African Educational Research Journal
Vol. 14(3), pp. 637-661, September 2026
ISSN: 2354-2160
Full Length Research Paper

Institutional conditions and transformative teaching practices in mathematics education: A systematic review based on the theory of practice architectures

Rosy Kyakimwe Kaliki[1]*, Kavish Jawahar[2], Wanjala Gidraf Joseph[1], Lekia Nkpordee[3], Julius Alochere Basake[1] and Kasereka Lutswamba Jean[4]

[1]Department of Educational Management, Kampala International University, Kampala, Uganda.
[2]Faculty of Education, Rhodes University, Makhanda, South Africa.
[3]Department of Mathematics and Statistics, Kampala International University, Kampala, Uganda.
[4] Faculty of Education and Psychological Sciences, Free University of the Great Lakes Countries, Goma, DRC.

Accepted 5 August, 2026

ABSTRACT

Despite sustained investments in curriculum reform, teacher professional development, and educational policy, improvements in mathematics teaching and learning remain inconsistent across many education systems, particularly in Sub-Saharan Africa and other resource-constrained contexts. Much of the existing reform agenda has focused on strengthening teachers' competencies while paying comparatively little attention to the institutional conditions that shape classroom practice. This systematic review examines how institutional conditions influence transformative teaching practices in mathematics education through the analytical lens of the Theory of Practice Architectures (TPA). Following the PRISMA 2020 guidelines, a systematic search was conducted across Scopus, Web of Science, ERIC, and Google Scholar, covering studies published between 2015 and 2025. Fifty studies that met the predefined inclusion criteria were synthesized using thematic analysis. The review identified four interconnected themes: cultural-discursive arrangements, material-economic arrangements, socio-political arrangements, and institutional support as the central mechanism linking these dimensions. The findings indicate that transformative mathematics teaching depends on the interaction of institutional beliefs, leadership, professional collaboration, policy implementation, and resource availability rather than on teacher competence alone. The review further demonstrates that coherent institutional environments strengthen learner-centred pedagogies, whereas fragmented leadership, inadequate resources, and weak professional support constrain instructional innovation. The study concludes that sustainable improvements in mathematics education require integrated institutional reforms that align educational policy, instructional leadership, professional learning, and resource investment to support transformative teaching practices and improve learner outcomes.

Keywords: Mathematics education, transformative pedagogy, institutional conditions, theory of practice architectures, systematic review.

*Corresponding author. Email: Kalikirosy@gmail.com.

Abbreviations: TPA – Theory of Practice Architectures; PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses; ICT – Information and Communication Technology; SSA – Sub-Saharan Africa; DRC – Democratic Republic of the Congo; ERIC – Education Resources Information Center; UNESCO – United Nations Educational, Scientific and Cultural Organization.

INTRODUCTION

Improving the quality of mathematics education remains a major priority across education systems because mathematics provides a foundation for scientific literacy, technological innovation, problem-solving, and economic

development. Strengthening mathematics education is therefore essential to develop the knowledge and competencies needed to support scientific advancement, technological progress, workforce development, and sustainable economic growth, particularly in developing countries (Onoshakpokaiye and Avwiri, 2025). Although many countries have introduced curriculum reforms, teacher professional development programmes, and policy initiatives to strengthen mathematics instruction, improvements in learners' mathematical achievement have been uneven. International and regional assessments continue to show that many learners complete basic education without acquiring the conceptual understanding, problem-solving abilities, and numeracy skills required for further education and participation in modern societies (UNESCO, 2022). Recent scholarship suggests that many reform efforts have had limited impact because they have focused mainly on improving teachers' individual competencies while paying insufficient attention to the institutional environments in which teaching and learning take place (Schweisfurth, 2020; Kemmis et al., 2022). Consequently, there is increasing recognition that transformative mathematics teaching depends not only on teacher knowledge and skills but also on the broader cultural, organizational, material, and policy conditions that shape classroom practice (Ndlovu, 2023). These institutional challenges are particularly evident in Sub-Saharan Africa, where education systems continue to operate under significant structural constraints. Many countries in the region face persistent challenges associated with inadequate educational funding, overcrowded classrooms, limited instructional resources, weak infrastructure, and shortages of qualified mathematics teachers. These conditions often restrict opportunities for implementing learner-centred and transformative pedagogies that promote critical thinking, collaboration, and conceptual understanding. Although governments and development partners have invested substantially in curriculum reform and teacher professional development, the outcomes have remained inconsistent across countries and school contexts. Evidence suggests that many reforms have achieved limited success because they were transferred from other educational settings without sufficient adaptation to local institutional realities and implementation capacities (Akyeampong, 2021; Ottevanger et al., 2021). Furthermore, rigid assessment systems, limited teacher autonomy, and inadequate institutional support continue to constrain the effective implementation of innovative mathematics teaching approaches throughout the region (Mhaka, 2022; Westbrook et al., 2020). The challenges are even more pronounced in fragile educational contexts within Sub-Saharan Africa, where prolonged political instability, economic hardship, displacement, and weak public institutions place additional pressure on education systems. In these settings, schools frequently experience shortages of qualified teachers, inadequate teaching materials, poor infrastructure, and limited opportunities for continuous professional development. Such conditions often discourage pedagogical innovation and reinforce teacher-centred instructional practices.

The Democratic Republic of the Congo provides an example of these broader regional challenges. Studies conducted in the country report that overcrowded classrooms, insufficient instructional resources, inconsistent policy implementation, and limited institutional support continue to undermine efforts to improve mathematics teaching and learning (Mukendi, 2023; UNESCO, 2023). Similar patterns have also been documented in other fragile contexts across Sub-Saharan Africa, where institutional conditions frequently limit teachers' capacity to implement transformative pedagogical approaches (Tshibangu and Muteba, 2021; Dryden Peterson, 2022). Although mathematics teacher education and professional development have attracted considerable scholarly attention, relatively few studies have systematically examined how institutional conditions shape transformative teaching practices in mathematics education within Sub-Saharan Africa and other fragile educational contexts. Existing research has predominantly focused on teacher knowledge, instructional strategies, and pedagogical competencies, with comparatively less attention given to the institutional arrangements that enable or constrain classroom transformation. Consequently, limited evidence is available on how school leadership, organizational culture, policy implementation, resource availability, and professional collaboration interact to influence transformative mathematics teaching in these settings (Kemmis and Grootenboer, 2022; Chikoko, 2021). More importantly, no recent systematic review has synthesized this body of evidence through the analytical lens of the Theory of Practice Architectures.

This represents an important conceptual and empirical gap because teaching practices are socially situated activities that are shaped by institutional arrangements as much as by individual teacher competence (Mahon et al., 2021; Sayed and Singh, 2020). Without a clearer understanding of these institutional influences, education reforms are likely to continue addressing symptoms rather than the structural conditions that shape classroom practice. To address this gap, the present study examines how institutional conditions influence transformative mathematics teaching practices through the theoretical lens of the Theory of Practice Architectures (TPA). The theory explains how cultural discursive, material economic, and social-political arrangements shape professional practice within specific institutional settings (Kemmis et al., 2022; Edwards Groves and Mahon, 2020). It therefore provides an appropriate framework for understanding how institutional environments either facilitate or constrain the implementation of learner-centred and transformative pedagogies. Using a systematic review approach, this study synthesizes empirical evidence published between 2015 and 2025,

with particular emphasis on Sub-Saharan Africa and fragile educational contexts where institutional constraints continue to influence the quality of mathematics education. This review contributes to mathematics education research in several important ways. Theoretically, it extends the application of the Theory of Practice Architectures to mathematics education by synthesizing evidence on how institutional arrangements shape teaching practices. Empirically, it integrates findings from diverse educational settings to identify common institutional barriers and enabling conditions associated with transformative mathematics teaching. From a policy and practice perspective, the review provides evidence that can assist governments, education ministries, school leaders, and teacher education institutions in designing reforms that move beyond teacher centred interventions towards broader institutional improvement (Kemmis et al., 2022; UNESCO, 2022). By placing institutional conditions at the center of the analysis, the study offers a more comprehensive understanding of the factors required to achieve sustainable improvements in mathematics teaching across Sub-Saharan Africa and other fragile educational contexts.

The review is guided by the following objectives:

1. To examine the institutional conditions that influence transformative teaching practices in mathematics education.
2. To analyse how cultural discursive, material-economic, and social-political arrangements shape mathematics teaching practices.
3. To identify institutional barriers and enabling factors affecting transformative mathematics education in Sub-Saharan Africa and fragile educational contexts.
4. To synthesize policy and practice implications for strengthening transformative mathematics teaching.

The study addresses the following research questions:

1. What institutional conditions shape transformative teaching practices in mathematics education?
2. How do practice architectures influence the implementation of transformative mathematics pedagogies?
3. What institutional barriers and enabling factors affect transformative mathematics teaching in Sub-Saharan Africa and fragile educational contexts?
4. What policy and practice lessons emerge from the reviewed literature?

THEORETICAL FRAMEWORK

Overview of the theory of practice architectures

The Theory of Practice Architectures (TPA) provides a comprehensive framework for understanding how educational practices are shaped by the institutional environments in which they occur. Developed by Kemmis and colleagues, the theory argues that teaching practices are not merely the product of individual teachers' knowledge, skills, or professional intentions. Rather, they are socially situated practices that are enabled and constrained by the cultural, material, and relational conditions within educational settings (Kemmis et al., 2022). This perspective shifts attention from individual teacher performance to the broader institutional arrangements that influence what teachers are able to say, do, and achieve in their everyday professional practice. Within mathematics education, this perspective is particularly valuable because classroom instruction is influenced by far more than teachers' pedagogical competence alone. Teachers operate within institutional environments that shape instructional decisions through curriculum expectations, assessment systems, leadership practices, professional cultures, resource availability, and policy frameworks. Consequently, efforts to improve mathematics teaching cannot rely exclusively on strengthening teacher knowledge without considering the institutional conditions that either support or restrict meaningful pedagogical change (Edwards Groves and Mahon, 2020; Kemmis et al., 2022).

Recent research on teacher professionalism similarly emphasizes that sustainable improvements in teaching quality require supportive institutional environments that promote collaboration, continuous learning, and professional autonomy rather than isolated investments in individual teacher capacity (OECD, 2023). The increasing application of TPA across educational research reflects a broader shift towards understanding teaching as a socially and institutionally embedded practice. The framework has been widely used to examine educational reform, teacher professional learning, instructional leadership, curriculum implementation, equity, and professional collaboration across different educational contexts (Mahon et al., 2023; Wilkinson and Kemmis, 2021). Beyond the TPA literature, contemporary scholarship on educational change also supports the view that successful instructional reform depends on coherent interactions among leadership, institutional culture, teacher agency, and organizational learning rather than isolated policy initiatives (Fullan, 2020; Hallinger, 2022). Similarly, research on teacher agency argues that teachers' capacity to implement innovative pedagogies is influenced by the opportunities, constraints, and professional relationships created within their institutions rather than by personal competence alone (Priestley et al., 2015).

