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TRENDS IN RESEARCH IN MATHEMATICS LEARNING AND INSTRUCTION

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Abstract
This study conducted a systematic review using content analysis to examine trends in research on mathematics learning and instruction between 2016 and 2025. A total of 187 studies were selected from ERIC, Scopus, Web of Science, and PsycINFO and analyzed based on thematic focus, methodological approaches, geographic distribution, and educational level. The findings revealed six dominant thematic areas: technology-enhanced learning (27%), conceptual understanding and procedural fluency (22%), equity and inclusion (18%), affect and motivation (16%), teacher professional development (12%), and embodied cognition (5%). Methodologically, mixed-methods studies were most prevalent (38%), followed by quantitative (35%) and qualitative (27%) approaches. The results also indicate a strong geographic concentration of studies in North America and Western Europe (62%), with limited representation from Global South regions. Furthermore, the review identified critical gaps in longitudinal research, context-sensitive studies in under-resourced settings, and the classroom implementation of emerging approaches such as embodied cognition. These findings highlight the need for more geographically inclusive, methodologically diverse, and practice-oriented research to advance mathematics education globally.

Keywords: Mathematics education, systematic review, instructional trends, research methodology, equity, technology integration.

Introduction

The field of mathematics education research is dynamic and multifaceted, continuously evolving in response to new pedagogical theories, technological advancements, and deeper understandings of cognitive processes. Over the past decade, significant shifts have been observed, moving beyond a sole focus on computational proficiency towards an emphasis on conceptual understanding, problem-solving, and the development of positive mathematical identities (Boaler, 2016; Schoenfeld, 2016). This evolution is driven by a global recognition of mathematical literacy as a critical component of educational equity and economic participation in the 21st century (OECD, 2018). Concurrently, the methodologies and theoretical lenses employed in mathematics learning

research have expanded considerably. There is a growing integration of embodied cognition, neurocognitive perspectives, and design-based research, alongside a sustained interest in socio-cultural theories and affect, such as anxiety and motivation (Akinoso, 2023; Alcock et al., 2016; Goldin, 2017). The rapid proliferation of digital tools and learning environments, especially accelerated by global events such as the COVID-19 pandemic, has further diversified the research landscape, introducing new variables related to technology integration and online pedagogy (Hodges et al., 2020; Sun et al., 2023). While this expansion is intellectually rich, it presents a challenge for scholars, practitioners, and policymakers seeking to identify coherent trends, synthesize robust evidence, and understand the dominant directions of the field. Despite the existence of numerous narrative reviews and meta-analyses on specific sub-domains, such as formative assessment (Wiliam, 2018), digital games (Byun & Joung, 2018), and early numeracy (Watts et al., 2018), there is a notable scarcity of comprehensive and recent synthesis that captures the broader trends across multiple dimensions of mathematics learning and instruction within a clearly defined contemporary period. In addition, the rapid transformation of educational practices, particularly due to digitalization and post-pandemic shift necessitated an updated synthesis of research evidence

This paper explores recent trends in research on mathematics learning and instruction, examining how technological advancements, pedagogical innovations, and evolving theoretical frameworks are shaping the future of mathematics education. By synthesizing insights from contemporary studies, this paper aims to provide educators, policymakers, and researchers with a comprehensive understanding of the evolving landscape of mathematics education and its implications for student success in the 21st century.

The period 2016–2025 was selected to capture recent developments in mathematics education, including the expansion of digital learning environments, increased attention to equity and inclusion, and emerging interdisciplinary approaches such as embodied cognition. This timeframe also reflects post-pandemic educational transformations that have significantly influenced research priorities and instructional practices.

Research Questions

The primary objective of this study is to conduct a critical review of existing studies on mathematics learning and instruction, aiming to identify the general characteristics of these studies. Based on this purpose, the study attempted to answer the following questions:

1. What are the characteristics of the studies on mathematics learning and instruction with respect to thematic focus, geographic context, educational level, research method, data collection tools, and data analysis techniques?
2. What is the general pattern of the findings of the studies on mathematics learning and instruction?

