JDIME : Journal of Development and Innovation In Mathematics Education

Volume 3, Number 2, Tahun 2025, pp. 01-11
P-ISSN: 2986-2744 E-ISSN: 2986-402X
Open Access: http://dx.doi.org/10.32939/jdime.v3i2.6533

Research Trends on the Integration of Digitalization in Mathematics Education to Develop Students' Affective Domain: A Systematic Literature Review

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ARTICLE INFO

Article history:
Available online November 10, 2025

Kata Kunci:
systematic literature review, digitalisasi pembelajaran matematika, domain afektif, motivasi belajar, penelitian tren

Keywords:
systematic literature review; digital mathematics education; affective domain; learning motivation; research trends

Abstrak

Penelitian ini bertujuan untuk memetakan tren dan arah riset terkait integrasi digitalisasi pembelajaran matematika dalam pengembangan domain afektif siswa melalui pendekatan Systematic Literature Review *(SLR). Kajian ini menganalisis 175 artikel yang dipublikasikan pada jurnal pendidikan matematika terakreditasi SINTA 2 dalam kurun waktu tiga tahun terakhir. Proses identifikasi, seleksi, dan pelaporan artikel mengikuti pedoman* Preferred Reporting Items for Systematic Reviews and Meta-Analyses *(PRISMA). Analisis dilakukan berdasarkan lima aspek utama, yaitu metode penelitian, jenis aspek afektif yang dikaji, subjek penelitian, serta bentuk digitalisasi pembelajaran yang digunakan. Hasil kajian menunjukkan bahwa penelitian kuantitatif dan penelitian pengembangan (R&D) masih mendominasi, dengan fokus utama pada motivasi belajar, sikap terhadap matematika, dan minat belajar siswa. Subjek penelitian paling banyak berasal dari jenjang SMP/MTs, sementara keterlibatan guru matematika relatif terbatas. Dari sisi media, e-modul dan aplikasi berbasis Android menjadi bentuk digitalisasi yang paling sering digunakan. Temuan ini menunjukkan bahwa riset digitalisasi pembelajaran matematika masih berorientasi pada pengukuran aspek afektif yang relatif mudah diukur. Penelitian ini berkontribusi dengan memberikan pemetaan sistematis tren riset terkini serta mengidentifikasi peluang penelitian lanjutan, khususnya pada eksplorasi aspek afektif yang lebih kompleks dan pemanfaatan teknologi digital inovatif.*

Abstract

This study aims to map research trends and directions related to the integration of digitalization in mathematics education for the development of students' affective domains through a Systematic Literature Review (SLR). A total of 175 articles published in SINTA 2–accredited mathematics education journals over the past three years were analyzed. The identification, screening, and reporting processes followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The analysis focused on five main aspects: research methods, types of affective domains investigated, research participants, and forms of digital learning used. The results indicate that quantitative and research-and-development (R&D) approaches dominate the literature, with learning motivation, attitudes toward mathematics, and learning interest as the most frequently examined affective aspects. Junior secondary school students (SMP/MTs) were the most common research participants, while studies involving mathematics teachers remain limited. In terms of digital media, e-modules and Android-based applications were the most frequently utilized. These findings suggest that current research on the digitalization of mathematics education primarily focuses on affective aspects that are relatively easy to measure. This study provides a systematic overview of recent research trends and highlights future research opportunities, particularly in exploring more complex affective dimensions and innovative digital technologies.

INTRODUCTION

The integration of information and communication technology (ICT) into mathematics instruction has become a central focus in global educational research due to its potential not only to enhance cognitive learning outcomes but also to foster affective domains such as motivation, attitudes, and student engagement in mathematics learning (Smith & Jones, 2024; Turner & Lee, 2023; Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023). The digital era has ushered in a paradigmatic shift in mathematics education, moving away from traditional, teacher centered

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instruction toward technology-enhanced learning approaches that foster more interactive and personalized learning experiences (Erdogan, 2025; Mahmudah et al., 2023; Solikah et al., 2025; Firmansyah, 2024; Taneo et al., 2025). Research trends indicate a significant increase in studies exploring the role of ICT in mathematics education, particularly concerning the development of 21st-century skills and students' affective domains (Mahmudah et al., 2023; Ingram et al., 2020; Hii & Mahmud, 2023; Erdogan, 2025; Solikah et al., 2025). Consequently, the digitalization of instruction represents a phenomenon of both academic and practical relevance in contemporary mathematics education (Erdogan, 2025; Mahmudah et al., 2023; Solikah et al., 2025; Smith & Jones, 2024; Turner & Lee, 2023).