These complementary perspectives reinforce the central proposition of TPA that educational practice is fundamentally shaped by the contexts in which it is enacted. The theory is especially relevant to mathematics education because transformative teaching approaches, including inquiry-based learning, collaborative problem solving, mathematical reasoning, and learner-centred

instruction, require institutional conditions that encourage innovation and professional reflection. Effective implementation of these approaches depends on curriculum flexibility, instructional leadership, supportive professional communities, and adequate teaching resources. Studies conducted in both African and international contexts consistently demonstrate that schools characterized by collaborative cultures, distributed leadership, and continuous professional learning are more successful in sustaining innovative mathematics teaching practices than institutions operating within rigid administrative structures (Hallinger, 2025; Mahon et al., 2023; Wilkinson and Kemmis, 2021).

Conversely, examination-oriented cultures, limited teacher autonomy, and resource constraints often discourage pedagogical innovation despite ongoing curriculum reforms. The theoretical assumptions of TPA are also consistent with institutional perspectives on educational improvement. Institutional theory suggests that school's function within broader systems of norms, rules, and organizational expectations that influence professional behaviour and educational decision making. Consequently, teachers' instructional practices cannot be understood independently of the institutional structures that regulate curriculum implementation, resource allocation, accountability mechanisms, and professional relationships (Scott, 2014). Likewise, scholarship on instructional leadership emphasizes that school leaders play a pivotal role in creating organizational conditions that support effective teaching through vision building, professional collaboration, and continuous instructional improvement (Hallinger, 2025).

Integrating these complementary perspectives strengthens the theoretical foundation of the present review by demonstrating that transformative mathematics teaching emerges from the interaction between individual professional expertise and supportive institutional environments. Despite the growing application of the Theory of Practice Architectures in educational research, its use within mathematics education remains relatively limited, particularly in evidence synthesis studies. Existing research has primarily examined TPA through individual empirical case studies, teacher professional learning, leadership practices, or curriculum implementation. To the best of current knowledge, no previous systematic review has comprehensively synthesized the evidence on how institutional conditions influence transformative mathematics teaching through the lens of the Theory of Practice Architectures. This represents an important conceptual and empirical gap because existing reviews in mathematics education have largely focused on instructional strategies, teacher knowledge, technology integration, or learner achievement without systematically examining the institutional arrangements that enable or constrain transformative pedagogical practice (Kemmis et al., 2022; Mahon et al., 2023). By addressing this gap, the present review extends the application of TPA within mathematics education and provides an integrated understanding of how cultural discursive, material economic, and social-political arrangements collectively shape transformative teaching across diverse educational contexts, with particular attention to Sub-Saharan Africa and other resource constrained settings. At the center of TPA is the understanding that educational practice consists of interconnected "sayings," "doings," and "relatings" that occur within socially organized environments. These practices are shaped by three interdependent forms of practice architectures: cultural discursive arrangements, which influence language, beliefs, and shared meanings; material economic arrangements, which determine access to physical, technological, and financial resources; and social political arrangements, which regulate leadership, power relations, collaboration, and professional interaction (Kemmis et al., 2022; Lloyd and Mahon, 2021). Rather than viewing these dimensions independently, TPA conceptualizes them as mutually reinforcing institutional conditions that collectively determine the possibilities for educational transformation. This integrated perspective provides a robust theoretical foundation for examining how institutional environments shape transformative mathematics teaching and learner outcomes across different educational settings.

Application of the theory of practice architectures to this review

The Theory of Practice Architectures served as the core analytical framework guiding every stage of this systematic review, from data extraction to coding, thematic development, and interpretation of findings. Rather than functioning solely as a theoretical background, TPA provided the conceptual structure through which institutional conditions influencing transformative mathematics teaching were systematically examined across the reviewed studies (Kemmis et al., 2022). During data extraction, each included study was examined using a structured extraction framework designed around the three dimensions of TPA.

Information relating to institutional beliefs, pedagogical philosophies, curriculum discourse, and classroom communication was coded under cultural discursive arrangements. Evidence concerning infrastructure, instructional materials, technological resources, funding, classroom conditions, and professional development opportunities was classified under material-economic arrangements. Similarly, findings related to leadership practices, institutional culture, teacher collaboration, policy implementation, governance structures, and professional relationships were coded under social-political arrangements (Hardy et al., 2021; Lloyd and Mahon, 2021). Following data extraction, an inductive thematic analysis was undertaken within the broader deductive structure provided by TPA. Initial codes were generated

through repeated reading of the included studies and were subsequently organized into broader categories representing recurring institutional conditions. These categories were then compared across studies to identify convergent patterns, contextual differences, and emerging relationships. Finally, related categories were synthesized into overarching themes that explained how institutional arrangements either enabled or constrained transformative mathematics teaching across different educational contexts. The analytical framework also provided a direct link between the review findings and the study objectives.

The first review objective, which sought to identify institutional conditions influencing transformative teaching practices, was addressed through the synthesis of cultural discursive, material-economic, and social-political arrangements across the reviewed literature. The second objective, which examined how these arrangements shape mathematics teaching practices, was explored by analyzing the interaction among the three dimensions of TPA. The third objective, focusing on institutional barriers and enabling factors within Sub-Saharan Africa and fragile educational contexts, was addressed through comparative synthesis of evidence across geographical settings. Finally, the fourth objective concerning policy and practice implications emerged from the integrated interpretation of institutional conditions influencing sustainable pedagogical transformation. Similarly, the thematic findings were explicitly aligned with the research questions.

The themes on cultural discursive, material-economic, and social-political arrangements addressed the first and second research questions concerning institutional conditions and practice architectures. The synthesis of institutional barriers and enabling factors responded directly to the third research question, while the cross-thematic analysis generated evidence-based policy and practice recommendations that addressed the fourth research question. This close alignment between the theoretical framework, review objectives, coding strategy, and thematic synthesis strengthened the methodological coherence of the review and ensured that the interpretation of findings remained firmly grounded within the Theory of Practice Architectures while incorporating broader perspectives on teacher agency, instructional leadership, institutional change, and professional learning.

Conceptual link between institutional conditions and transformative practices

The central assumption underpinning this review is that transformative mathematics teaching is shaped not only by teachers' knowledge and instructional skills but also by the institutional conditions within which teaching and learning occur. Drawing on the Theory of Practice Architectures (TPA), the review conceptualizes teaching practice as a socially situated activity that is enabled or constrained by interconnected cultural discursive, material-economic, and social-political arrangements. These institutional arrangements influence teachers' professional agency, instructional decision-making, and capacity to adopt learner-centred pedagogies, thereby affecting the quality of mathematics teaching and learning (Kemmis et al., 2022; Edwards Groves and Mahon, 2020). This perspective extends beyond teacher-focused explanations by recognizing that meaningful pedagogical transformation requires supportive institutional environments that align policy, leadership, resources, and professional culture. Institutional conditions also play a critical role in fostering learner autonomy and inclusive participation in mathematics classrooms. When schools provide supportive leadership, continuous professional learning opportunities, adequate instructional resources, and collaborative professional cultures, teachers are better positioned to implement inquiry based, problem solving, and reflective teaching approaches that encourage active learner engagement. Such environments strengthen learners' confidence, critical thinking, conceptual understanding, and capacity for independent mathematical reasoning (Hardy et al., 2021; Ngcobo and Tikly, 2022). Conversely, restrictive institutional cultures, inadequate resources, and rigid accountability systems often reinforce teacher centered instruction and limit opportunities for meaningful learner participation. Recent studies on teacher agency and educational change similarly argue that institutional support is fundamental to sustaining innovative classroom practices and improving educational outcomes (Priestley et al., 2015; Fullan, 2020). The review further recognizes equity and inclusion as integral outcomes of transformative mathematics education. Institutional cultures that promote equitable leadership, inclusive policies, and fair access to learning resources create conditions that enable teachers to address diverse learner needs and reduce barriers associated with gender, language, and social disadvantage. Such environments support broader participation in mathematics learning and contribute to more equitable educational outcomes (Wilkinson and Kemmis, 2021; Lloyd and Mahon, 2021). Based on these relationships, Figure 1 presents the conceptual framework underpinning this review.

The framework illustrates how cultural discursive, material-economic, and social-political arrangements interact to shape institutional support, which in turn influences transformative teaching practices, learner autonomy, equity, and inclusive mathematics education outcomes. The framework therefore provides the analytical foundation for organizing the thematic synthesis and interpreting how institutional conditions enable or constrain transformative mathematics teaching across diverse educational contexts.

