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Trends in the Use of Learning Media to Improve Students' Mathematical Problem-Solving Skills: A Systematic Literature Review

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Abstract

While mathematical problem-solving is a critical competency supported by innovative learning media, existing reviews lack a specific mapping of instructional design models, effectiveness indicators, and the depth of students' cognitive exploration. This study aims to identify research method trends, indicators of learning media effectiveness, and the exploration of students' mathematical thinking. Employing a Systematic Literature Review (SLR) via the PRISMA protocol, articles were retrieved from Google Scholar, Crossref, and Semantic Scholar. These open-access databases were purposely selected to ensure the comprehensive capture of regional applied development studies frequently omitted in premium databases like Scopus and WoS. Out of 1,313 initially identified articles, 23 met the inclusion criteria. The findings reveal a consistent positive trend in improving procedural problem-solving, predominantly driven by Research and Development (R&D) utilizing the ADDIE model and evaluated through validity, practicality, and N-Gain. However, the literature treats cognitive processes as a "black box," measuring mathematical thinking almost exclusively through quantitative scores while leaving metacognitive monitoring and cognitive obstacles unexamined. A primary methodological limitation of this review is its exclusive reliance on open-access databases. Therefore, future research must shift from score-centric evaluations to comprehensive cognitive analyses, integrating qualitative approaches to examine reasoning trajectories and embedding metacognitive features in media design.

Keywords: learning media, mathematical problem-solving, systematic literature review, mathematical thinking

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1. Introduction

While mathematical problem-solving is widely recognized as a critical competency, the rapid proliferation of digital and physical learning media has created a highly fragmented landscape of instructional solutions. To effectively support this cognitive skill, the educational research community needs to synthesize how these diverse pedagogical innovations are currently being developed, evaluated, and implemented in mathematics classrooms. Although researchers like Laraswati et al. (2023) emphasize the need for active knowledge construction, a systematic understanding of which media designs truly facilitate this process remains scattered across primary studies.

As foundational background, prior to the current rapid digital shifts, primary literature has extensively documented the effectiveness of various mathematical learning media. These historical examples range from the development of digital media in the form of Android-based educational games (Ardani et al., 2020), to the use of environment-based physical media integrated with local wisdom values, as revealed by Parwati et al. (2019). Although innovations such as Problem-Based Learning (PBL) modules and e-learning (Suastra et al., 2019), then gamified learning models (Utami & Harahap, 2026) have been empirically proven to improve students' problem-solving skills, their practical implementation in the field still faces several obstacles. Suarsana et al. (2021) highlight that students' cognitive processes in solving problems are not always seamless. This is supported by Mariawan and Parwati (2018), who found that students frequently make significant errors during the planning and execution stages of problem-solving. For instance, students with hearing impairments often experience linguistic difficulties at the stage of reading word problems before they can perform computational procedures. Furthermore, the existing literature indicates a wide variation in measurement methods, such as the differing outcomes when teachers employ authentic assessments compared to conventional assessments.

Although prior meta-analyses have investigated technology integration in mathematics education (e.g., Laraswati et al., 2023), they predominantly catalog existing studies based on media types or treat problem-solving as a peripheral outcome. A critical research gap remains, there is a scarcity of systematic reviews that critically evaluate the pedagogical design methodologies alongside the depth of cognitive exploration facilitated by these media. Merely cataloging educational products offers limited theoretical contribution if it fails to expose how these technological tools actually interact with students' reasoning trajectories. Without addressing this void, educators and media developers will continue to struggle in designing innovations that scaffold deep mathematical understanding. To substantiate this gap and articulate a clear original contribution, this study moves beyond descriptive summaries by applying a novel tripartite analytical framework. This review systematically examines three interrelated dimensions: (1) the instructional design models driving media development, (2) the prevailing quality and effectiveness metrics, and crucially, (3) the extent to which current literature qualitatively captures students' mathematical thinking processes rather than merely reporting aggregated scores. By synthesizing these dimensions, this study

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produces novel insights that expose a major methodological blind spot in contemporary educational design research, namely, the over-reliance on quantitative outcomes at the expense of qualitative cognitive mapping. Ultimately, this Systematic Literature Review (SLR) aims to establish a more rigorous foundation for shifting from score-centric to process-centric instructional media design.

2. Methods

This study employs a SLR utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to ensure a comprehensive, transparent, and reproducible methodology. The review process was designed to synthesize prior studies in response to the formulated research questions.