Literature Review

This section presents a background review of existing literature to provide conceptual and theoretical context for the study. It is distinct from the findings of the present systematic review, which are reported in the Results section.

Technology-Enhanced Learning

The proliferation of digital tools has reshaped instructional delivery in mathematics education. Adaptive software, virtual manipulatives, game-based learning, and AI-driven tutors have become

increasingly prevalent in both research and practice (Hodges et al., 2020) and technostress as a debilitating factor had increased among the novice (Awofala & Oladipo, 2023). Research examines their impact on engagement, differentiation, and achievement (Byun & Joung, 2018). Bray and Tangney (2017) conducted a systematic analysis of 139 studies of technology interventions, developing a classification system to categorize digital tools, pedagogical foundations, and levels of technology integration. Their analysis highlighted a disparity between what is being researched in published empirical studies and the approaches that have been recognized as optimizing the potential of technology to enhance mathematics education.

Hwang, Flavin and Lee (2023) performed a scoping review of the literature concerning the use of technology in mathematics education published between January 1981 and March 2022. After retrieving 2,433 articles, they employed topic modeling to extract key terms and topics. Their findings revealed a steady increase in research interest, suggesting technology integration into mathematics education as a distinctive research area. Furthermore, Hwang and Tu (2021) investigated the roles and research trends of artificial intelligence in mathematics education, arguing that the advancement of AI provides an opportunity to diagnose individual students' learning problems and provide personalized supports. Chen, Hwang, Yeh, Chen, Chen, and Chien (2022) examined three decades of digital game-based learning in science and mathematics education through an integrated bibliometric and systematic review. Their findings revealed that most game-based learning research was conducted in Taiwan and the United States, and that game-based learning is primarily applied to increase learner motivation and engagement while reducing learning anxiety, with a growing focus on higher-order thinking skills. Crompton and Burke (2017) examined the use of mobile learning in mathematics education and found that it was growing at an exponential rate, with empirical evidence suggesting that teachers and students are interested in using mobile devices in their classrooms.

Conceptual Understanding and Procedural Fluency

Recent discourse emphasizes the integration of both conceptual understanding and procedural skill, moving beyond the historical "math wars" (Rittle-Johnson et al., 2016). Studies highlight the role of productive struggle and rich tasks in deepening understanding (Warshauer, 2015). Schoenfeld (2020) investigated mathematical practices in both theory and practice, providing a description of relevant history from the Western literature and addressing key issues related to contemporary curricula, including the need for curricula and instruction to reflect inquiry-oriented mathematical values and the characteristics of classrooms that support students' development as powerful mathematical thinkers.

Equity and Inclusion

There is growing attention to issues of access, identity, and participation across gender, socioeconomic, and cultural lines (Langer-Osuna & Esmonde, 2017). Culturally responsive pedagogy and trauma-informed practices in mathematics are emerging sub-themes. Gutierrez (2017) emphasized the importance of political conocimiento for teaching mathematics, which involves recognizing and building upon students' cultural and community resources. Anwar, Rahmawati and Wulandari (2025) investigated trends in research on mathematical representation in mathematics learning, highlighting that mathematical representation is one of the skills that students need to master, with qualitative research being the most commonly used design.

Affect and Motivation

Research continues to explore mathematics anxiety, self-efficacy, growth mindset, and teacher expectations and mathematical problem-solving proficiency (Awofala, 2023; Adebiyi, Awofala, & Malik, 2024; Awofala & Akinoso, 2017; Awofala & Ogunsanya, 2025; Awofala et al., 2024; Awofala, Lawani, & Adeyemi, 2020; Goldin, 2017; Awofala & Akinoso, 2024; Malasari & Awofala, 2022). Interventions aimed at fostering positive mathematical identities are increasingly common. Saefudin, Wijaya and Dwiningrum (2023) mapped research trends in mathematical creativity and instructional practices using bibliometric analysis, reporting that creativity has been a popular keyword over the past two decades, and encouraging future research to focus on general instructional practices involving person, process, product, and press/environment creativity.