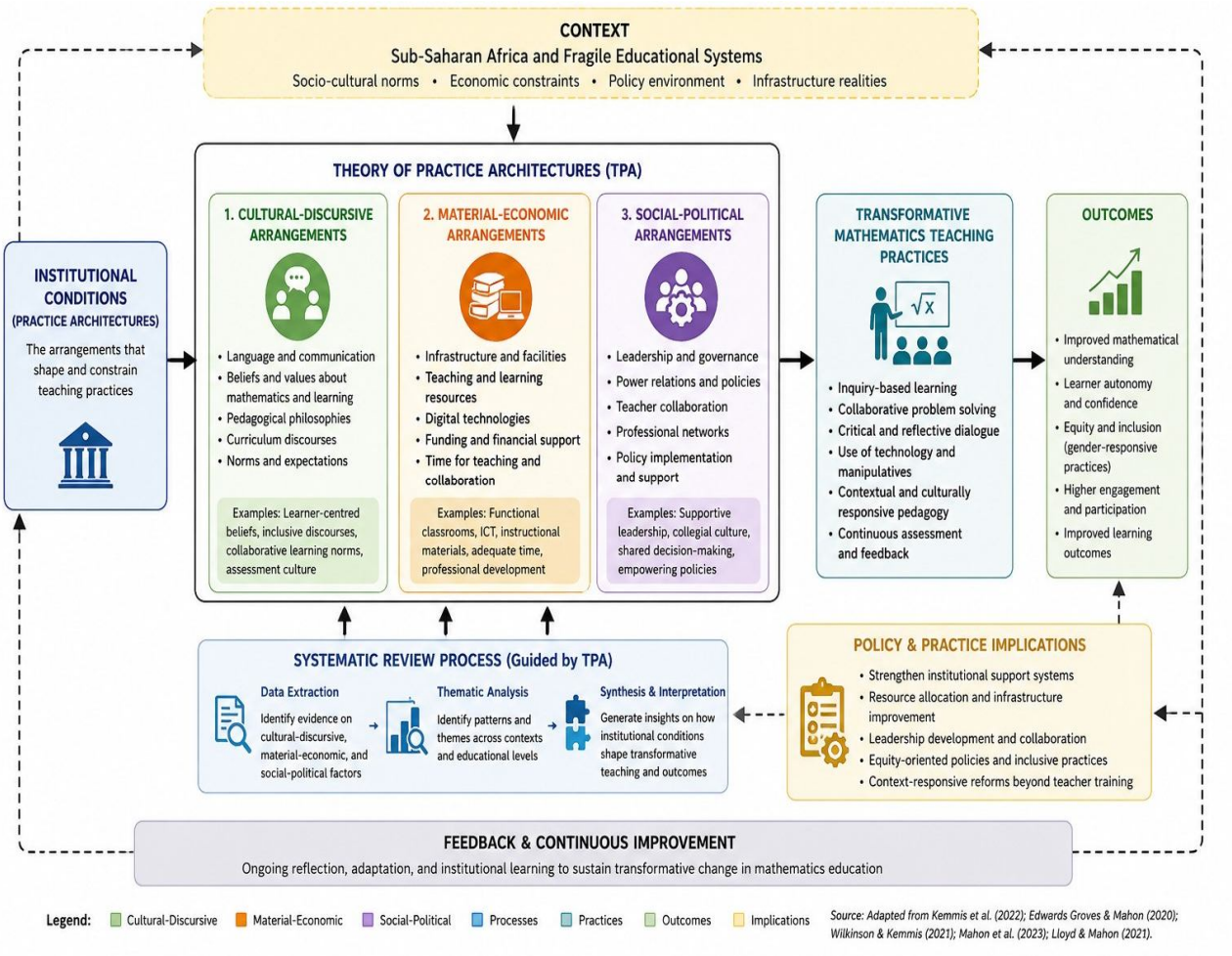

Figure 1. Conceptual framework of institutional conditions and transformative mathematics teaching practices based on the theory of practice architectures (TPA). Source: Adapted and synthesized by the authors from Kemmis et al. (2022), Edwards Groves and Mahon (2020), Wilkinson and Kemmis (2021), and Mahon et al. (2023). Source: Adapted and synthesized by the authors from Kemmis et al. (2022), Edwards Groves and Mahon (2020), Wilkinson and Kemmis (2021), and Mahon et al. (2023).

METHODOLOGY

Systematic review design

This article reports on the results of a systematic review exploring how institutional conditions shape transformative mathematics pedagogies, informed by the lens of the Theory of Practice Architectures. A systematic review approach was utilized because it provides a rigorous, transparent, and reproducible approach to synthesizing the evidence from a heterogeneous body of empirical and scholarly literature. In this study, the aim is not to collect new data but to draw on existing research to identify commonalities, relationships and differences in a body of literature through critical aggregation. The review utilized a PRISMA-guided process in an effort to achieve transparency in all stages of study identification, screening, eligibility and inclusion.

Review approach

The review followed a systematic approach with interpretive synthesis guided by the Theory of Practice Architectures. The PRISMA framework structured the study selection process through four main phases: identification, screening, eligibility, and inclusion, as presented in Table 1.

Data sources

A comprehensive search was conducted across four databases to ensure broad coverage of literature in mathematics education as shown in Table 2.

Table 1. PRISMA phases of study selection process.

Phase	Description	Purpose
Identification	Records retrieved from databases	Comprehensive literature capture
Screening	Titles and abstracts reviewed	Remove irrelevant studies
Eligibility	Full texts assessed	Apply inclusion criteria
Inclusion	Final studies selected	Evidence synthesis

Source: Developed by the authors based on the PRISMA 2020 Statement (Page et al., 2021).

Table 2. Distribution of retrieved records by database.

Database	Records retrieved	Description
Scopus	842	Peer-reviewed international journals
Web of Science	613	High-impact indexed publications
ERIC	289	Education-focused literature
Google Scholar	1,256	Supplementary scholarly sources
Total	3,000	Combined records before screening

Source: Developed by the authors from the systematic database search conducted in January 2026.

Search strategy

A comprehensive search strategy was developed to identify empirical studies and scholarly literature examining institutional conditions and transformative teaching practices in mathematics education. The strategy combined controlled vocabulary, free-text terms, phrase searching, truncation where supported, and Boolean operators to balance the breadth and precision of retrieval.

The search was conducted in Scopus, Web of Science, ERIC, and Google Scholar between 12 and 25 January 2026. Database-specific search syntax was adapted to accommodate differences in indexing systems and search functionalities while maintaining conceptual consistency. The search was limited to literature published between 2015 and 2025, consistent with the review's predefined temporal scope.

Search terms were organized around four core concepts: mathematics education, institutional conditions, transformative teaching practices, and the Theory of Practice Architectures. Boolean operators were used to combine these concepts, with OR linking related or synonymous terms within each concept and AND connecting the main conceptual groups. This approach was intended to maximize the retrieval of relevant literature while maintaining sufficient specificity for the subsequent screening and eligibility assessment.

The principal search string was structured as follows: ("mathematics education" OR "mathematics teaching" OR "mathematics teacher education") AND ("institutional conditions" OR "institutional support" OR "practice architectures" OR "Theory of Practice Architectures") AND ("transformative teaching" OR "learner-centred pedagogy" OR "learner-centred pedagogy" OR "student-centred learning" OR "student-centred learning") AND ("teacher professional development" OR "teaching practice") Additional database specific combinations were used where necessary to improve the retrieval of relevant studies. The search terms and Boolean combinations used in this review are summarized in Table 3.

Table 3. Search terms and Boolean combinations used in the literature search.

Concept	Search terms	Boolean operator
Mathematics education	“Mathematics education”, “mathematics teaching”, “mathematics teacher education”	OR
Institutional conditions	“Institutional conditions”, “institutional support”, “practice architectures”, “Theory of Practice Architectures”	OR
Transformative pedagogy	“Transformative teaching”, “learner-centred pedagogy”, “learner-centered pedagogy”, “student-centred learning”, “student-centered learning”	OR
Professional practice	“Teacher professional development”, “teaching practice”	OR
Combined search strategy	(Concept 1) AND (Concept 2) AND (Concept 3) AND (Concept 4)	AND

Source: Developed by the authors for the systematic literature search.

The search results obtained from each database were exported into a reference management spreadsheet for organization and preliminary screening. Duplicate records identified across the four databases were removed before the screening process commenced. The remaining records underwent a sequential screening process in accordance with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines. This process involved identification, duplicate removal, title screening, abstract screening, full text assessment for eligibility, and final inclusion of studies that satisfied the predefined eligibility criteria. Studies were excluded during full text assessment when they did not address the review objectives, lacked empirical evidence, were published outside the specified time frame, or did not meet the inclusion criteria established for this review. The complete study selection process is presented in the PRISMA flow diagram (Figure 2).

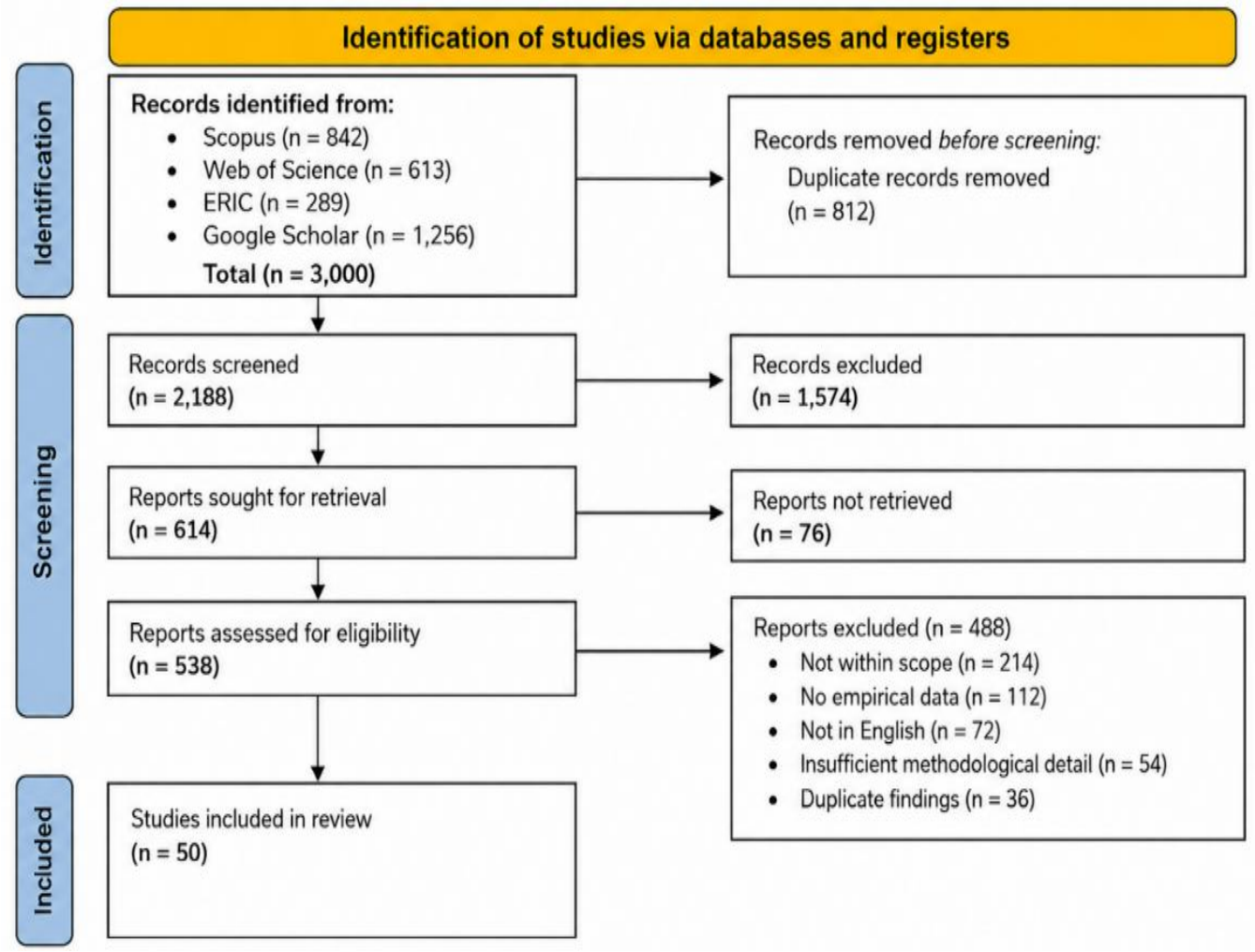

Figure 2. PRISMA flow diagram of study selection. Source: Developed by the authors based on the PRISMA 2020 Statement (Page et al., 2021).

Inclusion criteria

Studies were included based on predefined conditions to ensure relevance and quality, as presented in Table 4.

Exclusion criteria

Studies were excluded when they did not meet minimum methodological or conceptual requirements. This is presented in Table 5.

Table 4. Inclusion criteria.