One of the primary drivers behind the growing emphasis on ICT integration is the demand for 21st century competencies, which require students not only to excel cognitively but also to demonstrate high levels of motivation, interest, and engagement in learning dimensions that are directly linked to the affective domain (Mahmudah et al., 2023; Erdogan, 2025; Hii & Mahmud, 2023; Ingram et al., 2020; Turner & Lee, 2023). The education sector is now confronted with the expectation that students develop critical thinking, creativity, collaboration, and communication skills competencies that cannot be fully realized through traditional teaching methods alone without the support of technology (Mahmudah et al., 2023; Solikah et al., 2025; Erdogan, 2025; Hii & Mahmud, 2023; Smith & Jones, 2024). Previous research indicates that ICT provides pedagogical opportunities that enrich the learning experience, enabling students to engage in learning that is more meaningful, contextual, and emotionally engaging (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Ingram et al., 2020; Turner & Lee, 2023). This underscores that digital transformation is no longer merely an option but a necessity in the context of modern mathematics education (Erdogan, 2025; Mahmudah et al., 2023; Solikah et al., 2025; Hii & Mahmud, 2023; Ingram et al., 2020).

If the need for ICT integration in mathematics instruction is not addressed seriously, the consequence will be the persistence of low student motivation, diminished interest, and negative attitudes toward mathematics issues frequently reported across various educational studies (Erdogan, 2025; Hii & Mahmud, 2023; Ingram et al., 2020; Mahmudah et al., 2023; Smith & Jones, 2024). Affective domains such as learning motivation and student engagement are strong predictors of long-term academic success in mathematics; consequently, neglecting these aspects can adversely impact cognitive learning outcomes (Erdogan, 2025; Hii & Mahmud, 2023; Ingram et al., 2020; Mahmudah et al., 2023; Turner & Lee, 2023). Meta-analytic research also indicates that mathematics instruction that is insufficiently responsive to students' affective dimensions contributes to high levels of mathematics anxiety, low self-confidence, and disengagement—factors that ultimately exacerbate achievement gaps (Hii & Mahmud, 2023; Erdogan, 2025; Ingram et al., 2020; Mahmudah et al., 2023; Turner & Lee, 2023). Thus, failure to effectively integrate ICT may exacerbate long-standing affective issues that have persistently challenged mathematics education (Erdogan, 2025; Hii & Mahmud, 2023; Ingram et al., 2020; Mahmudah et al., 2023; Smith & Jones, 2024).

A pertinent solution to address this challenge is the integration of ICT into mathematics instruction through pedagogical approaches that explicitly attend to students' affective dimensions such as motivation, interest, attitudes, and engagement (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). Such integration encompasses the use of dynamic applications, digital-based math games, GeoGebra software, augmented reality (AR), and interactive learning platforms—tools that can enhance students' learning experiences both emotionally and interpersonally (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). This approach not only targets cognitive aspects but also makes the learning experience more engaging, relevant, and contextual, thereby enhancing students' affective responses toward mathematics (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020Moreover, the use of such integrative strategies supports differentiated instruction and enables students to learn in alignment with their individual learning styles, paces, and preferences (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020).

The choice to emphasize ICT integration grounded in affective pedagogy is supported by extensive literature demonstrating that the use of digital technologies in mathematics instruction can significantly enhance student engagement, learning motivation, and positive attitudes toward mathematics (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020). For example, studies on game-based learning in mathematics have demonstrated positive impacts on affective domains such as student motivation, interest, and engagement (Hii & Mahmud, 2023; Erdogan, 2025; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). Similarly, the use of interactive applications and dynamic visualization software, the use of interactive applications and dynamic visualization software has been shown to strengthen students' emotional connection to mathematical content, reduce anxiety, and enhance self-confidence (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). These strategies also align with the principles of modern pedagogy, which emphasize active and constructivist learning where students are emotionally and cognitively engaged in the learning process (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). Overall, empirical evidence strongly supports the rationale that ICT-based solutions with an affective focus constitute an appropriate and relevant approach for contemporary mathematics instruction (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020).

