhyastuti et al. (2026)	Develop interactive multimedia using Articulate Storyline	Development and Evaluation	Fourth-grade students	Articulate Storyline	Improved problem-solving and self-learning skills.
Adeyele (2024)	Compare the effectivene	Quasi-experimental	8 schools	Interactive multimedia	Interactive multimedia was most

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Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
	ss of simulation games, blended learning, and interactive multimedia				effective in mainstream schools.
Cherif (2025)	Examine the impact of interactive multimedia on achievement and academic behavior	Mixed-method	Young learners	Canva, Powtoon, educational games	Enhanced achievement, cognitive interaction, and self-regulation.
Angraini and Fitri (2023)	Improve mathematical problem-solving skills	Quasi-experimental	University students	Interactive e-learning multimedia	Significant improvement in problem-solving ability.
Wasi'ah and	Investigate the effect of interactive	Systematic Literature	20 studies	Literature analysis	Interactive multimedia significantl

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Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
Cahyono (2025)	multimedia on problem-solving skills	Review (SLR)			y improved problem-solving skills.
Herrera et al. (2024)	Enhance spatial visualization in mathematics	Quasi-experimental	255 students	Virtual environments and 3D printing	25% increase in spatial visualization efficiency.
Winarso et al. (2023)	Address mathematical misconceptions	Design-based R&D	Mathematics students	Cognitive conflict-based multimedia	Reduced misconceptions and improved conceptual understanding.
Pratiwi et al. (2024)	Explore the potential of multimedia integrated with contextual learning	SLR	Published studies	CTL and Multimedia	Improved achievement, motivation, and conceptual understanding.

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Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
Nurmawati et al. (2020)	Improve mathematics learning outcomes	Experimental	Fourth-grade students	Interactive multimedia	Experimental group outperformed the control group.
Amelia and Harahap (2021)	Increase students' interest in mathematics during remote learning	Quantitative	School students	Interactive multimedia	Achievement increased by 29.95%.
Abdulrahaman et al. (2020)	Review multimedia tools in education	Systematic Review	Previous studies	Various digital media	Multimedia effectiveness depends on technological components.
Daryanes et al. (2023)	Develop interactive learning media to improve problem-	ADDIE-based R&D	Students	Articulate Storyline	Highly effective in developing problem-solving skills.

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Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
	solving skills				
Hafizah and Samosir (2023)	Develop Canva-based educational media	ADDIE-based R&D	Grade 8 students	Canva	Improved achievement and problem-solving skills.
Sukmawati et al. (2022)	Develop interactive multimedia for teaching circles	ADDIE-based R&D	Junior high school students	Interactive multimedia	High validity, practicality, and effectiveness.
Hartanto (2024)	Review the use of interactive multimedia in mathematics and science education	Literature Review	Published studies	Literature analysis	Interactive multimedia effectively supports learning.
Sutomo and Turmudi (2024)	Review the impact of interactive multimedia on	Systematic Literature Review	188 studies	Literature analysis	Improved mathematical understanding and

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Author(s) & Year	Objective	Methodology	Sample	Tool/Technology	Key Findings
	mathematics learning outcomes				academic achievement.

Reference	Methodology	Target Variables	Key Technological Components	Main Finding
Pratiwi et al. [10]	Systematic Literature Review (SLR)	Contextual Teaching and Learning (CTL) + Interactive Multimedia	Contextual digital environments and simulations	Bridging the gap between abstract mathematical concepts and real-life applications.
Nurmawati et al. [11]	Experimental with comparative data	Learning outcomes + Student motivation	Text, images, animation, video, and audio	Clear statistical superiority for the experimental group and mitigating mathematics anxiety.

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Reference	Methodology	Target Variables	Key Technological Components	Main Finding
Amelia & Harahap [12]	Quantitative Classroom Effect Study	Student interaction + Learning outcomes during crises	Integrated interactive multimedia models	A surge in the experimental performance by \$29.95\%\$, compared to only \$8.60\%\$ for the conventional approach.
Abdulrahaman et al. [13]	Systematic Literature Review (SLR)	Academic performance + Providing quality education access	Audio, video, animation, and 3D technologies	The success of digital tools is directly attributed to the quality of the technical/engineering components integrated into them.