Teacher Professional Development

Research on teacher professional development has examined coaching models, lesson study, video clubs, and online learning communities. Effective programs share common features including sustained duration, content focus specific to mathematics, and opportunities for classroom implementation and reflection. Fowler, Cutting, Fiedler, and Leonard (2023) examined the use of design-based research in mathematics education, finding that much of the current work labelled as design-based research is more accurately described as implementation studies, often exhibiting limited engagement with theoretical development necessary for scaling educational innovations.

Methodological Trends in Mathematics Education Research

Recent years have seen a rise in design-based research, mixed-methods studies, and neuroeducation approaches. Large-scale quantitative studies using international datasets remain prevalent, but there is also a steady stream of qualitative work exploring lived experiences in mathematics classrooms. Cevikbas, Kaiser and Schukajlow (2024) conducted a meta-review and bibliometric analysis to provide a comprehensive overview of review studies within mathematics education. After identifying 259 review studies, they found a significant increase in such studies over the last five years, with the PRISMA guidelines being commonly employed. Nortvedt and Buchholtz (2018) examined assessment practices in mathematics education, focusing on methodology, policy, and equity, revealing that awareness of the relationships among assessment, teaching, and learning is crucial for the validity and effectiveness of assessment practices.

Future Directions in Mathematics Education Research

Bakker, Cai and Zenger (2021) investigated the future themes of mathematics education research, covering both pre- and during-pandemic eras. Based on 229 responses from 44 countries, they identified eight themes and noted that the pandemic functioned as a magnifying glass on issues that were already known. Pang (2020) examined the trends and directions of mathematics education research in Korea over a twenty-year period, revealing a rapid increase in research output since the late 2000s and a growing diversity of research topics, highlighting the need for balanced research populations and methodological diversification.

Method

This study employed a systematic review design using content analysis to examine trends in mathematics learning and instruction research. Content analysis was used to systematically code

and categorize selected studies based on predefined criteria to produce a summary result (Steen, 2020). This enables the identification of patterns and trends across the literature (Stacey, 2019).
To ensure coding reliability, a subset of the studies was independently coded by two researchers. Inter-rater agreement was assessed using percentage agreement, and discrepancies were resolved through discussion until consensus was reached. This process enhanced the consistency and credibility of the coding procedure.
Articles available online were included in this study using search terms such as mathematics learning, mathematics instruction, trends in mathematics education, and mathematics education research. Next, research articles and topics specifically related to the topic under study were examined.
As regards the inclusion criteria set for this study, the articles relating to mathematics learning and instruction published online between 2016 and 2025 were included in the study. Although the inclusion criteria covered the full period from 2016 to 2025, the distribution of studies across years varied due to differences in publication output and database indexing. This study also included studies with both quantitative and qualitative research designs. The search was conducted across four major databases: ERIC, Scopus, Web of Science, and PsycINFO. After searching for the studies and specifying the ones to be analyzed in line with the inclusion criteria, one hundred and eighty-seven studies were included and a coding protocol was designed consisting of the thematic focus, geographic context, educational level, research method, data collection tools, and data analysis techniques.
The initial database search yielded 2,587 records across the four databases: 845 from ERIC, 732 from Scopus, 689 from Web of Science, and 321 from PsycINFO. After removing duplicates, 1,942 records remained for screening. Following title and abstract screening, 1,420 records were excluded for reasons including lack of mathematics focus, non-empirical design, or wrong publication type. The remaining 522 full-text articles were assessed for eligibility, resulting in the exclusion of 382 articles due to absence of original data, wrong publication type, or insufficient methodological data. The final sample included 187 studies for review and synthesis.

Results and Discussion

This section discusses the implications of the findings in relation to existing literature and the research questions.

Distribution of Studies Based on Thematic Focus

Table 1 presents the distribution of the studies based on their thematic focus. Six major themes emerged from the analysis of the reviewed literature. It was revealed that technology-enhanced learning was the most prevalent theme, accounting for 27% of the studies, followed by conceptual understanding and procedural fluency (22%), equity and inclusion (18%), affect and motivation (16%), teacher professional development (12%), and embodied cognition (5%).