2.1. Search Strategy and Database Selection

An exhaustive literature search was conducted on July 20, 2026. Articles were retrieved from three databases: Google Scholar, Crossref, and Semantic Scholar, utilizing the Publish or Perish (PoP) software to ensure a broad coverage of regional and open-access publications. The exact search string applied across these databases (adapted to the title and keyword fields) was: ("pengembangan media" OR "media pembelajaran" OR "developing media" OR "learning media") AND ("problem solving" OR "pemecahan masalah") AND ("matematika" OR "mathematics"). The search was strictly limited to publication dates between January 1, 2021, and July 20, 2026.

2.2. Eligibility Criteria and Quality Assessment

The inclusion and exclusion criteria are detailed in Table 1. To ensure study quality, the articles had to be indexed in at least SINTA 4 or Scopus. "Reputable proceedings" were defined as conference papers published by recognized international publishers, such as IOP, AIP, or IEEE, that are indexed in Scopus. The indexing status and journal quartiles were verified directly and manually on the exact search date (July 20, 2026) using the official SINTA website and the Scopus database. While specific journal quartiles were recorded during data extraction, the minimum threshold for inclusion was set at SINTA 4 or any Scopus quartile.

Table 1.
Inclusion and Exclusion Criteria for Articles

Inclusion Criteria	Exclusion Criteria
Articles published within the last 5 years (January 1, 2021, to July 20, 2026)	Articles not published within the last 5 years (published before 2021)
Articles written in Indonesian or English	Articles not written in Indonesian or English
Articles containing the following keywords: "pengembangan media" OR "media pembelajaran" OR "developing media" OR	Articles that do not contain the keywords: "pengembangan media" OR "media pembelajaran" OR "developing media" OR

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"learning media" AND "problem solving" OR "pemecahan masalah" AND "matematika" OR "mathematics"	"learning media" AND "problem solving" OR "pemecahan masalah" AND "matematika" OR "mathematics".
Articles discussing mathematical content or topics	Articles that do not discuss mathematical content
Open-access articles	Inaccessible articles (restricted access)
Relevant document types (i.e., research articles or conference proceedings)	Document types other than journal articles or conference proceedings
Articles indexed at least in SINTA 4, Scopus, or published in reputable proceedings	Articles indexed below SINTA 4, non-Scopus, or published in non-reputable proceedings
Primary research articles	Duplicate articles
Articles examining the effectiveness of the media	Articles that do not examine the effectiveness of the media

2.3. Study Selection and Screening Procedure

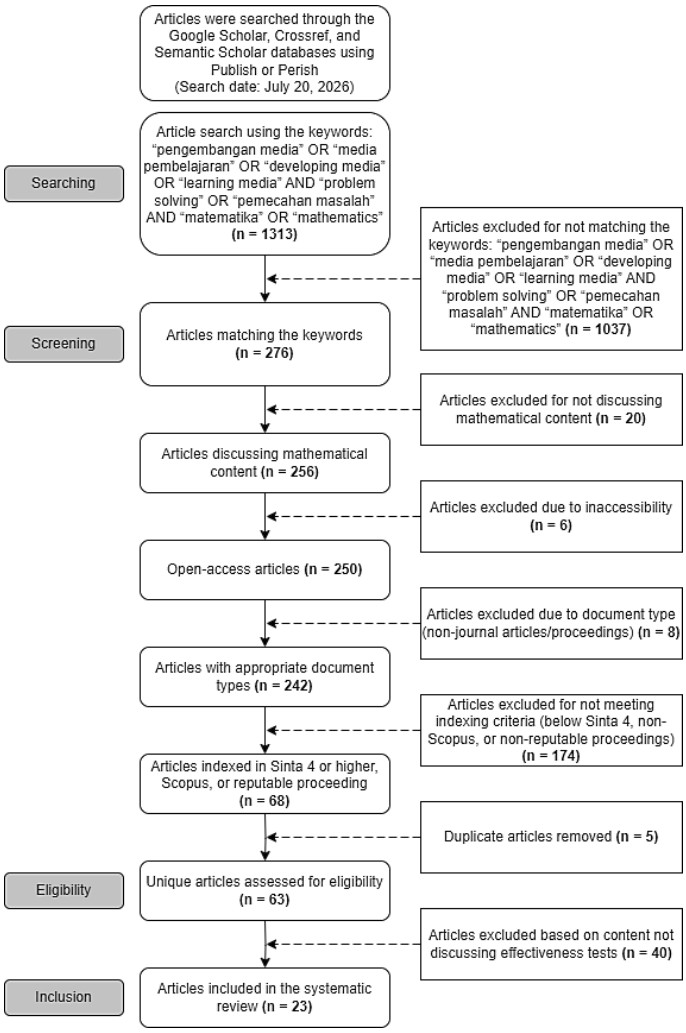
The screening procedure was primarily conducted by the first author. Initially, all retrieved records were exported to a spreadsheet, where the duplicate-removal procedure was conducted both automatically via PoP and manually by comparing titles and authors. Following this, the title/abstract screening procedure was performed to eliminate articles clearly irrelevant to mathematical problem-solving or those lacking media development. Subsequently, a full-text screening procedure was conducted to thoroughly assess the methodology, indexing validity, and the presence of media effectiveness tests. Any uncertainties or conflicts during the screening phases were resolved through discussion and validation with the co-authors (the second, third, and fourth authors).