Criterion	Specification
Publication period	January 2015 to December 2025
Source type	Peer-reviewed journal articles and relevant scholarly publications, including empirical studies, reviews, conceptual/theoretical analyses, research-based chapters and scholarly proceedings
Focus area	Mathematics education and institutional conditions
Language	English
Methodology	Empirical, qualitative, quantitative, mixed-methods, review, conceptual, theoretical, bibliographic or other research-based scholarly designs relevant to the review questions

Source: Developed by the authors based on the study objectives and PRISMA guidelines.

Table 5. Exclusion criteria.

Criterion	Reason for exclusion
Publications lacking sufficient scholarly or methodological basis	Insufficient basis for reliable synthesis
Out-of-period studies	Published outside January 2015 to December 2025
Out-of-field studies	Not related to mathematics education, institutional conditions or transformative teaching
Incomplete texts	Insufficient methodological or scholarly detail
Duplicate findings	Multiple publications reporting the same evidence

Source: Developed by the authors based on the review protocol.

Screening process

The PRISMA screening process ensured transparent filtering of studies. The PRISMA screening process was used to ensure a transparent and systematic selection of studies for inclusion in the review. Records identified through the database search were first imported into a reference management system, where duplicate publications were identified and removed. The remaining records were then screened based on their titles and abstracts to determine their relevance to the review objectives. Studies that appeared to satisfy the inclusion criteria progressed to full- text assessment, while those that did not meet the eligibility requirements were excluded. The reasons for exclusion at the full-text stage included conceptual mismatch, lack of empirical evidence, publication outside the specified review period, and failure to address institutional conditions or transformative mathematics teaching practices. To enhance the consistency of the screening process, all stages of study selection were conducted by one reviewer using the predefined inclusion and exclusion criteria. After the initial screening of titles, abstracts, and full-text articles, the reviewer repeated the entire screening process two weeks later using the same eligibility criteria to verify the consistency of the selection decisions. Any discrepancies identified between the two screening rounds were carefully reviewed and resolved before the final list of included studies was confirmed. This repeated screening process helped reduce selection bias and improved the reliability and transparency of the study selection procedure.

The outcome of the screening process is presented in Table 6.

Table 6. PRISMA screening outcomes.

Stage	Records	Excluded	Remaining
Identification	3,000	812 duplicates removed	2,188
Title and abstract screening	2,188	1,574 excluded	614
Full-text retrieval	614	76 inaccessible	538
Eligibility assessment	538	488 excluded	50
Final inclusion	50	0	50

Source: Developed by the authors from the PRISMA-guided study selection process.

Table 6 shows that 3,000 records were initially identified from the selected databases.

After removing 812 duplicate records, 2,188 unique studies remained for title and abstract screening. A total of 1,574 records were excluded because they did not meet the inclusion criteria, leaving 614 articles for full text retrieval. Of these, 76 articles could not be accessed, resulting in 538 studies for eligibility assessment. During the full text assessment, 488 studies were excluded due to conceptual mismatch with the review objectives, lack of empirical evidence, failure to address institutional conditions or transformative mathematics teaching, insufficient methodological detail, language restrictions, or duplication of findings across multiple publications. Consequently, 50 studies met all the inclusion criteria and were included in the final thematic synthesis.

PRISMA flow summary

The selection process followed a structured pathway from identification to inclusion, ensuring traceability and methodological transparency as shown in Table 7. The flow of the study selection is illustrated in Figure 2.

Table 7. Summary of PRISMA flow.

Stage	Number of studies
Identified records	3,000
After duplicates removed	2,188
After screening	614
Full texts assessed	538
Excluded full texts	488
Final included studies	50

Source: Developed by the authors from the systematic review screening process.

Data extraction

A structured extraction form was used to ensure consistency across studies.

Table 8. Data extraction framework.

Variable	Description
Author(s)	Study authorship details
Year	Publication year
Country	Geographical context
Study focus	Institutional and pedagogical themes
Key findings	Main findings relevant to the review questions

Source: Developed by the authors for systematic data extraction.

Data analysis method

Thematic analysis was used to synthesize findings across studies. Coding was guided by the Theory of Practice Architectures, focusing on cultural discursive arrangements, material-economic arrangements, and social-political arrangements as shown in Table 9. Methodological design ensured transparency, reproducibility and academic rigor. PRISMA guided the selection; inclusion criteria produced consistency in selecting research; and a systematic search strategy combined with the screening process, in line with the protocol, underpinned by the theory generated and applied in thematic synthesis to combine the evidence on the institutional conditions that influenced mathematics teaching.

Table 9. Thematic analysis framework.

Stage	Description	Output
Familiarization	Repeated reading of studies	Initial understanding
Coding	Identification of key concepts	Code list
Theme development	Grouping similar codes	Thematic structure
Interpretation	Linking to theory	Theoretical synthesis

Source: Developed by the authors based on Braun and Clarke (2006) and the Theory of Practice Architectures.

Quality appraisal of included studies

To strengthen methodological rigor, the Mixed Methods Appraisal Tool (MMAT) was applied to the empirical qualitative, quantitative, and mixed-methods studies within the 50-source corpus. Scholarly reviews, conceptual and theoretical analyses, bibliographic studies, chapters, and other non-empirical scholarly publications were not assigned MMAT scores; instead, they were assessed for methodological transparency, conceptual clarity, relevance, and fit with the review questions. Evidence from sources with clearer methodological reporting was given greater interpretive weight during synthesis.

This approach avoids treating heterogeneous scholarly sources as if they were all empirical studies. The quality appraisal therefore informs the interpretation of the empirical subset, while the broader scholarly sources contribute contextual, theoretical, and review-based evidence to the thematic synthesis.

Table 10. Methodological quality appraisal of the included evidence.

Evidence type	Appraisal approach
Empirical qualitative, quantitative and mixed-methods studies	MMAT criteria appropriate to the research design
Systematic, scoping, narrative and other scholarly reviews	Assessed for methodological transparency, relevance and fit to the review questions; not assigned MMAT scores
Conceptual/theoretical analyses, bibliographic studies, chapters and other scholarly publications	Assessed for relevance, conceptual clarity and scholarly transparency; not assigned MMAT scores

Source: Developed by the authors based on the Mixed Methods Appraisal Tool (Hong et al., 2018).

RESULT AND THEMATIC ANALYSIS

The thematic synthesis of the 50 studies and scholarly reviews included in this systematic review demonstrates that transformative mathematics teaching is shaped by interconnected institutional conditions rather than by teacher competence alone. Across the reviewed literature, evidence consistently shows that classroom practices emerge through the interaction of cultural-discursive, material-economic, and socio-political arrangements, as conceptualized by the Theory of Practice Architectures (Kemmis et al., 2022). Although these institutional dimensions were examined separately for analytical purposes, the findings indicate that they operate as mutually reinforcing systems that either enable or constrain transformative pedagogical practices. The reviewed studies also reveal considerable contextual variation. While research conducted in well- resourced educational systems frequently reports successful implementation of learner-centred and technology-enhanced mathematics instruction (Fazio et al., 2024; Liu, 2025; Prediger and Selter, 2024), studies from Sub-Saharan Africa and other resource-constrained settings consistently identify institutional barriers that limit the translation of policy reforms into classroom practice (Agbata et al., 2024; Wondem et al., 2023). Rather than presenting uniform patterns, the evidence suggests that institutional context moderates the effectiveness of transformative teaching approaches. Four interrelated themes emerged from the thematic analysis.

Core components of the theory of practice architectures (TPA)

Cultural discursive arrangements

Cultural discursive arrangements refer to the shared beliefs, professional language, pedagogical values, and institutional norms that shape how mathematics teaching is understood and enacted within schools. Across the reviewed studies, this dimension emerged as one of the strongest influences on teachers' instructional decisions because it defines what teachers perceive as legitimate classroom practice. A dominant pattern across studies from Africa, Europe, Asia, and Australia is the persistence of traditional beliefs about mathematics as a body of fixed procedural knowledge that should be transmitted from teacher to learner (Guler and Celik, 2023; Mageed, 2025; Madi and Gusni, 2025). These beliefs continue to reinforce teacher-centred instruction despite widespread curriculum reforms advocating inquiry-based and learner-centred pedagogies. For example, Agbata et al. (2024) reported that mathematics education across many African countries remains strongly influenced by examination-oriented traditions and conventional instructional practices, while Wondem et al. (2023) similarly found that institutional cultures in Ethiopian schools limited teachers' willingness to adopt innovative instructional approaches. However, the evidence is not entirely consistent. Several international reviews reported that schools promoting culturally responsive teaching, ethnomathematics, and critical pedagogy achieved higher learner engagement and conceptual understanding (Kusi and Bonyah, 2025;

Lamsal, 2025; Villarin et al., 2024). Likewise, Ferguson (2024) and Mageed (2025) demonstrated that culturally inclusive instructional approaches encouraged active participation and improved mathematics learning outcomes. These contrasting findings suggest that cultural beliefs do not operate independently but are mediated by institutional expectations and professional learning cultures. Language of instruction also emerged as an important institutional condition. Studies conducted in multilingual educational contexts indicate that the exclusive use of official languages during mathematics instruction often reduces classroom interaction and limits learners' opportunities to explain mathematical reasoning (Agbata et al., 2024; Aminifar et al., 2024). Conversely, culturally responsive approaches that recognize learners' linguistic backgrounds appear to promote greater participation and conceptual understanding (Villarin et al., 2024; Mageed, 2025). Taken together, these findings suggest that cultural discursive arrangements influence not only what teachers believe about mathematics but also how those beliefs are translated into classroom practice. Within the Theory of Practice Architectures, these shared meanings shape the "sayings" of educational practice and either enable or constrain the adoption of transformative pedagogies. (Table 11)

Table 11. Cultural discursive conditions and their influence on mathematics teaching.

Cultural discursive condition	Evidence synthesized from reviewed studies	Implications for transformative teaching
Traditional beliefs about mathematics	Studies reported continued reliance on procedural and teacher-centred instruction (Agbata et al., 2024; Guler and Celik, 2023; Wondem et al., 2023).	Restricts inquiry-based learning and learner autonomy.
Examination-driven institutional culture	Curriculum coverage and examination preparation often take precedence over conceptual understanding (Agbata et al., 2024; Madi and Gusni, 2025).	Encourages transmission-oriented teaching practices.
Culturally responsive pedagogy	Reviews reported improved learner engagement where teaching reflected learners' cultural experiences (Ferguson, 2024; Kusi and Bonyah, 2025; Mageed, 2025).	Supports inclusive and learner-centred mathematics instruction.
Language of instruction	Multilingual contexts show that language practices can influence participation and opportunities to explain mathematical reasoning (Agbata et al., 2024; Amini far et al., 2024).	Influences classroom interaction and conceptual understanding.

Source: Synthesized by the authors from the reviewed studies and scholarly reviews (n = 50).

Overall, the evidence indicates that transformative mathematics teaching depends not only on teachers' pedagogical knowledge but also on institutional beliefs and professional discourses that legitimize learner-centred instructional practices.