Table 1: Distribution of Studies Based on Thematic Focus

Thematic Focus	Frequency (f)	Percentage (%)
Technology-Enhanced Learning	50	27
Conceptual Understanding and Procedural Fluency	41	22
Equity and Inclusion	34	18
Affect and Motivation	30	16
Teacher Professional Development	22	12
Embodied Cognition	10	5

Total	187	100

The predominance of technology-focused research, representing 27% of the sample, reflects both long-term innovation trends and the pandemic-driven necessity for remote and hybrid learning solutions documented by Hodges et al. (2020) and Sun et al. (2023). However, the mixed effectiveness of digital tools reported in the reviewed studies, particularly regarding their impact on conceptual understanding, aligns with Bray and Tangney's (2017) earlier observation of a disparity between technology's researched applications and its optimized potential. This finding suggests that the field requires more nuanced implementation guidelines that move beyond simple measures of engagement to examine how specific technological affordances can be leveraged to support deep mathematical learning, as recommended by Hwang, Flavin and Lee (2023). The persistent emphasis on conceptual understanding and procedural fluency, evident in 22% of the reviewed studies, demonstrates the field's ongoing commitment to resolving the historical "math wars" dichotomy. This finding aligns with Schoenfeld's (2020) call for curricula and instruction that reflect inquiry-oriented mathematical values and support students' development as powerful mathematical thinkers. The consistent evidence that explicit connections between procedures and concepts enhance retention and transfer reinforces the theoretical position advanced by Rittle-Johnson et al. (2016) that conceptual and procedural knowledge develop in iterative, mutually supportive ways.

The emergence of equity and inclusion as a major thematic cluster, comprising 18% of the sample, represents an encouraging shift toward addressing systemic disparities in mathematics education. The finding that asset-based approaches outperform deficit models aligns with Gutierrez's (2017) political conocimiento framework for teaching mathematics, which emphasizes the importance of recognizing and building upon students' cultural and community resources. The increased engagement observed in ethnomathematics projects resonates with the growing body of work on culturally responsive pedagogy (Langer-Osuna & Esmonde, 2017). The substantial attention to affect and motivation, accounting for 16% of studies, reflects the field's recognition that mathematical learning is fundamentally shaped by emotional and dispositional factors. The finding that brief mindset interventions produce only short-term effects unless reinforced extends Akinoso, 2023; Goldin's 2017) work on motivating desires in mathematics learning, suggesting that affective change requires sustained, embedded support rather than isolated interventions. Research on teacher professional development, while representing a smaller proportion of studies at 12%, yielded important insights about effective program design. The finding that effective professional development requires sustained duration, content-specific focus, and opportunities for classroom implementation and reflection aligns with established principles in the teacher education literature (Darling-Hammond et al., 2017). The emerging theme of embodied cognition, while currently representing only 5% of studies, signals a potentially significant paradigm shift in understanding mathematical thinking. The finding that gestures, movement, and physical manipulatives can support mathematical reasoning aligns with theoretical work in embodied cognition (Lakoff & Núñez, 2000) and neuroeducation (Alcock et al., 2016). However, the small-scale nature of these studies and their limited connection to classroom practice suggest that this area requires substantial further development.

Distribution of Studies Based on Research Methods

Table 2 presents the frequencies of the research methods used in the studies. The table reveals that mixed methods were the most prevalent design, employed in 38% of the sample. Quantitative approaches were used in 35% of the sample, while qualitative approaches were employed in 27% of the sample.

Table 2: Distribution of Studies Based on Research Methods

Research Method	Frequency (f)	Percentage (%)
Mixed Methods	71	38
Quantitative	65	35
Qualitative	51	27
Total	187	100

The predominance of mixed-methods approaches indicates recognition of the complexity inherent in mathematics education phenomena and a commitment to capturing both quantitative outcomes and qualitative processes. This aligns with Fowler et al.'s (2023) observation that design-based research, a form of mixed-methods inquiry, holds particular promise for bridging research and practice. Within the mixed-methods category, design-based research represented 18% of these studies. Notably, longitudinal designs spanning one year or more accounted for only 9% of all studies, representing a significant limitation in the field's ability to understand the sustained impacts of interventions and the developmental trajectories of mathematical learning. As Cevikbas, Kaiser and Schukajlow (2024) noted in their meta-review, the field would benefit from more rigorous, long-term investigations that can track effects over meaningful time periods. This result conformed with the result of Ajao and Awofala (2022) on trends in research in curriculum development and evaluation in mathematics.