2.4. Data Extraction and Quality Assessment

The initial stage of the literature search focused on studies examining learning media for students' mathematical problem-solving skills, utilizing the Google Scholar, Crossref, and Semantic Scholar databases with the assistance of the PoP software. Following the PRISMA protocol, a collection of relevant articles (n = [insert number of articles]) was retrieved, as illustrated in Figure 1 below.

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Figure 1.
PRISMA Flow Diagram for the SLR



The literature search, limited to the last five years (from January 1, 2021, to July 20, 2026) across the Google Scholar, Crossref, and Semantic Scholar databases, yielded a total of 1,313 articles. These records were retrieved separately from each database as follows: Google Scholar (n = 1000), Crossref (n = 117), and Semantic Scholar (n = 196). Subsequently, the articles were screened, resulting in the exclusion of 1,037 articles that did not match the keywords, leaving 276 articles. Following this, 20 out of the 276 articles were excluded as they did not focus on mathematical content, yielding 256 eligible articles. Then, 6 articles were excluded due to inaccessibility, resulting in 250 articles. Furthermore, 8 articles were removed as they were not journal articles or conference proceedings, leaving 242 articles. Afterward, 174 articles were excluded for being

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indexed below SINTA 4, not indexed in Scopus, or not published in reputable proceedings, resulting in 68 suitable articles. Next, 5 articles were removed due to duplication, leaving 63 articles. Finally, 40 out of the 63 articles were excluded because they did not examine effectiveness, yielding a final set of 23 articles eligible for inclusion in this review. The review of these 23 included articles is utilized to address the following Research Questions (RQs): *RQ1: What are the trends in the research methods used to improve students' mathematical problem-solving skills with the assistance of learning media? RQ2: What are the indicators of effectiveness for learning media in enhancing students' problem-solving skills? RQ3: To what extent has the existing literature explored students' mathematical thinking during the process of using learning media?*

To answer the RQs, a standardized data extraction procedure was used to collect information on authors, year, publication source, research method, effectiveness indicators, and the exploration of mathematical thinking. Furthermore, because RQ3 is substantially qualitative, a clear coding framework was established to prevent subjectivity. A study was coded as "exploring mathematical thinking" if it met at least one of the following criteria: (a) it utilized qualitative methods to analyze students' step-by-step reasoning during media use, or (b) it explicitly measured specific cognitive sub-dimensions rather than merely reporting an aggregated final quantitative score, such as N-Gain, for procedural problem-solving.

3. Result and Discussion

The findings of this SLR focus on the 23 relevant articles previously identified, which were sourced from the Google Scholar, Crossref, and Semantic Scholar databases utilizing the PRISMA protocol. These data were derived from the identification of open-access articles published between 2021 and 2026 in relevant journals and proceedings. A summary of the review of these 23 articles is presented in Table 2 below.