Based on the preceding comparison and discussion, a set of key findings can be drawn that constitute the scientific justification for the current study. First, the results demonstrated a clear statistical advantage for interactive media. The numerical data, particularly the quantitative results in study [Amelia and Harahap (2021)], showed that learning environments supported by interactive media achieved a remarkable leap in conceptual understanding. The net growth in student achievement in the experimental groups was more than three times that achieved by students in traditional classrooms (29.95% versus 8.60%), confirming the powerful impact of these media on improving

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academic performance. Second, multimedia is no longer merely a tool for improving grades; it has become an effective therapeutic and preventative tool. It has proven its ability to dismantle deeply ingrained "mathematical misconceptions" [Winarso and Udin (2023], in addition to its role in addressing "mathematical phobia" and traditional educational apathy, by enhancing interaction and raising the level of intrinsic motivation among learners [Nurmawati et al., (2020)].]. Third, major systematic reviews [Abdulrahman et al., (2020)] underscore the importance of quality engineering and technological construction in educational software design. The success of any mathematics education system depends on the degree to which advanced technologies, such as two-dimensional and three-dimensional graphics and motion simulation, are systematically integrated. This means that simply displaying static digital text is no longer sufficient to produce effective learning.

Finally, the current research gap lies in the absence of unified structural frameworks that integrate interactive media, contextual learning, and misconception correction within a single applied model for teaching mathematics. This is what the current study aims to address.

8. Recommendations

Based on the results of the systematic review and comparative analysis of the studies included in this review, from Sulaiman (2023) to Sutomo and Tormody (2024), and taking into account the shared findings and identified research gaps, the following recommendations are proposed:

1. Recommendations for Practitioners and Teachers (Educational Practice)

It is recommended to expand the integration of interactive multimedia technologies in mathematics teaching across different educational stages, given their proven effectiveness in improving academic achievement, conceptual understanding, and students' mathematical problem-solving abilities (Potri et al., 2022; Angrini and Vetri, 2023; Nurmawati et al., 2020). Teachers are also encouraged to adopt interactive learning environments supported by digital tools such as Articulate Storyline, Canva, and simulation applications to promote active learning, self-directed learning, and student engagement (Windhyastuti et al., 2026; Hafizah and Samosir, 2023; Sherif, 2025).

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Furthermore, mathematics teachers should use multimedia-based teaching strategies that connect abstract mathematical concepts to real-life situations and practical applications, thereby increasing student motivation and facilitating effective learning (Pratiwi et al., 2024). Interactive multimedia can also be used as an educational tool to identify and address students' misconceptions through visualization, animation, and cognitive contrast-based activities (Winarso et al., 2023).

2. Recommendations for Curriculum Designers and Educational Technology Developers

Curriculum developers are encouraged to integrate interactive multimedia components as an integral part of the mathematics curriculum, rather than as supplementary resources. Particular attention should be paid to integrating visual representations, simulations, animations, virtual environments, and problem-solving-based learning activities that support higher-order thinking skills and mathematical problem-solving (Herrera et al., 2024; Wasiya and Kahyuno, 2025).

Instructional software developers should focus on designing learner-centered multimedia environments that combine ease of use, interactivity, and pedagogical effectiveness. The results of numerous studies indicate that the educational value of multimedia is closely linked to the quality of its instructional and technical design, including its audio, video, animation, and visualization characteristics (Abdulrahman et al., 2020). Furthermore, flexible platforms capable of supporting in-person, blended, and remote learning modes should be developed to ensure continuity of learning under varying educational conditions (Amelia and Harahap, 2021).

3. Recommendations for Researchers and Future Studies

Future research is recommended to explore the integration of interactive multimedia with emerging technologies, such as artificial intelligence, adaptive learning systems, virtual reality, and augmented reality, to provide personalized mathematics learning experiences and enhance students' problem-solving skills. Researchers are also encouraged to conduct longitudinal studies to examine the long-term effects of interactive multimedia on mathematical achievement, concept understanding, critical thinking, and problem-solving abilities.

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Furthermore, more comparative studies are needed to evaluate the effectiveness of different multimedia design models, teaching strategies across various educational stages, and learner characteristics. Future systematic reviews could also explore the relationships between multimedia design principles, learner engagement, and learning outcomes in mathematics education to provide more comprehensive evidence to support educational decision-making.

9. Conclusion:

This study aimed to review and analyze the scientific literature on the impact of interactive multimedia on developing mathematical problem-solving skills through a systematic review of published studies in this field. The results of the analysis showed that interactive multimedia is one of the most effective educational methods for improving mathematics learning, contributing to raising academic achievement levels and developing mathematical thinking and problem-solving skills among learners at various educational levels.

Despite the differences in research methodologies, samples, and tools used in previous studies, most agreed that interactive multimedia has a significant positive impact on developing mathematical problem-solving skills and improving learning outcomes. The review also revealed a growing interest in developing interactive digital learning environments based on integrated educational and technological foundations, reflecting a shift from using technology as a support tool to considering it a fundamental component in designing the educational process.

Based on these findings, it can be concluded that interactive multimedia represents a promising approach to developing mathematics education and enhancing 21st-century skills in learners. Furthermore, there is a need for further research exploring the integration of interactive multimedia with emerging technologies, such as artificial intelligence, virtual reality, and augmented reality, and examining their long-term effects on academic achievement and the development of mathematical problem-solving skills in diverse educational contexts.

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