Distribution of Studies Based on Geographic Context

Table 3 presents the distribution of the studies based on the context where they were conducted. Geographic analysis revealed substantial disparities in research representation. North America contributed the largest proportion of studies with 42% of the sample, followed by Western Europe (20%), East Asia (15%), Australia and New Zealand (8%), Latin America (7%), Africa (5%), and the Middle East (3%).

Table 3: Distribution of Studies Based on Geographic Context

Geographic Context	Frequency (f)	Percentage (%)
North America	79	42
Western Europe	37	20
East Asia	28	15
Australia/New Zealand	15	8
Latin America	13	7
Africa	9	5
Middle East	6	3
Total	187	100

The geographic distribution of research reveals a troubling concentration of scholarship in North America and Western Europe, which together account for 62% of the sample, while Africa contributes only 5% and Latin America only 7%. This disparity echoes Inglis and Foster's (2018) documentation of persistent Western dominance in mathematics education research and raises fundamental questions about the generalizability and relevance of prevailing findings to the majority of the world's learners. The unique challenges facing mathematics education in under-resourced settings, including large class sizes, limited access to technology, and shortages of

qualified teachers, require locally generated research that can inform contextually appropriate solutions.

Distribution of Studies Based on Educational Level

Table 4 presents the distribution of studies based on the educational level examined. Elementary education was the focus of 38% of studies, secondary education accounted for 34%, tertiary education represented 22%, and studies addressing multiple educational levels comprised 6% of the sample.

Table 4: Distribution of Studies Based on Educational Level

Educational Level	Frequency (f)	Percentage (%)
Elementary	71	38
Secondary	64	34
Tertiary	41	22
Multiple Levels	11	6
Total	187	100

The relatively balanced distribution across elementary and secondary levels indicates sustained attention to mathematics learning throughout the K-12 years. The substantial proportion of tertiary-level studies (22%) reflects growing interest in undergraduate mathematics education and the preparation of future mathematics teachers. However, the limited attention to early childhood mathematics and adult mathematics education represents gaps that future research should address.

General Pattern of the Findings of the Studies on Mathematics Learning and Instruction

The analysis revealed several recurring patterns across the reviewed studies, regardless of context or time of publication. The common findings can be classified under the themes of teacher-related, student-related, content-related, and context-related issues. Regarding teacher-related issues, studies consistently found that teacher knowledge, beliefs, and instructional practices significantly influence student learning outcomes. Teachers with strong mathematical content knowledge and pedagogical content knowledge were more effective in implementing innovative instructional approaches. Professional development programs that were sustained, content-focused, and provided opportunities for classroom implementation and reflection were found to be most effective in enhancing teacher practice. Concerning student-related issues, research revealed that affective factors including mathematics anxiety, attitude, self-efficacy, engagement, motivation, and mindset play crucial roles in mathematics learning (Awofala, 2023; Awofala, 2017; Awofala, 2020; Awofala, Akinoso, 2024; Awofala, Olaguro, Fatade, & Arigbabu, 2024; Lawal & Awofala, 2021). Students with positive mathematical identities and growth mindsets demonstrated greater persistence and achievement. Interventions targeting mathematics anxiety were most effective when combined with cognitive support rather than implemented in isolation. Regarding content-related issues, studies consistently found that making explicit connections between procedures and concepts enhanced both retention and transfer of mathematical knowledge. Curricula that emphasized both conceptual understanding and procedural fluency produced better student outcomes than those prioritizing one aspect over the other. Multiple representation use and mathematical discourse were identified as effective strategies for deepening understanding of 21st century skills (Awofala et al., 2019). These lessen the use of traditional lecture method which has been faulted for promoting passive recipients of information among the students (Adeniyi & Awofala, 2023). Concerning context-related issues, research highlighted the importance of equitable access to resources and opportunities for all students. Students from under-resourced

communities faced significant barriers to mathematics achievement, including limited access to technology, large class sizes, and shortages of qualified teachers. Culturally responsive pedagogy and ethnomathematics approaches were found to increase engagement among students from underrepresented groups.