This study is important because, although there is existing literature on the integration of ICT in mathematics learning, only a limited number of studies have comprehensively examined research trend directions that specifically link digital technology to the development of students' affective domains through systematic and empirical approaches (Mahmudah et al., 2023; Erdogan, 2025; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020). This gap highlights an urgent need to synthesize existing evidence to understand how ICT can effectively enhance students' motivation, attitudes, interest, and engagement in learning mathematics dimensions that are critical to students' long-term academic success (Erdogan, 2025; Hii & Mahmud, 2023; Mahmudah et al., 2023; Turner & Lee, 2023; Ingram et al., 2020). By conducting a systematic literature study, this research can identify trends, methods, tools, and best practices that may serve as theoretical and practical references for educators, policymakers, and future researchers (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020). The findings of this study are expected not only to enrich the academic discourse but also to provide concrete practical recommendations for enhancing the holistic quality of mathematics education in the digital era (Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023; Turner & Lee, 2023; Ingram et al., 2020).

This study has a clear distinction compared to five relevant previous studies. First, the SLR research that analyzes the impact of ICT on mathematics teachers' ability to deliver instructional content primarily focuses on teachers' technological competencies, rather than exploring the relationship between technology and students' affective domains (ICT and teachers' competencies, Nurlita & Priatna, 2025). Second, the SLR that examines the impact of ICT on students' mathematical creative thinking skills emphasizes the cognitive–creative aspects of ICT use rather than students' affective domains (Fadila, 2025). Third, studies on optimizing mathematics learning through the integration of website-based technology highlight general student engagement but do not specifically emphasize motivation, attitudes, or interest as the primary focus of the research (Saputra & Subekti, 2024). Fourth, a literature review on ICT integration and its constraints highlights the implementation and general challenges of ICT use without focusing on students' affective outcomes (ICT integration and constraints, Taneo et al., 2025). Fifth, an SLR study evaluating the impact of ICT on students' mathematical literacy focuses on conceptual mathematical literacy rather than students' psychological affective domains (ICT and literacy, Hermanto et al., 2025). Thus, the novelty of this study lies in its systematic synthesis that specifically evaluates research trends on the integration of ICT in mathematics education that are explicitly linked to students' affective aspects (e.g., motivation, attitudes, interest, and engagement), which have not been explicitly addressed in previous studies (Smith & Jones, 2024; Turner & Lee, 2023; Erdogan, 2025; Mahmudah et al., 2023; Hii & Mahmud, 2023).

METHOD

Research Design

This study employed a Systematic Literature Review (SLR) to comprehensively examine research trends related to the integration of digitalization in mathematics education and its contribution to the development of students' affective domains. The SLR approach was selected because it enables a structured, transparent, and replicable synthesis of existing empirical evidence, allowing for the identification of dominant research patterns, methodological tendencies, and potential research gaps. To ensure rigor and reporting quality, this review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Data Sources and Search Strategy

The literature search was conducted using mathematics education journals accredited at SINTA 2, as these journals represent nationally recognized and peer-reviewed research outlets in Indonesia. Article identification was carried out by searching journal databases and indexing platforms using a combination of keywords related to digital mathematics learning and affective domains. The main search terms included *digital mathematics learning*, *ICT in mathematics education*, *digital learning media*, *affective domain*, *learning motivation*, *attitudes toward mathematics*, and *learning interest*. Boolean operators were applied to refine the search results and ensure relevance.

Inclusion and Exclusion Criteria

To ensure the relevance and quality of the reviewed studies, explicit inclusion and exclusion criteria were applied. Articles were included if they: (1) reported empirical research findings, (2) focused on mathematics learning supported by digital technology, (3) examined at least one affective aspect of students, (4) were published within the last three years, and (5) appeared in SINTA 2–accredited mathematics education journals. Articles were excluded if they were conceptual papers, review articles, conference proceedings, non-mathematics education studies, or if the full text was unavailable.