Material economic conditions

Material economic arrangements refer to the physical, technological, and financial conditions that support or constrain mathematics teaching. Across the reviewed studies, this theme emerged as one of the most consistently reported determinants of successful pedagogical transformation. Most studies conducted in low- and middle-income countries identified inadequate instructional resources, poor ICT infrastructure, overcrowded classrooms, and insufficient funding as persistent barriers to implementing learner-centred mathematics instruction (Agbata et al., 2024; Erdoğan, 2025; Wondem et al., 2023). Similar findings were reported by Mukuka and Alex (2024), who observed that although teachers valued collaborative and innovative teaching approaches, unequal access to instructional resources substantially reduced implementation effectiveness. Technology integration presents an important example of this contextual variation. International systematic reviews consistently concluded that digital technologies enhance conceptual understanding, learner engagement, and mathematics achievement when adequate institutional support is available (Fatwana et al., 2024; Mustafa, 2024; Putri et al., 2025). Likewise, Liu (2025) demonstrated that technology-supported instruction significantly improved learner participation and mathematical problem solving in Chinese classrooms. However, these positive outcomes were rarely replicated in resource-constrained educational systems where limited infrastructure, unstable internet connectivity, and inadequate technical support prevented meaningful technology integration (Agbata et al., 2024;

Erdoğan, 2025). The evidence also reveals differences in classroom organization. Studies from developing countries repeatedly associated overcrowded classrooms with reduced opportunities for formative assessment, collaborative learning, and differentiated instruction (Agbata et al., 2024; Wondem et al., 2023). In contrast, research conducted in higher resource settings reported that access to manipulatives, digital technologies, and flexible learning environments supported more interactive mathematics instruction (Fazio et al., 2024; Roesken Winter et al., 2021). These findings indicate that material-economic arrangements extend beyond the availability of physical resources. They shape what teachers are practically able to do in classrooms and therefore influence the "doings" of educational practice within the Theory of Practice Architectures. The evidence further suggests that positive teacher beliefs alone are insufficient to sustain transformative pedagogy when institutional resources remain inadequate.

Table 12. Material economic conditions and their influence on mathematics teaching.

Material economic condition	Evidence synthesized from reviewed studies	Implications for transformative teaching
ICT infrastructure	Technology integration improves learning where infrastructure exists but remains limited in many developing contexts (Erdoğan, 2025; Fatwana et al., 2024; Mustafa, 2024).	Determines opportunities for technology-enhanced instruction.
Teaching and learning resources	Limited instructional and technological resources can reduce teachers' capacity to implement learner-centred pedagogy (Agbata et al., 2024; Mukuka and Alex, 2024).	Restricts instructional diversity and learner engagement.
Classroom conditions	Overcrowded classrooms constrain formative assessment and collaborative learning (Agbata et al., 2024; Wondem et al., 2023).	Limits active participation and personalized instruction.
Institutional investment	Sustained investment in professional development and instructional resources supports stronger implementation of mathematics reforms (Fazio et al., 2024; Roesken Winter et al., 2021).	Supports sustainable pedagogical transformation.

Source: Synthesized by the authors from the reviewed studies and scholarly reviews (n = 50).

The synthesis demonstrates that material-economic arrangements influence transformative teaching through the resources and opportunities available to teachers. While technology and innovative instructional approaches consistently improve mathematics learning, their effectiveness depends on adequate institutional investment and supportive learning environments rather than on teacher commitment alone.

Socio-political conditions

Socio-political arrangements refer to the institutional relationships, leadership practices, governance structures, and professional interactions that shape how mathematics teaching is enacted within schools. Across the 50 studies reviewed, this dimension consistently emerged as a critical determinant of whether transformative teaching practices were successfully implemented or remained constrained. Rather than influencing classroom practice independently, leadership, teacher collaboration, institutional culture, and equity policies interacted to either strengthen or weaken teachers' capacity to adopt learner-centred pedagogies.

A common finding across studies conducted in the United States, Germany, Australia, Türkiye, and African educational contexts was that supportive instructional leadership promotes teacher innovation, collaborative planning, and sustained professional learning (Cobb et al., 2017; García Martínez et al., 2018; Prediger and Selter, 2024; Roesken Winter et al., 2021; Wondem et al., 2023). Similarly, McClain and Cobb (2024) and Fazio et al. (2024) reported that schools where leaders actively supported curriculum implementation and professional development created favorable conditions for instructional improvement. In contrast, studies from Ethiopia and other resource-constrained contexts found that hierarchical management structures, limited teacher participation in decision-making, and weak institutional support discouraged experimentation with innovative mathematics teaching approaches (Wondem et al., 2023; Agbata et al., 2024).

Teacher collaboration also emerged as an important mechanism through which social-political arrangements influenced classroom practice. Studies from Australia, the United Kingdom, Brazil, and the United States consistently showed that professional learning communities, collaborative lesson planning, and reflective dialogue enhanced teacher confidence, instructional quality, and the adoption of learner-centred pedagogies (Balatti and

Belward, 2022; Clark Wilson, 2017; Rossa and Estevam, 2022; Stein and Coburn, 2018). However, this pattern was not universal. Evidence from Oman and several Sub-Saharan African contexts suggested that collaboration often remained informal because of heavy workloads, inadequate institutional structures, and limited time for professional interaction, thereby reducing opportunities for sustained pedagogical improvement (Mukuka and Alex, 2024; Agbata et al., 2024). The review also revealed variation in the implementation of equity and inclusion policies. While studies from the United States and New Zealand reported that inclusive institutional cultures promoted equitable participation and challenged discriminatory classroom practices (Salazar, 2023; Guler and Celik, 2023), research conducted in developing educational contexts found that gender responsive policies were frequently implemented at the policy level but only partially reflected in classroom practice. Persistent cultural norms, unequal participation, and teacher expectations continued to influence girls' engagement in mathematics learning (Ngcobo and Tikly, 2022; Aminifar et al., 2024). These contrasting findings suggest that institutional commitment alone is insufficient unless accompanied by supportive leadership, continuous professional development, and inclusive school cultures.

Table 13. Social-political conditions and their influence on mathematics education.

Social-political factor	Evidence synthesized from reviewed studies	Influence on mathematics teaching
Leadership support	Collaborative and instructional leadership strengthened teacher innovation and curriculum implementation (McClain and Cobb, 2024; García Martínez et al., 2018; Prediger and Selter, 2024).	Greater adoption of learner-centred and inquiry-based teaching.
Professional collaboration	Professional learning communities enhanced teacher learning, while collaboration can remain weak in low-resource settings (Stein and Coburn, 2018; Clark Wilson, 2017; Agbata et al., 2024).	Improved instructional quality where sustained collaboration exists.
Institutional culture and equity	Inclusive school cultures promoted equitable participation, while traditional institutional norms can limit equity (Salazar, 2023; Guler and Celik, 2023; Aminifar et al., 2024).	Greater learner participation and inclusion were institutional cultures support equity.

Source: Synthesized by the authors from the reviewed studies and scholarly reviews (n = 50).

Viewed through the Theory of Practice Architectures, the findings demonstrate that social-political arrangements shape the "relatings" of educational practice by influencing professional relationships, institutional authority, and collaborative engagement. Institutions characterized by participatory leadership and strong professional networks were consistently associated with transformative mathematics teaching, whereas rigid governance structures constrained teacher agency and innovation.

Overall, the reviewed evidence indicates that institutional support is the central mechanism linking policy, professional learning, leadership, and resource provision. Rather than operating independently, these institutional structures reinforce the broader practice architectures that enable transformative mathematics teaching.

Institutional support as a central driver

Institutional support emerged as a cross-cutting condition connecting the three dimensions of the Theory of Practice Architectures. Across the reviewed studies, institutional support extended beyond financial investment to include coherent policy implementation, sustained professional development, organizational leadership, curriculum support, and long-term investment in teaching resources. The findings indicate that these institutional mechanisms determine whether educational reforms become embedded in classroom practice or remain policy aspirations.

A consistent finding across studies from Germany, the United States, Australia, Canada, and China were that successful mathematics reforms depended on coordinated institutional systems rather than isolated teacher interventions (Cobb et al., 2017; Fazio et al., 2024; Liu, 2025; Prediger and Selter, 2024; Roesken Winter et al., 2021). These studies showed that curriculum materials, leadership support, continuous professional learning, and institutional planning reinforced one another to sustain pedagogical change. Similar conclusions were reached by Visnovska and Zhao (2021), who found that teachers required ongoing institutional support that recognized both instructional practice and local teaching contexts.

Policy implementation emerged as one of the strongest institutional influences. While competency based and learner centred curricula were widely promoted across many education systems, several studies reported

substantial gaps between policy intentions and classroom implementation because teachers often received limited follow up support after reforms were introduced (Agbata et al., 2024; Wondem et al., 2023; Erdoğan, 2025). Comparable implementation challenges were reported in global systematic reviews, where innovative pedagogies frequently produced positive outcomes only when accompanied by sustained institutional investment and organizational commitment (Jamil et al., 2025; Madi and Gusni, 2025).

Professional development also differentiated high performing and low performing institutional systems. Studies consistently demonstrated that continuous, collaborative, and practice based professional development improved teachers' instructional competence more effectively than isolated workshops or one-off training programmes (Clark Wilson, 2017; Fatwana et al., 2024; Webb, 2018). However, several reviews observed that professional development initiatives in many low- and middle-income countries remained irregular, externally driven, and weakly connected to classroom realities, thereby limiting long term sustainability (Agbata et al., 2024; Fatwana et al., 2024).

Taken together, these findings suggest that institutional support functions as the integrating mechanism through which cultural discursive, material economic, and social political arrangements are translated into sustainable classroom practice. Where institutional support systems were coherent, transformative mathematics teaching was more likely to be sustained across different educational contexts.

Table 14. Institutional support structures and their role in teaching transformation.

Institutional support structure	Evidence synthesized from reviewed studies	Influence on mathematics teaching
Policy implementation	Curriculum reforms were more successful when supported by coherent institutional planning and continuous implementation support (Prediger and Selter, 2024; Roesken Winter et al., 2021).	Improved implementation of learner-centred pedagogies.
Professional development	Continuous, collaborative professional learning strengthened instructional competence more effectively than short-term training (Clark Wilson, 2017; Webb, 2018; Fatwana et al., 2024).	Greater sustainability of pedagogical innovation.
Institutional investment	Adequate funding, leadership support and curriculum resources enhanced implementation of mathematics reforms (Cobb et al., 2017; Fazio et al., 2024; Liu, 2025).	Increased institutional capacity for transformative teaching.

Source: Synthesized by the authors from the reviewed studies and scholarly reviews (n = 50).

Overall, the reviewed evidence indicates that institutional support is the central mechanism linking policy, professional learning, leadership, and resource provision. Rather than operating independently, these institutional structures reinforce the broader practice architectures that enable transformative mathematics teaching.