Conclusion and Suggestions

Conclusion

This study provided a comprehensive synthesis of research trends in mathematics learning and instruction between 2016 and 2025. In response to the first research question, the findings revealed that studies are predominantly focused on technology integration, conceptual understanding, and equity-related issues, with a strong preference for mixed-methods approaches and a concentration in Western contexts. Regarding the second research question, the analysis identified consistent patterns emphasizing the importance of teacher knowledge, student affective factors, conceptual-procedural integration, and equitable learning environments.

Overall, the findings highlight both the progress and limitations within the field, particularly the need for greater geographic inclusivity, increased longitudinal research, and stronger connections between research and classroom practice. These insights provide a clearer direction for future research and policy development in mathematics education.

Suggestions for Future Research

Based on the findings of this study, the following suggestions are offered for future research:

1.Geographic Diversification: Future studies should prioritize research in underrepresented regions, particularly in Africa, Latin America, and the Middle East, to generate locally relevant knowledge and address the unique challenges facing mathematics education in these contexts. International collaborations that respect local knowledge and priorities should be encouraged.

2.Longitudinal Investigations: Researchers should design and implement more longitudinal studies that track intervention effects and developmental trajectories over meaningful time periods. Funding agencies and journals should prioritize long-term investigations that can provide insights into the sustainability and long-term impacts of mathematics education interventions.

3. Interdisciplinary Collaborations: The promise of embodied cognition as an emerging paradigm suggests opportunities for interdisciplinary collaborations between education researchers, cognitive scientists, and neuroscientists. Such collaborations could yield innovative approaches to understanding and supporting mathematical thinking.

4. Practice-Oriented Research: The gap between research and practice, evidenced by the limited attention to implementation studies, suggests that the field would benefit from greater emphasis on participatory research designs that involve teachers as co-researchers and focus on the practical challenges of translating research findings into classroom practice.

5.Diversification of Research Methods: While mixed-methods approaches have gained prominence, researchers should continue to explore innovative methodologies, including design-based research, that can address both process and outcome questions. Greater integration of qualitative and quantitative approaches could provide a more comprehensive understanding of mathematics learning phenomena (Ajao & Awofala, 2022).

6. Attention to Underrepresented Populations: Future research should intentionally include diverse student populations, including students with disabilities, English language learners, and students from marginalized communities, to ensure that findings apply to all learners. Asset-based

approaches that recognize and build upon students' cultural and community resources should be prioritized.

7. Examination of Technology Integration: Given the mixed effectiveness of digital tools reported in the literature, future research should move beyond simple measures of engagement to examine how specific technological affordances can be leveraged to support deep mathematical learning and avoid digital distraction (Akinoso, 2017; Akinoso, 2019; Awofala, Olabiyi, Okunuga, Ojo, Awofala, & Lawani, 2020). Implementation guidelines that address the conditions under which technology enhances learning should be developed. Artificial intelligence tools should be used to supplement students' learning of mathematics (Akinoso, Olaniyi, & Akinoso, 2025; Awofala, Bazza, Ojo, Oladipo, Oladipo, & Arigbabu, 2025).

8. Integration of Cognitive and Affective Factors: Research should continue to explore the interplay between cognitive and affective factors in mathematics learning, recognizing that mathematical thinking is fundamentally shaped by emotional and dispositional factors (Awofala, Olaguro, Fatade, & Arigbabu, 2024; Zakariya, Awofala, & Radmehr, 2024). Interventions that address both cognitive and affective dimensions simultaneously should be developed and evaluated (Lawal & Awofala, 2021).

By addressing these suggestions, researchers can contribute to the advancement of mathematics education through improved understanding of learning and instruction that ultimately enhances student outcomes across diverse contexts.

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