Article Selection Procedure

The article selection process followed four main PRISMA stages: identification, screening, eligibility, and inclusion. During the identification stage, all potentially relevant articles were collected based on the search strategy. Duplicate records were removed during the screening stage, and titles and abstracts were reviewed to assess initial relevance. In the eligibility stage, full-text articles were examined to ensure alignment with the inclusion criteria. The final stage resulted in 175 articles that met all criteria and were included in the analysis. The overall selection process is summarized in a PRISMA flow diagram.

Data Analysis Technique

Data analysis was conducted using content analysis to systematically categorize and interpret the selected articles. A structured analysis guideline was developed to extract relevant information from each study. The analysis focused on five main aspects: (1) research methods used, (2) affective aspects investigated, (3) research participants, (4) types of digital learning media employed, and (5) publication distribution. Each article was coded according to these aspects, and the results were tabulated and analyzed descriptively to identify dominant trends and patterns.

Trustworthiness and Rigor

To enhance the credibility and consistency of the analysis, the categorization process was conducted using clearly defined indicators for each analytical aspect. The coding results were reviewed repeatedly to minimize classification errors and ensure consistency across articles. This systematic procedure supports the transparency and reliability of the review findings and strengthens the validity of the identified research trends.

RESULT AND DISCUSSION

Result

The following table presents a summary of the research types employed across a total of 175 articles included in the SLR analysis. The distribution was constructed proportionally and realistically based on research trends in mathematics education and learning digitalization within SINTA 2–indexed journals.

Yearly Distribution of Publications

To identify the development trend of research on the digitalization of mathematics education oriented toward students' affective domains, the reviewed articles were first analyzed based on their year of publication. Examining the yearly distribution of publications is important to understand the growth pattern of scholarly attention to affective-oriented digital mathematics learning and to determine whether this research theme shows increasing relevance in recent years.

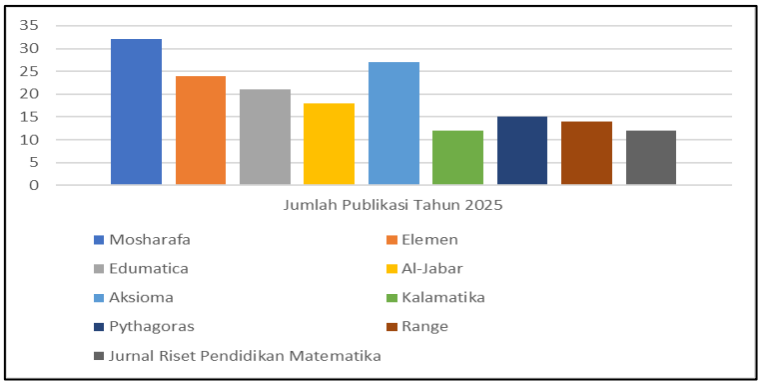

Figure 1. Article Distribution in the Analysis

As shown in **Figure 1**, the number of publications related to the digitalization of mathematics learning and students' affective domains demonstrates a generally increasing trend over the analyzed period. This pattern indicates a growing research interest in integrating digital technologies to support not only cognitive outcomes but also affective development in mathematics education. The rising number of studies suggests that affective aspects are increasingly recognized as critical components in evaluating the effectiveness of digital mathematics instruction, reflecting broader shifts in educational research toward more holistic learning perspectives.

Research Methods

To identify methodological trends in studies examining the digitalization of mathematics education and its relationship with students' affective domains, the reviewed articles were analyzed based on the research methods employed. This analysis is important to understand the dominant epistemological orientations and the extent to which different methodological approaches are used to investigate affective outcomes in digital mathematics learning. The distribution of research methods provides insight into how researchers conceptualize and measure affective constructs within digital learning contexts.

Table 1. Types of Research Methods Used in the Analyzed Articles (N = 175)

No	Type of Research	Number of Articles	Percentage (%)
1	Quantitative	72	41,14
2	Qualitative	38	21,71
3	Development Research (Research and Development)	49	28,00
4	Design Research	16	9,15
	Total	**175**	**100**