Integrated interaction of practice architectures

Although the four themes were examined separately to facilitate analysis, the evidence synthesized from the 50 reviewed studies demonstrates that the three dimensions of the Theory of Practice Architectures (TPA), namely cultural discursive, material-economic, and social-political arrangements, function as an interconnected institutional system rather than as independent influences on mathematics teaching. Across diverse educational contexts, transformative teaching practices were consistently observed where these institutional conditions operated in a complementary manner, while weaknesses in one dimension frequently constrained the effectiveness of the others (Edwards Groves and Grootenboer, 2024; Kemmis, 2015; Edwards Groves et al., 2020). The review further shows that institutional beliefs about mathematics teaching shaped how available resources were used and how leadership supported instructional innovation. For example, studies conducted in Australia, Germany, and the United States found that learner-centred pedagogies were more sustainable when schools combined collaborative professional cultures, adequate instructional resources, and coherent leadership structures (Cobb et al., 2017; Prediger and Selter, 2024; Roesken Winter et al., 2021).

In contrast, studies from Ethiopia and broader African contexts reported that even where teachers expressed positive attitudes towards learner-centred instruction, inadequate infrastructure, weak institutional support, and limited professional collaboration often prevented these approaches from being implemented effectively (Agbata et al., 2024; Wondem et al., 2023). These contrasting findings suggest that institutional conditions moderate the relationship between teachers' pedagogical beliefs and classroom practice. A consistent pattern across the

reviewed studies is that sustainable transformation in mathematics education depends on the alignment of institutional culture, resource availability, and leadership support rather than on improvements in teacher competence alone. This finding reinforces the central proposition of the Theory of Practice Architectures that educational practice is produced through the interaction of cultural discursive, material economic, and socio-political arrangements that shape what teachers are able to say, do, and achieve within specific institutional settings (Kemmis et al., 2022; Variyan and Edwards Groves, 2024).

Table 15. Integrated interaction of practice architecture dimensions and mathematics teaching outcomes.

Cultural discursive arrangements	Material economic arrangements	Social-political arrangements	Observed teaching outcome
Traditional beliefs about mathematics as procedural knowledge	Limited ICT infrastructure, inadequate instructional resources, overcrowded classrooms	Directive leadership, weak collaboration, limited teacher autonomy	Predominantly teacher-centred instruction with low learner participation
Learner-centred pedagogical beliefs	Adequate instructional materials, digital technologies, supportive learning environments	Collaborative leadership, professional learning communities, continuous professional development	Transformative teaching charact-erized by inquiry-based learning, learner autonomy, collaboration and active learner engagement

Source: Synthesized by the authors from the reviewed studies and scholarly reviews (n = 50).

Synthesis across themes

Taken together, the findings demonstrate that transformative mathematics teaching is shaped by the interaction of institutional conditions rather than by individual teacher capability alone. Cultural discursive arrangements influence teachers' beliefs and instructional practices, material-economic arrangements determine the practical conditions under which teaching occurs, while social-political arrangements influence leadership, collaboration, and professional agency. Institutional support operates across these dimensions by strengthening policy implementation, professional development, and resource allocation. Consequently, reforms that focus exclusively on teacher training without addressing the broader institutional environment are unlikely to produce sustained improvements in mathematics teaching. The evidence therefore supports a systems-based approach to mathematics education reform in which institutional culture, resources, leadership, and professional learning are developed simultaneously to create conditions that sustain transformative teaching practices (Cobb et al., 2017; Edwards Groves and Grootenboer, 2024; Kemmis et al., 2022).

DISCUSSION

This review applied the Theory of Practice Architectures (TPA) to examine how institutional conditions shape transformative teaching practices in mathematics education. Rather than viewing instructional change as the outcome of individual teacher competence alone, the findings indicate that sustainable pedagogical transformation depends on the interaction between cultural discursive, material-economic, and social-political arrangements. TPA provides an explanatory lens for understanding why similar mathematics reforms produce different outcomes across educational contexts. The evidence suggests that reform initiatives are more likely to succeed when institutional beliefs, resources, leadership, and professional relationships operate in a coordinated manner. This interpretation extends earlier conceptual work by Kemmis et al. (2022) and Edwards Groves and Grootenboer (2024), who argue that educational practices are socially and institutionally produced rather than individually determined.

The review further demonstrates that cultural discursive arrangements influence transformative mathematics teaching by shaping how teachers interpret curriculum reform and classroom practice. Although many education systems formally advocate learner-centred and inquiry-based approaches, several studies indicate that teachers continue to work within institutional cultures that privilege procedural knowledge, examination performance, and teacher authority (Guler and Celik, 2023; Mageed, 2025; Ferguson, 2024). This helps explain why policy reforms frequently fail to produce meaningful classroom transformation. The issue is therefore not simply resistance to innovation, but the persistence of institutional discourses that define what is considered legitimate mathematics teaching. Similar observations have been reported by Schweisfurth (2020), Ndlovu (2023), and Lamsal (2025), who argue that transformative pedagogies require parallel changes in institutional culture if they are to become embedded in everyday classroom practice. The findings also suggest that material-economic conditions influence reform implementation by determining the extent

to which teachers are able to translate pedagogical intentions into classroom practice. Across both high-income and low-resource settings, innovative approaches such as technology-enhanced learning, ethnomathematics, blended learning, and inquiry-based instruction consistently improved learner engagement when adequate institutional support was available (Mustafa, 2024; Putri et al., 2025; Madi and Gusni, 2025).

Evidence from Ethiopia, many Sub-Saharan African countries, and other resource-constrained settings shows that inadequate infrastructure, limited instructional materials, and weak digital capacity continue to restrict implementation (Wondem et al., 2023; Agbata et al., 2024; Erdoğan, 2025). These contrasting findings indicate that material resources do not independently guarantee transformative practice. Instead, they operate as enabling conditions that allow teachers to enact innovative pedagogies when supported by appropriate institutional systems. A similar pattern emerged for socio-political arrangements. The review indicates that instructional leadership, collaborative professional cultures, and coherent professional development systems strengthen teacher agency and encourage experimentation with learner-centred pedagogies. Studies conducted in Australia, Germany, the United States, and other contexts consistently show that collaborative professional learning communities and supportive leadership create favorable conditions for sustained instructional improvement (Stein and Coburn, 2018; Roesken Winter et al., 2021; Prediger and Selter, 2024). Nevertheless, evidence from fragile and resource-constrained education systems suggests that highly centralized governance structures, examination-driven accountability, and limited teacher autonomy often reduce opportunities for innovation (Mukendi, 2023; Mukuka and Alex, 2024). These contrasting findings reinforce the TPA proposition that professional practice is shaped not only by teachers' expertise but also by institutional relationships and power structures that influence professional decision-making. An important contribution of this review is the recognition that the three dimensions of TPA function as an interconnected system rather than as separate influences on teaching practice. Across the reviewed studies, institutional culture influenced how resources were utilized, leadership shaped opportunities for collaboration, and professional relationships affected teachers' willingness to implement new pedagogical approaches. Evidence from implementation research similarly demonstrates that mathematics reforms are most successful when curriculum, leadership, professional development, and institutional support evolve simultaneously rather than through isolated interventions (Cobb et al., 2017; Fazio et al., 2024; McClain and Cobb, 2024).

This interaction explains why reforms that address only one institutional dimension frequently produce limited or short-lived improvements. The review also identifies several important gaps within the existing literature. First, although institutional support is widely recognized as essential for successful reform, there remains considerable variation in how it is conceptualized. Some studies define institutional support primarily in terms of funding and infrastructure, whereas others include leadership, policy alignment, teacher collaboration, and professional learning (Visnovska and Zhao, 2021; Fatwana et al., 2024). This conceptual inconsistency makes comparisons across studies difficult and limits cumulative knowledge development. Second, relatively few studies directly examine how institutional conditions influence measurable learner outcomes such as conceptual understanding, learner autonomy, equity, and mathematical achievement. Finally, while gender equity is frequently discussed within policy documents, there remains limited empirical evidence explaining how institutional arrangements either reproduce or reduce gender disparities in mathematics classrooms. Addressing these gaps would strengthen future applications of the Theory of Practice Architectures and provide a more comprehensive understanding of how institutional reform contributes to sustainable improvements in mathematics education.

Limitations of the review

Like all systematic reviews, this study has several limitations that should be considered when interpreting the findings. First, the review included only studies published in English. As a result, relevant evidence reported in other languages may not have been captured, particularly from multilingual educational contexts. Second, the synthesis was restricted to English-language peer-reviewed and relevant scholarly publications that met the revised eligibility criteria. This strengthened the scholarly basis of the corpus while excluding non-scholarly grey literature and publications that did not provide sufficient research or conceptual detail for the review questions. The review also relied partly on Google Scholar to complement searches conducted in Scopus, Web of Science, and ERIC.

While Google Scholar increases the breadth of literature coverage, its indexing process is less transparent than that of curated bibliographic databases, and search results may vary over time. In addition, the review is subject to publication bias because studies reporting significant or positive findings are generally more likely to be published than those with null or inconclusive results. Although a structured quality appraisal was undertaken, some degree of reviewer judgment was unavoidable during study screening, quality assessment, and thematic interpretation. Such judgments may introduce a small degree of subjective bias despite the use of predefined review procedures. Furthermore, this review employed a qualitative thematic synthesis rather than a meta-analysis because the included studies differed substantially in research design, methodological approaches, contexts,

and outcome measures. Consequently, the review identifies patterns across studies but does not estimate pooled effect sizes. Finally, much of the available evidence originated from Sub-Saharan Africa and other fragile educational settings, reflecting the focus of this review. While this strengthens the contextual relevance of the findings for these regions, caution should be exercised when generalizing the conclusions to educational systems with different institutional, cultural, or economic conditions. Future systematic reviews could broaden the geographical scope, incorporate studies published in additional languages, include high-quality grey literature where appropriate, and apply meta-analytic techniques where sufficient comparable evidence is available.

Review implications

Policy implications

The findings indicate that improving mathematics teaching requires policy reforms that extend beyond strengthening individual teacher competencies to addressing the institutional conditions that shape classroom practice. From the perspective of the Theory of Practice Architectures (TPA), reforms are more likely to succeed when curriculum policies, school leadership, resource allocation, and professional development operate as mutually reinforcing systems rather than as isolated interventions. Evidence from the reviewed studies suggests that policy implementation is most effective when governments invest in sustained professional learning, equitable distribution of instructional resources, and school-level support structures that enable teachers to adopt learner-centred pedagogies (Cobb et al., 2017; García Martínez et al., 2018; Prediger and Selter, 2024). These findings imply that education policies should emphasize institutional coherence alongside teacher development to achieve sustainable improvements in mathematics education.