Table 2.
Data Extraction of the Included Studies

Authors & Year	Media Type & Learning Model	Research Method & Design	Effectiveness Indicators & Results	Mathematical Thinking Explored
Ulia et al. (2022)	Digital learning media ("Ancermat")	R&D	Valid, practical, and effective	Problem-solving, Mathematical representation
Putri et al. (2022)	PBL-based media integrated with self-confidence	R&D	Valid (87.5%), Practical (90.2%), N-Gain 0.48 (Medium)	Problem-solving, Self-confidence (Affective)

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Yuswar et al. (2023)	Instructional materials / Discovery Learning	R&D	Valid (RPP 3.51), Practical (91.88%)	Problem-solving
Ardani & Amaral (2022)	Pop-Up Book / PBL	Experiment	Significantly improves problem-solving	Problem-solving, Curiosity (Affective)
Mekarsariningtyas & Rizqi (2024)	Canva animated video / Problem Solving	Experiment	Strong influence on learning outcomes	Problem-solving, Systematic/Creative thinking
Adiastuty et al. (2025)	Canva-based interactive e-module	R&D	Valid (94.67%), Practical (90%), significant N-Gain	Problem-solving
Vinasti et al. (2024)	Articulate Storyline	R&D	10 essay questions based on Polya's stages	Problem-solving (Polya), Independent learning
Alfayani et al. (2025)	Powtoon / PBL (Ethnomathematics)	Experiment	Effective (t-test significance 0.003)	Problem-solving
Sari & Setiawan (2024)	Manipulative media ("Kebun Hitung")	R&D	Practical (100%), average score 88%	Problem-solving (Polya's 4 stages)
Zai et al. (2024)	Liveworksheet LKPD	R&D	Highly valid (>90%), effective	Problem-solving (Polya)
Marpaung & Samosir (2025)	E-module / PBL	R&D	Valid, Practical (94.54%), N-Gain 54% high	Problem-solving
Sukmarani et al. (2025)	Interactive media / PBL	R&D	Valid (97.2%), N-	Problem-solving

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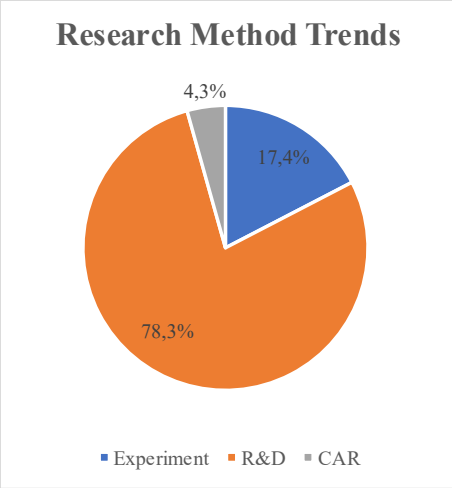
			Gain 1 (High category)	
Nurhidayah (2021)	Online media / VARK Learning Style	Experiment	Score increase from 56.25 to 89.5	Problem-solving, Conceptual understanding
Amalia et al. (2025)	E-module with scientific calculator / PBL	R&D	Effective in improving skills	Problem-solving
Irmaya et al. (2024)	Mathematical e-comic / PBL	R&D	Valid, practical, effective	Problem-solving, Learning interest
Wilandari et al. (2024)	Augmented Reality e-module / PBL	R&D	Significant score improvement	Problem-solving, Abstract concept visualization
Nufus & Muliana (2024)	Student worksheets (LKPD) / PBL	R&D	Highly valid (91.89%), Practical (89%)	Problem-solving
Sarman et al. (2023)	Electronic LKPD	R&D	Classical learning mastery rate 88%	Problem-solving
Pratiwi et al. (2024)	Interactive instructional media / PBL	R&D	Valid, practical, fairly effective	Problem-solving
Ningrum et al. (2026)	Gamification-based card media	CAR (Kemmis & McTaggart)	Mastery increases from 14.81% to 81.48%	Problem-solving, Student engagement
Nurhalimah et al. (2026)	Android-based interactive media / PBL	R&D	Highly valid, highly practical, effective	Problem-solving
Riani et al. (2022)	STEM-based materials (GeoGebra)	R&D	Highly valid, practical, effective	Problem-solving
Febrianti et al. (2024)	Interactive e-module / PBL	R&D	Valid, practical, effective	Critical thinking skills

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3.1. Trends in The Research Methods Used to Improve Students' Mathematical Problem-Solving Skills with The Assistance of Learning Media

An analysis of the research methods employed in the 23 articles reveals a significant shift in the research paradigm, transitioning from an experimental-verificative approach toward a developmental-productive one. Developmental research methods (R&D) have emerged as the predominant approach, particularly in articles published from 2022 onwards. This indicates that the research orientation has shifted from merely evaluating the impact of instructional media to actively designing and producing the media products themselves. A visual representation of the distribution of the employed research methods is illustrated in Figure 2.