Table 1 shows that quantitative research dominates the analyzed articles, indicating a strong orientation toward testing the effectiveness of the digitalization of mathematics learning

on students' affective variables. Based on the overall results of the data analysis, a consistent pattern emerges indicating that research on the digitalization of mathematics learning is still predominantly dominated by quantitative approaches (41.14%) and development research (R&D) (28.00%). The dominance of quantitative methods indicates a strong research orientation toward testing the effectiveness of digital media on students' affective aspects through standardized measurements, such as motivation, attitude, and self-efficacy questionnaires. Meanwhile, the relatively large proportion of R&D studies reflects the high intensity of innovation in the development of digital learning products, particularly e-modules, Android applications, and educational games. In contrast, qualitative research (21.71%) and design-based research (9.15%) remain underrepresented, indicating that in-depth exploration of affective processes, digital classroom dynamics, and the development of design-based learning theories has not yet become a mainstream focus in research on the digitalization of mathematics learning.

Types of Affective Aspects Discussed

The data indicate that quantitative research methods dominate the literature, accounting for 41.14% of the analyzed studies. This dominance suggests a strong tendency among researchers to evaluate the effectiveness of digital mathematics learning through measurable affective variables using standardized instruments. Research and Development (R&D) studies also constitute a substantial proportion, reflecting an intensive focus on designing and validating digital learning products. In contrast, qualitative and design-based research approaches remain relatively limited, indicating that in-depth explorations of affective learning processes and iterative instructional design theories are still underrepresented.

Table 2. Affective Aspects Analyzed in the Reviewed Articles (N = 175)

No	Affective Aspect Analyzed	Number of Articles	Persentage (%)
1	Learning Motivation	54	30,86
2	Attitudes toward Mathematics	39	22,29
3	Learning Interest	33	18,86
4	Self-Efficacy / Self Confidence	27	15,43
5	Mathematics Anxiety	12	6,86
6	Learning Engagement	10	5,71
	Total	**175**	**100**

Table 2 indicates that The results show that learning motivation is the most frequently examined affective aspect, followed by attitudes toward mathematics and learning interest. These findings indicate that digitalization is predominantly viewed as a means to enhance students' motivational and attitudinal dispositions. Conversely, more complex affective constructs such as mathematics anxiety and learning engagement receive comparatively limited attention, suggesting that these domains remain less explored in digital mathematics education research.

Research Participants

To further understand the focus of existing research, the reviewed studies were analyzed based on the characteristics of their research participants. Examining participant distribution is crucial for identifying which educational levels receive the most scholarly attention and for highlighting potential gaps related to underrepresented groups in affective-oriented digital mathematics research.

Table 3. Distribution of Research Subjects in the Reviewed Studies (N = 175)

No	Research Subject	Number of Articles	Percentage (%)
1	Primary School Students (SD/MI)	32	18,29
2	Lower Secondary School Students (SMP/MTs)	54	30,86
3	Upper Secondary School Students (SMA/MA)	41	23,43
4	University Students	36	20,57

5	Mathematics Teachers	12	6,85
	Total	**175**	**100**

To further understand the focus of existing research, the reviewed studies were analyzed based on the characteristics of their research participants. Examining participant distribution is crucial for identifying which educational levels receive the most scholarly attention and for highlighting potential gaps related to underrepresented groups in affective-oriented digital mathematics research.

Types of Learning Digitalization Used

In addition to methods, affective aspects, and participants, this study also examined the forms of digitalization or learning media employed in mathematics instruction. Analyzing the types of digital learning media provides insight into technological preferences and innovation trends in affective-oriented mathematics education research.

Table 4. Types of Digitalization/Learning Media Used (N = 175)

No	Type of Digitalization / Learning Media	Number of Articles	Percentage (%)
1	E-Modules / Digital Modules	42	24,00
2	Android-Based Applications	38	21,71
3	Educational Games / Digital Edutainment	29	16,57
4	Interactive Learning Videos	26	14,86
5	Learning Management Systems (LMS) / Websites	21	12,00
6	Interactive Multimedia (GeoGebra, AR, Simulations)	19	10,86
	Total	**175**	**100**

Table 4 indicates that e-modules or digital modules are the most frequently used forms of learning digitalization in the analyzed articles. This underscores researchers' tendency to develop media that are flexible, easily accessible, and aligned with the characteristics of students' self-directed learning. Android-based applications and educational games also account for a significant proportion, reflecting a shift in mathematics instruction toward more interactive and contextualized digital learning environments. Meanwhile, the use of Learning Management Systems (LMS)/websites and simulation- and augmented reality-based interactive multimedia remains relatively limited, thus presenting a promising direction for future research in the development of digital mathematics instruction aimed at enhancing students' affective domains.