Institutional implications

The review demonstrates that institutional environments influence the extent to which teachers can implement transformative pedagogies. Universities, teacher education institutions, and schools should therefore strengthen collaborative professional cultures through mentoring, professional learning communities, reflective practice, and instructional leadership. Such institutional arrangements enhance teacher agency and encourage the sustained adoption of innovative teaching approaches rather than one off pedagogical change (Edwards Groves et al., 2020; Roesken Winter et al., 2021; Visnovska and Zhao, 2021). Institutional investment in supportive leadership, continuous professional development, and collaborative learning environments is likely to create conditions that enable meaningful and lasting instructional improvement.

Practice implications

For classroom practice, the findings suggest that transformative mathematics teaching depends on teachers working within supportive institutional contexts rather than relying solely on individual expertise. Mathematics teachers should be encouraged to integrate inquiry-based learning, collaborative problem solving, culturally responsive teaching, and appropriate digital technologies to promote learner engagement and conceptual understanding. However, these practices should be adapted to local contexts and available resources because evidence from the reviewed studies shows that the effectiveness of innovative pedagogies varies according to institutional capacity and classroom realities (Madi and Gusni, 2025; Putri et al., 2025; Erdoğan, 2025). This highlights the importance of context responsive professional learning rather than universal implementation models.

Research implications

The review also identifies several priorities for future research. First, there is a need for more empirical studies that examine how the three dimensions of TPA interact to influence mathematics teaching and learner outcomes in different educational contexts. Second, longitudinal and mixed methods studies would provide stronger evidence on how institutional reforms shape pedagogical change over time. Third, future systematic reviews should incorporate methodological quality appraisal and comparative analyses across geographical regions to strengthen the evidence base. Finally, more research is needed in Sub-Saharan Africa and other resource-constrained contexts, where empirical applications of the Theory of Practice Architectures remain relatively limited despite increasing policy interest in transformative mathematics education (Edwards Groves and Grootenboer, 2024; Wondem et al., 2023; Mukuka and Alex, 2024).

Conclusion

This systematic review demonstrates that transformative mathematics teaching is best understood as an institutional rather than purely individual process. Interpreted through the Theory of Practice Architectures, the evidence suggests that classroom innovation emerges when cultural discursive, material-economic, and social political arrangements operate in ways that collectively

support teachers' professional practice. The review therefore explains why similar pedagogical reforms often produce different outcomes across educational contexts. Where institutional conditions are coherent and supportive, teachers are better able to sustain learner-centred and transformative approaches. Conversely, reforms implemented in environments characterized by limited resources, fragmented leadership, and weak professional collaboration are less likely to translate into meaningful classroom change. The review contributes to mathematics education scholarship by synthesizing contemporary evidence on how institutional conditions shape transformative teaching practices while extending the application of the Theory of Practice Architectures to mathematics education. It also highlights an important gap in the existing literature, namely the limited empirical evidence linking institutional arrangements with learner outcomes in resource- constrained settings. Rather than viewing teacher development as an isolated intervention, the findings suggest that sustainable improvement in mathematics education depends on coordinated institutional reforms that align educational policy, instructional leadership, professional learning, and resource provision. Such an integrated perspective provides a stronger foundation for improving mathematics teaching quality and promoting equitable learner outcomes across diverse educational contexts.

ACKNOWLEDGEMENTS

The authors acknowledge the contribution of scholars whose studies were included in this systematic review and the databases that provided access to the reviewed literature.

REFERENCES

Agbata, B. C., Obeng Denteh, W., Abraham, S. A., Asante Mensa, F., Kwabi, P. A., Okpako, S. O., Amoah Mensah, J., & Arivi, S. S. (2024). Advancing mathematics education in Africa: Challenges, strategies, and prospects. *Science World Journal, 19*(3), 808–818. https://doi.org/10.4314/swj.v19i3.28

Akyeampong, K. (2021). Rethinking teacher preparation and development in Africa. *International Journal of Educational Development, 85,* 102441. https://doi.org/10.1016/j.ijedudev.2021.102441

Aminifar, E., Malaki, M., Ryan, U., & Mesgarani, H. (2024). A long-term shift to include students' first language in the mathematics teaching practice: Socialization events and learning opportunities. *Educational Studies in Mathematics, 116*(1), 113–135. https://doi.org/10.1007/s10649-024-10307-7

Balatti, J., & Belward, S. (2022). *Working through the practice architectures of first year university mathematics teaching. In Mathematics education: Expanding horizons*. Proceedings of the 35th Annual Conference of the Mathematics Education Research Group of Australasia (pp. 827–830). Mathematics Education Research Group of Australasia.

Chikoko, V. (2021). School leadership and instructional improvement in Sub Saharan Africa. *Educational Management Administration & Leadership, 49*(6), 903-918.

Clark Wilson, A. (2017). *Transforming mathematics teaching with digital technologies: A community of practice perspective*. In L. Gómez Chova, A. López Martínez, & I. Candel Torres (Eds.), Mathematics education and technology rethinking the terrain (pp. 45 to 57). Springer. https://doi.org/10.1007/978-3-319-33808-8_4

Cobb, P., Dean, C., Lamberg, T., Visnovska, J., & Zhao, Q. (2015). *The institutional setting of mathematics teaching and learning: Introduction*. In A. Bikner Ahsbahs, C. Knipping, & N. Presmeg (Eds.), Approaches to qualitative research in mathematics education (Vol. 48, pp. 199–206). Springer. https://doi.org/10.1007/978-90-481-9729-3_12

Cobb, P., Jackson, K., Smith, T. M., & Henrick, E. (2017). *Supporting improvements in the quality of mathematics teaching on a large scale*. In B. Rott, G. Törner, H. Steinbring, & J. Visnovska (Eds.), Views and beliefs in mathematics education: The role of beliefs in the classroom (pp. 203 to 221). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-14979-6_17

Daluma, H. E., & Naval, A. (2025). From emergency to transformation in mathematics education: A bibliometric analysis of the COVID 19 era and beyond. *Philippine E Journal for Mathematics, 45*(2), 248–256. https://doi.org/10.70838/pemj.450207

Dryden Peterson, S. (2022). Education in conflict and crisis contexts. *Oxford Review of Education, 48*(2), 145-160.

Edwards Groves, C., & Grootenboer, P. (2024). *Practice architectures.* In Oxford Research Encyclopedia of Education. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.1827

Edwards Groves, C., & Mahon, K. (2020a). Pedagogical practices and the theory of practice architectures. *Pedagogy, Culture & Society, 28*(3), 421-437.

Edwards Groves, C., & Mahon, K. (2020b). Pedagogy, education, and praxis in critical times. *Pedagogy, Culture & Society, 28*(4), 575-584.

Edwards Groves, C., Brennan Kemmis, R., Hardy, I., & Ponte, P. (2020c). Relational architectures: Recovering solidarity and agency as living practices in education. *Pedagogy, Culture & Society, 18*(1), 43–54. https://doi.org/10.1080/14681360903556814

Efron, N. (2023). *Keeping theorizing in touch with practice: Practical rationality as a middle range theory of mathematics teaching.* In B. Kaur, R. Huang, & D. Y. Dai (Eds.), Theory and practice: An interface or a great divide? (pp. 189 to 224). Springer. https://doi.org/10.1007/978-3-031-25613-4_7

Erdoğan, F. (2025). Interactive futures: The integration of digital technologies into mathematics education. *Journal of Computer and Education Research, 13*(26), 1076–1099. https://doi.org/10.18009/jcer.1669338

Escudero Cabarcas, J. M., & González Velasco, J. M. (2025). Transformation of mathematics education with situated cognition and artificial intelligence: A scoping review. *Lex Localis, 23(*S6), 728–754. https://doi.org/10.52152/801851

Fatwana, H., Mohamed Elsayed, S. A., Azhari, B., & Chand, S. P. (2024). Mathematics teaching program to become a professional teacher in the digital era: Recent developments. *Journal of Professional Learning and Sustainable Education, 1*(1), 1–16. https://doi.org/10.62568/jplse.v1i1.45

Fazio, X., Kemmis, S., & Zugic, J. (2024). Viewing science teacher learning and curriculum enactment through the lens of theory of practice architectures. *Science Education.* Advance online publication. https://doi.org/10.1002/sce.21901

Ferguson, N. (2024). *Mathematics education reform through socio-political means: A synthesis*. Portland State University Honors College. https://doi.org/10.15760/honors.1603

Fowler, S., Leonard, S. N., & Gabriel, F. (2023). Empowering mathematics teachers to meet evolving educational goals: The role of epistemic objects in developing actionable practice knowledge in tumultuous times. *Asia Pacific Journal of Teacher Education, 51*(1), 45–57. https://doi.org/10.1080/1359866X.2022.2119368

Fullan, M. (2020). *Leading in a culture of change* (2nd ed.). Jossey Bass.

García Martínez, I., Ubago Jiménez, J. L., López Burgos, J., & Tadeu, P. (2018). The pedagogical leadership of the mathematics faculty: A systematic review. *Education Sciences, 8*(4), Article 217. https://doi.org/10.3390/educsci8040217

Gardner, A., Goldsmith, R., & Vessalas, K. (2016). *Using practice architectures theory to compare consecutive offerings of the same subject*. In Proceedings of the Australian Collaborative Education Network Conference (pp. 266–275). Southern Cross University.

Goodyear, V. A., Casey, A., & Kirk, D. (2017). Practice architectures and sustainable curriculum renewal. *Journal of Curriculum Studies, 49*(2), 235–254. https://doi.org/10.1080/00220272.2016.1149223

Guler, M., & Celik, D. (2023). Are beliefs believable? An investigation of novice mathematics teachers' beliefs and teaching practices. *European Journal of Science and Mathematics Education, 11*(3), 410–426. https://doi.org/10.30935/scimath/12905

Hallinger, P. (2025). *Principal instructional leadership and teacher attitudes: A meta-analytic review, 1989–2024.* European Journal of Education.

Hardy, I., Kemmis, S., & Edwards Groves, C. (2021). Understanding educational practice through practice architectures. *Educational Action Research, 29*(4), 567- 582.

Hong, Q. N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M. P., Griffiths, F., Nicolau, B., O'Cathain, A., Rousseau, M. C., & Vedel, I. (2018). Mixed Methods Appraisal Tool (MMAT), version 2018: User guide. Canadian Intellectual Property Office.

Hopkins, M., & Spillane, J. P. (2015). Conceptualizing relations between instructional guidance infrastructure (IGI) and teachers' beliefs about mathematics instruction: Regulative, normative, and cultural cognitive considerations. *Journal of Educational Change, 16*(4), 421–450. https://doi.org/10.1007/S10833-015-9257-1

Jamil, N. B., Rosli, R. B., & Mahmud, M. S. B. (2025). Transformative teaching strategies for algebraic thinking: A systematic review of cognitive, pedagogical, and curricular advances. *Eurasia Journal of Mathematics, Science and Technology Education, 21*(10), Article em2721. https://doi.org/10.29333/ejmste/17250

Kemmis, S. (2015). *Is mathematics education a practice? Mathematics teaching?* Griffith University.