Figure 2.
Trends in Research Methods Used



The most widely adopted development model is ADDIE, applied in over half of the articles and encompassing almost all educational levels from elementary to senior high school. At the elementary school level, ADDIE is applied in research developing PBL Android-based interactive media (Nurhalimah et al., 2026), student worksheets (LKPD) utilizing Liveworksheet (Zai et al., 2024), the manipulative media "KEBUN HITUNG" (Sari & Setiawan, 2024), PBL E-Comics (Irmaya et al., 2024), and PBL-based interactive media for fourth-grade elementary students (Sukmarani et al., 2025). At the junior high school level, ADDIE is utilized for developing electronic student worksheets (E-LKPD) on curved surface 3D shapes (Sarman et al., 2023) and an e-module assisted by a scientific calculator for exponential topics (Amalia et al., 2025). Meanwhile, at the senior high school level, ADDIE is also implemented through the development of PBL interactive media integrated with self-confidence character building for trigonometry topics in the eleventh grade of SMA Negeri 5 Padang (Putri et al., 2022). The consistent use of ADDIE across

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articles and educational levels indicates that this model has become an established standard in the development of mathematics learning media in Indonesia.

An alternative development model that is also widely applied is the three-phase Plomp model, the use of which is not limited to the PBL approach. In articles employing the PBL approach, the Plomp model is applied for the development of STEM instructional materials utilizing GeoGebra (Riani et al., 2022) and PBL-oriented interactive media (Pratiwi et al., 2024). The analysis results reveal that the Plomp phases encompass preliminary investigation, prototyping with several iterations, and extensive assessment involving larger subject groups. For example, progressing from 26 students in a limited trial, to 35 students in field test I, and up to 43 students in field test II (Pratiwi et al., 2024). It is interesting to note that Plomp is also applied in articles using approaches other than PBL, namely an article developing Discovery Learning-based instructional materials to enhance the problem-solving skills of eighth-grade students at SMPN 34 Padang on statistics topics (Yuswar et al., 2023). This demonstrates the flexibility of the Plomp model, which can be adapted not only for the PBL approach but also for Discovery Learning. Furthermore, Thiagarajan's 4-D model is employed in articles concerning a PBL interactive e-module on flat-surface 3D shapes (Febrianti et al., 2024) and PBL-based student worksheets (LKPD) for statistics (Nufus & Muliana, 2024).

On the other hand, not all articles follow the PBL approach. One article at the elementary school level implements the Problem Solving model (distinct from PBL) utilizing Canva animated video media for students in classes III A and III B (Mekarsariningtyas & Rizqi, 2024). This approach explicitly differentiates itself from PBL by focusing on the problem-solving process as a model of thinking rather than as problem-based learning. In articles utilizing the Discovery Learning model, despite not employing PBL, the ultimate goal remains the same: enhancing problem-solving skills through a series of systematic development phases (Yuswar et al., 2023). Quasi-experimental methods and t-tests are still utilized in articles focusing on effectiveness verification, such as in an article on ethnomathematics-based Powtoon for fractions demonstrating a significance of 0.003 (Alfayani et al., 2025), and the implementation of VARK learning styles among junior high school students (Nurhidayah, 2021). The use of the Kemmis and McTaggart model in a two-cycle Classroom Action Research (CAR) is also still found, for instance, in an article on gamification card media involving 27 students (Ningrum et al., 2026). This longitudinal pattern clearly indicates that recent years have been dominated by Research and Development (R&D) utilizing the ADDIE model and integrating modern digital technology. However, there remains a diversity of approaches in terms of both the development models and the underlying instructional models of the media.

3.2. Indicators of Effectiveness for Learning Media in Enhancing Students' Problem-Solving Skills

Indicators of the effectiveness of learning media in improving students' problem-solving skills demonstrate a fairly strong consensus on the standard quality criteria for educational design