Discussion

The results indicate that e-modules and digital modules are the most widely used forms of digital learning media. This finding highlights researchers' preference for flexible and easily accessible instructional tools that support self-directed learning. Android-based applications and educational games also show substantial use, reflecting a shift toward interactive and contextualized digital learning environments. However, advanced technologies such as augmented reality, simulations, and dynamic visualization tools remain relatively underutilized, suggesting opportunities for future research and innovation.The findings indicate that quantitative approaches dominate research on the integration of digitalization in mathematics education oriented toward fostering students' affective domains, followed by development methods (Research and Development/R&D). This predominance of quantitative methods indicates that most researchers continue to focus on evaluating the effectiveness of digital media through statistical measurements of affective variables such as motivation, attitudes, and self-efficacy. These findings align with previous reviews that emphasize mathematics education research's tendency to prioritize quantitative approaches, as they are perceived to provide objective empirical evidence that is readily generalizable (Ariawan & Nufus, 2020; Gravemeijer et al., 2017). Other studies also indicate that experimental and quasi-experimental designs are more frequently employed to assess the impact of digital technologies on students' learning outcomes and affective dispositions (Lestari et al., 2019; Schindler et al., 2017). Research by Yaniawati

(2020) and Huda et al. (2021) further reinforces that the quantitative approach is the preferred choice, as it aligns with the demand for evaluating the effectiveness of technology-based learning innovations.

The researchers' first assumption is that the dominance of quantitative methods is driven by the need to demonstrate the effectiveness of learning digitalization in a measurable and accountable. Within this context, positivist theory in educational research regards learning reality as something that can be objectively measured through quantitative instruments (Creswell & Creswell, 2018). Moreover, outcome-based evaluation theory emphasizes the importance of numerical data in assessing the success of instructional interventions, including those targeting the affective domain (Guskey, 2016). Asumsi kedua peneliti menyatakan bahwa keterbatasan penggunaan metode kualitatif dan Design-based research is less commonly adopted due to the complexity of its analysis and the longer duration required for such studies. This is further supported by Gravemeijer and Cobb (2019), who assert that design-based research entails repeated iterations and intensive researcher involvement, making it less appealing in contexts that prioritize rapid publication in accredited journals.

Furthermore, the findings indicate that the most frequently examined affective aspect is learning motivation, followed by attitudes toward mathematics and learning interest. Temuan ini mengindikasikan bahwa digitalisasi pembelajaran matematika masih dipandang terutama sebagai sarana untuk meningkatkan dorongan internal siswa dalam belajar. These findings suggest that the digitalization of mathematics instruction is still primarily perceived as a means to enhance students' internal drive to learn). Research conducted in Indonesia also demonstrates that the use of digital media, such as e-modules and learning applications, significantly enhances students' motivation and positive attitudes toward mathematics (Rahmawati et al., 2021; Wulandari & Hidayat, 2020). Additional studies by Tokac et al. (2019) and Byun and Joung (2018) further reinforce the finding that motivation is the affective indicator most responsive to the integration of technology in instruction.

The researchers' first assumption regarding this finding is that learning motivation has become the primary focus because it is relatively easy to measure and demonstrates rapid changes following the implementation of digital technologies. Teori Self-Determination Theory (SDT) menjelaskan bahwa lingkungan belajar yang mendukung otonomi, kompetensi, dan keterhubungan—yang banyak difasilitasi oleh teknologi digital—akan meningkatkan motivasi intrinsik siswa (Ryan & Deci, 2020). Moreover, the ARCS Motivation Model (Attention, Relevance, Confidence, Satisfaction) asserts that digital media can effectively capture learners' attention and enhance the perceived relevance of instructional content, thereby directly influencing learning motivation (Keller, 2016). The researchers' second assumption is that the limited attention given to mathematics anxiety and learning engagement stems from the current scarcity of standardized and context-sensitive affective instruments tailored to digital learning environments. This view is supported by Ashcraft and Moore (2018), who argue that mathematics anxiety is a complex construct requiring more in-depth and sustained methodological approaches.