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research (often rooted in Nieveen's framework), which consist of three primary aspects: validity, practicality, and effectiveness. Validity is measured through validation sheets by subject matter experts and media experts, where a score of 80% and above indicates highly valid criteria. Consistent findings of high validity are observed across the majority of the articles. For instance, a score of 91.89% from media experts and 80.14% from subject matter experts for PBL-based student worksheets (LKPD) meeting the highly valid criteria (Nufus & Muliana, 2024), 94.67% from subject matter experts and 91.54% from media experts for the Canva e-module (Adiastuty et al., 2025), and 97.2% from subject matter experts alongside 97.6% from media experts for PBL interactive media (Sukmarani et al., 2025). In an article on the development of PBL media integrated with self-confidence character building, the average validity reached 90.7% (highly valid), specifically comprising 89.28% from subject matter experts and 88.3% from language experts (Putri et al., 2022). Meanwhile, for Discovery Learning-based articles, validity utilized a different scale, yielding an average of 3.51 for the lesson plans (RPP) and 3.46 for the student worksheets (LKPD), both meeting the valid criteria (Yuswar et al., 2023). Furthermore, in the Canva-assisted Problem Solving article, validation was conducted by two teacher validators, resulting in an average score of 4.0 and an excellent criterion (Mekarsariningtyas & Rizqi, 2024). However, direct comparisons of these percentages and scores across studies must be interpreted with caution. The reviewed manuscripts utilized different validation instruments, varying rating scales, diverse minimum criteria for determining validity categories, and differing numbers of expert validators. Therefore, these validation percentages should be viewed as general trends indicating that the developed media have met their respective local feasibility standards, rather than as absolute, universally comparable metrics.

Practicality serves as the second pillar, evaluated based on teacher and student responses, where response criteria exceeding 80% indicate high practicality. Prominent practicality findings include a 100% student response for the "KEBUN HITUNG" media, indicating highly practical criteria (Sari & Setiawan, 2024), a 90% teacher response and an 86% student response for the Canva e-module (Adiastuty et al., 2025), and a 94.54% teacher response alongside an 83.63% student response for the eighth-grade PBL E-Module (Marpaung & Samosir, 2025). Specifically, in the article concerning self-confidence integrated PBL media, practicality reached 100% from educators and 85% from learners, categorized as highly practical and practical, respectively (Putri et al., 2022). In the Discovery Learning article, the practicality of the lesson plans (RPP) reached 91.88% and the student worksheets (LKPD) 90.24%, with small group observations achieving 90% under the highly practical category (Yuswar et al., 2023).

The third pillar, effectiveness, is tested through problem-solving skills using Polya's stages as the primary measurement instrument, which encompasses four aspects: understanding the problem, devising a plan, carrying out the plan, and looking back. This Polya-based instrument is consistently used in the "KEBUN HITUNG" article with an average score of 88% across all four aspects (Sari & Setiawan, 2024), in the Liveworksheet LKPD comprising 5 essay questions (Zai et al., 2024), and in the Articulate Storyline media featuring 10 essay questions aligned with Polya's

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four indicators (Vinasti et al., 2024). The effectiveness of the media is reinforced through normalized N-Gain analysis, paired sample t-tests, or independent sample t-tests. The analysis results reveal significant findings. For instance, an N-Gain of 1 categorized as high for the Phase B PBL interactive media (Sukmarani et al., 2025), a high category improvement for 54% of students and a medium category for 46% of students using the eighth-grade PBL e-module (Marpaung & Samosir, 2025), and pretest-to-posttest results indicating that the problem-solving skills in the PBL Powtoon control group were significantly lower than those in the experimental group (Alfayani et al., 2025). In the article regarding self-confidence integrated PBL media, an N-Gain of 0.48 in the medium category was observed, which is slightly lower than other N-Gain findings, yet it still demonstrates effectiveness as it exceeds the predetermined threshold (Putri et al., 2022). Supporting indicators from several articles incorporate aspects of student activity and engagement (Ningrum et al., 2026), increased learning interest following the intervention with PBL E-Comics (Irmaya et al., 2024), curiosity (Ardani & Amaral, 2022), self-confidence integrated into the media design (Putri et al., 2022), and conceptual understanding skills measured simultaneously with problem-solving, exhibiting an average increase from 56.25 to 89.5 in the VARK article (Nurhidayah, 2021). In the Discovery Learning article, effectiveness data were derived from students' learning outcomes in the form of a final test on problem-solving skills, with the instrumentation still utilizing Polya's framework (Yuswar et al., 2023).

3.3. Existing Literature Explored Students' Mathematical Thinking During The Process of Using Learning Media

To rigorously map the extent to which existing literature explores students' mathematical thinking, the 23 included studies were coded against five explicit analytical categories. Furthermore, to provide a precise methodological critique, this review distinguishes between cognitive dimensions that were not measured, processes that were measured quantitatively, and processes that were examined qualitatively.