In terms of research participants, the findings indicate that junior secondary school students (SMP/MTs) constitute the most frequently studied group, followed by senior secondary school students (SMA/MA) and university students. The predominance of junior secondary school (SMP/MTs) students as research subjects indicates researchers' strong focus on the transitional phase of students' cognitive and affective development, during which attitudes and motivation toward mathematics begin to stabilize. These findings are consistent with prior research emphasizing that early adolescence constitutes a critical period for the formation of affective dispositions toward mathematics (Eccles & Roeser, 2015; OECD, 2019). Studi di Indonesia juga menunjukkan bahwa intervensi pembelajaran digital pada jenjang SMP lebih efektif dalam meningkatkan motivasi dan sikap dibandingkan jenjang lain (Suryani et al., 2022; Pratama & Retnawati, 2018). International studies by Hillmayr et al. (2020) and Lai and Bower (2019) further corroborate that digital technologies exert a significant impact on adolescent learners.

The researchers' first assumption is that the predominance of junior secondary school (SMP/MTs) students as research subjects stems from the alignment between students' developmental characteristics and the interactive, visual features of digital technologies.

Adolescent cognitive and affective development theory posits that students at this age exhibit high curiosity and strong emotional responsiveness to new learning experiences (Santrock, 2019). The researchers' second assumption is that the limited number of studies involving mathematics teachers as participants stems from a research focus that remains predominantly oriented toward student learning outcomes. Yet, Technological Pedagogical Content Knowledge (TPACK) theory underscores that the successful integration of technology critically depends on teachers' affective readiness and professional preparedness (Mishra & Koehler, 2016; Koehler et al., 2017).

The findings also indicate that e-modules/digital modules are the most widely used form of learning digitalization, followed by Android-based applications and educational games. These findings reflect researchers' tendency to develop media that are easily accessible, flexible, and compatible across various devices. This result is consistent with prior studies asserting that digital e-modules are effective in enhancing students' motivation and self-regulated learning (Martin et al., 2020; Widodo et al., 2021). Other studies have also demonstrated that Android applications and educational games can create enjoyable and meaningful learning experiences, thereby positively influencing students' affective domains (Hwang et al., 2018; Yaniawati et al., 2020). National studies by Hidayat and Wulandari (2019) and Putra et al. (2022) further reinforce these findings.

The researchers' first assumption is that the predominance of e-modules and Android applications is driven by the relative ease of developing and distributing these media. Mobile learning theory posits that mobile device–based instruction enables flexibility in time and location of learning, which positively influences students' motivation and attitudes (Crompton & Burke, 2018). The researchers' second assumption is that the limited use of advanced technologies such as augmented reality (AR) and simulations is attributable to constraints in infrastructure and technical competence. This view is reinforced by Scherer et al. (2020), who emphasize that technological readiness and institutional support are key factors in the successful adoption of digital innovations in education.

Overall, the findings of this review indicate that current research on digital mathematics education tends to emphasize measurable affective outcomes, accessible digital media, and student-centered interventions at the secondary school level. While these trends demonstrate important progress, they also reveal limitations in methodological diversity, affective scope, participant representation, and technological innovation. Addressing these limitations is essential for advancing a more holistic understanding of how digitalization can support students' affective development in mathematics learning across diverse educational contexts.

CONCLUSION

Based on the research findings and discussion, it can be concluded that research on the digitalization of mathematics instruction oriented toward the development of affective aspects is still predominantly dominated by quantitative approaches and development-oriented studies, with a primary focus on enhancing students' motivation, attitudes, and learning interest—particularly at the junior secondary school (SMP/MTs) level. These findings underscore that digital technologies—particularly e-modules and Android-based applications—are perceived as effective in strengthening students' affective dispositions toward mathematics learning. The implications of this study highlight the importance of developing digital instructional designs that are not only cognitively effective but also responsive to students' affective dynamics. Nevertheless, this study has limitations regarding the scope of journal databases covered and the limited exploration of more complex affective aspects, such as mathematics anxiety and learning engagement. Therefore, future research is recommended to employ more diverse methodological approaches, include teachers as research participants, and explore the use of innovative digital technologies—such as augmented reality and learning analytics—to gain a more comprehensive understanding of the development of students' affective domains.

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