1. **Problem-Solving Stages and Strategy Selection**
   This category is the most dominant, with direct evidence found in 20 out of 23 studies. Most media products evaluate problem-solving using Polya's four stages as the primary indicator (e.g., Sari & Setiawan, 2024; Vinasti et al., 2024; Zai et al., 2024). However, a critical distinction must be made: these processes are overwhelmingly measured quantitatively through final essay scores, normalized gain (N-Gain), and t-tests. The actual qualitative process of how students select their strategies during media interaction is largely treated as a "black box" and not qualitatively examined.
2. **Mathematical Representation and Conceptual Reasoning**
   Direct evidence for this category was identified in 5 studies. For instance, the utilization of "Ancermat" digital media explicitly targeted mathematical representation (Ulia et al., 2022), while the VARK online media measured conceptual understanding (Nurhidayah, 2021). The Augmented Reality e-module (Wilandari et al., 2024) specifically facilitated the reasoning of abstract concepts. Similar to the first category, the exploration in these studies relied on

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quantitative measurement (pretest-posttest score improvements) rather than an in-depth qualitative analysis of how conceptual reasoning was constructed.

3. **Student Interaction with Digital or Physical Learning Media**
   Direct evidence regarding media interaction was reported in all 23 studies, primarily presented as "practicality" or user response data. Studies documented interactions such as independent learning through Articulate Storyline (Vinasti et al., 2024) and student engagement via gamification (Ningrum et al., 2026). Nevertheless, these interactions were measured quantitatively using closed-ended practicality questionnaires. The qualitative nuances of human-computer interaction or tactile engagement with physical media, such as "Kebun Hitung", were not deeply investigated.
4. **Metacognitive Monitoring and Solution Verification**
   This category is glaringly absent from the reviewed literature. While Polya's final stage "looking back" theoretically involves verification, none of the 23 studies provided direct qualitative or explicit quantitative evidence measuring how students monitor their own thinking or verify their solutions while using the developed media. This dimension was largely an unmeasured outcome across the dataset.
5. **Cognitive Obstacles, Misconceptions, and Mathematical Justification**
   Direct evidence for this category is also extremely scarce. The reviewed R&D studies predominantly focus on reporting the successful efficacy of the media through N-Gain scores or mastery rates result that without analyzing the misconceptions or cognitive obstacles students encountered during the field tests. The lack of qualitative analysis in this domain does not necessarily mean students did not experience cognitive difficulties or formulate justifications. Rather, it indicates that these processes were an unmeasured outcome in the current evaluation paradigms.

In summary, the third research question reveals a significant methodological pattern. While mathematical problem-solving is extensively targeted, it is almost exclusively measured quantitatively. The absence of qualitative analysis in the reviewed papers highlights a critical gap. Current research excels at proving that learning media improve final scores, but falls short of explaining how students' mathematical thinking and reasoning trajectories evolve during the use of these educational tools.

4. Conclusion

This SLR aimed to map the trends in using learning media to improve students' mathematical problem-solving skills. Regarding the research methods, the trend is heavily dominated by R&D studies, with the ADDIE instructional design model being the most predominantly utilized. In terms of effectiveness indicators, while the reviewed literature demonstrates a highly consistent positive trend in improving procedural problem-solving, primarily evidenced through high validity, practicality, and quantitative N-Gain scores, the strength of this evidence is strictly limited to short-term, score-based outcomes. Rather than presenting uniformly positive claims about media

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efficacy, this review highlights a critical weakness in the current evidence base concerning the exploration of mathematical thinking. The existing literature treats cognitive processes as a "black box," focusing almost exclusively on aggregated quantitative learning outcomes while failing to qualitatively examine cognitive obstacles, misconceptions, or metacognitive monitoring. There remains a significant lack of robust evidence regarding how students actually think and construct solutions during their interaction with the media.

Therefore, to support the development of learning media that more effectively foster mathematical problem-solving ability, future research must shift from score-centric evaluations toward a more comprehensive cognitive analysis. Researchers are explicitly encouraged to integrate qualitative approaches, such as clinical interviews or cognitive behavioral observations, to capture the complete reasoning trajectory of students. Additionally, media developers should deliberately embed metacognitive features that prompt students to review and verify their generated solutions, ensuring the media functions optimally as a cognitive tool rather than merely a vehicle for procedural practice.

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