Kemmis, S., & Grootenboer, P. (2022a). Practice architectures and education. *Singapore Journal of Education, 42*(1), 3-17.

Kemmis, S., Wilkinson, J., Edwards Groves, C., Hardy, I., Grootenboer, P., & Bristol, L. (2022b). *Changing practices, changing education*. Springer.

Kusi, P., & Bonyah, E. (2025). A systematic review and bibliometric report: Ethnomathematics and culturally responsive pedagogy in mathematics education. *European Journal of Education Studies, 12*(9). https://doi.org/10.46827/ejes.v12i9.6187

Lamsal, H. P. (2025). Critical pedagogy in mathematics education: A systematic review of practices, challenges, and opportunities. *The EFFORTS Journal of Education and Research, 6*(1), 64–87. https://doi.org/10.3126/ejer.v6i1.83052

Li, Y., Silver, E. A., & Li, S. (2024). *Transforming mathematics instruction: Multiple approaches and practices.* Springer.

Liu, J. (2025). Multi perspective exploration of mathematics teaching practice in higher education. *Higher Education and Practice, 2*(8), 24–30. https://doi.org/10.62381/h251805

Lloyd, A., & Mahon, K. (2021). Practice architectures and educational transformation in contemporary schooling. *Journal of Curriculum Studies, 53(*5), 641-658.

Madi, U., & Gusni, E. (2025). Innovative pedagogical models in mathematics education: A systematic review of global challenges, trends, and future research directions. *International Journal of Learning, Teaching and Educational Research, 24*(9), 167–191. https://doi.org/10.26803/ijlter.24.9.9

Mageed, I. A. (2025). *The interwoven tapestry: The significant impact of global and cultural issues on mathematics education* (Version 1) [Preprint]. Zenodo. https://doi.org/10.5281/zenodo.16964459

Mahon, K., & Galloway, L. (2017). *Provoking praxis amidst a faculty restructure: A practice architectures perspective.* In K. Mahon, S. Francisco, & S. Kemmis (Eds.), Exploring education and professional practice: Through the lens of practice architectures (pp. 183–199). Springer. https://doi.org/10.1007/978-981-10-2219-7_11

Mahon, K., Francisco, S., & Kemmis, S. (2021). Exploring education and professional practice through practice architectures. *Studies in Continuing Education, 43*(2), 131-145.

Mahon, K., Kemmis, S., Francisco, S., & Lloyd, A. (2023). Practice architectures and educational change in diverse learning contexts. *Teaching and Teacher Education, 125,* 104041. https://doi.org/10.1016/j.tate.2023.104041

McClain, K., & Cobb, P. (2024). *The critical role of institutional context in teacher development*. In Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education (Vol. 3, pp. 249–256). International Group for the Psychology of Mathematics Education.

Mhaka, M. (2022). Challenges of learner centered mathematics teaching in African secondary schools. *African Educational Research Journal, 10*(3), 250-259.

Mukendi, P. (2023). Institutional barriers to quality mathematics education in the Democratic Republic of the Congo. *African Journal of Educational Studies, 15*(1), 44-58.

Mukuka, A., & Alex, J. K. (2024). Profiling mathematics teacher educators' readiness for digital technology integration: Evidence from Zambia. *Journal of Mathematics Teacher Education, 28,* 315–339. https://doi.org/10.1007/s10857-024-09657-z

Mustafa, A. N. (2023). Transformative approaches and challenges in 21st century mathematics education: A comprehensive review. *World Journal of Advanced Research and Reviews, 20*(3), 1200–1212. https://doi.org/10.30574/wjarr.2023.20.3.2508

Ndlovu, M. (2023). Transformative pedagogies and mathematics learning in developing contexts. *Journal of Mathematics Education in Africa, 8*(2), 66-81.

Ngcobo, T., & Tikly, L. (2022). Equity and inclusion in mathematics education in Sub Saharan Africa. *International Journal of Educational Development, 90,* 102545. https://doi.org/10.1016/j.ijedudev.2022.102545

OECD. (2023). *Teachers and teaching in a changing world: Building professionalism and supporting teacher quality*. OECD Publishing.

Onoshakpokaiye, O. E., & Avwiri, H. E. (2025). Science, technology and mathematics education: A roadmap to economic growth and sustainable development of developing nations. *Indonesian Journal of Education and Mathematical Science, 6*(2), 59–69. https://doi.org/10.30596/ijems.v6i2.23902

Ottevanger, W., Feiter, L., & Van den Akker, J. (2021). Curriculum reform implementation in Sub Saharan Africa. *Prospects, 51*(1 to 3), 213-228.

Oxley, V. (2024). Exploring institutional and partial meanings in mathematics: A model of structure and dynamics. *Journal of Educational Studies in Science and Mathematics, 3*(2), 77–86. https://doi.org/10.29329/jessm.2024.1110.2

Pinias, C. (2025). Exploring the balance between theory and practice of transformative science, technology, engineering, arts, and mathematics teacher education: A systematic literature review. *Discover Education, 4*(1). https://doi.org/10.1007/s44217-025-00695-0

Prediger, S., & Selter, C. (2024). *Establish shared visions and support productive adaptations on all levels. Implementation and Replication Studies in Mathematics Education*. Advance online publication. https://doi.org/10.1163/26670127-bja10020

Priestley, M., Biesta, G., & Robinson, S. (2015). Teacher agency: An ecological approach. Bloomsbury Academic.

Putri, L. I., Retnawati, H., Jaedun, A., Murfi, A., & Begimbetova, G. A. (2025). Enhancing mathematical skills through multicontextual approaches: A meta-analysis of realistic mathematics, ethnomathematics, and technology integration. *Cogent Education, 12*(1). https://doi.org/10.1080/2331186X.2025.2548648

Roesken Winter, B., Stahnke, R., Prediger, S., & Gasteiger, H. (2021). Towards a research base for implementation strategies addressing mathematics teachers and facilitators. *ZDM Mathematics Education, 53*(5), 1007 to 1019. https://doi.org/10.1007/s11858-021-01220-x

Rossa, E. P. O., & Estevam, E. J. G. (2022). (Re)constitution of the mathematics teacher's professional practice. *Revista Prática Docente, 7*(2), e22056. https://doi.org/10.23926/rpd.2022.v7.n2.e22056.id1512

Salazar, S. B. (2023). Can math teaching challenge institutional racism? *Prometeica, 27,* 554–564. https://doi.org/10.34024/prometeica.2023.27.15344

Sayed, Y., & Singh, M. (2020). Evidence and educational reform in Africa. *Comparative Education, 56*(2), 196-214.

Schweisfurth, M. (2020). Learner centered education in international perspective. *Educational Review, 72*(3), 293-312.

Şimşek, A., & Clark Wilson, A. (2025). Adopting a framework for investigating mathematics teachers' technology integrated classroom teaching practice: Structuring features of classroom practice. *International Journal of Science and Mathematics Education, 23,* 589–

616. https://doi.org/10.1007/s10763-024-10480-4
Stein, M. K., & Coburn, C. E. (2018). Architectures for learning: A comparative analysis of two urban school districts. *American Journal of Education, 114*(4), 583–626. https://doi.org/10.1086/589315
Sun, J., Zhang, R., & Forsyth, P. B. (2023). The effects of teacher trust on student learning and the malleability of teacher trust to school leadership: A 35-year meta-analysis. *Educational Evaluation and Policy Analysis, 59*(4). https://doi.org/10.1177/0013161X231183662
Tshibangu, T., & Muteba, M. (2021). Teaching practices in conflict affected schools in Central Africa. *International Review of Education, 67*(5), 701-720.
UNESCO. (2022). *Transforming education from within: Current trends in teacher development*. UNESCO Publishing.
UNESCO. (2023). *Global education monitoring report 2023: Education in fragile contexts*. UNESCO Publishing.
Uygun, T. (2020). Inquiry-based design research for teaching geometric transformations by developing mathematical practices in a dynamic geometry environment. *Mathematics Education Research Journal, 32*(3), 523 to 549. https://doi.org/10.1007/S13394-020-00314-1
Variyan, G., & Edwards Groves, C. (2024). The theory of practice architectures and its discontents: Disturbing received wisdom to make it dangerous again. *Critical Studies in Education*. Advance online publication. https://doi.org/10.1080/17508487.2024.2334779
Villarin, J. M., Dolino, C. B., Fin, R. A., Miñoza, M. L. S., Ubay, R. G., & Kilag, O. K. T. (2024). Unlocking mathematical learning: Exploring ethnomathematics' impact on student engagement, conceptual understanding, and equity in mathematics education. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence, 1*(3), 157–171. https://doi.org/10.5281/zenodo.11069253
Visnovska, J., & Zhao, Q. (2021). *Learning from a professional development design experiment: Institutional context of teaching.* In Proceedings of the 43rd Annual Conference of the Mathematics Education Research Group of Australasia (pp. 744 to 751). Australian Association of Mathematics Teachers (AAMT) & Mathematics Education Research Group of Australasia (MERGA).
Webb, J. (2018). *Conceptualizing and investigating mathematics teacher learning of practice* (Doctoral dissertation, The University of North Carolina at Greensboro). ProQuest Dissertations Publishing. https://www.proquest.com/dissertations-theses/conceptualizing-investigating-mathematics/docview/2117573560
Wilkinson, J., & Kemmis, S. (2021). Leadership and professional practice in education: A practice architectures perspective. *Educational Management Administration & Leadership, 49*(6), 911-928.
Winsløw, C., Barquero, B., De Vleeschouwer, M., & Hardy, N. (2024). An institutional approach to university mathematics education: From dual vector spaces to questioning the world. *Research in Mathematics Education, 16*(2), 95–111. https://doi.org/10.1080/14794802.2014.918345
Wondem, D. T., Tesfamicael, S. A., & Getahun, D. A. (2023). Institutional setting and its influence on the teaching of mathematics: Implications to implementing reform vision in mathematics education in Ethiopian schools. *Education Sciences, 13*(2), Article 114. https://doi.org/10.3390/educsci13020114

Citation: Kaliki, R. K., Jawahar, K., Joseph, W. G., Nkpordee, L., Basake, J. A., and Jean, K. L. (2026). Institutional conditions and transformative teaching practices in mathematics education: A systematic review based on the theory of practice architectures. *African Educational Research Journal, 14*(3), 637-661.

APPENDIX A

Summary of studies included in the systematic review

S/N	Author(s)	Country/context	Research method	Main findings	Gap identified
1	Edwards Groves and Grootenboer (2024)	International	Conceptual review	Practice architectures explain how cultural, social and institutional conditions shape educational practices and quality improvement.	Limited empirical validation in secondary schools of developing countries.
2	Ferguson (2024)	United States	Literature synthesis	Equity-oriented instructional reforms improve mathematics learning through differentiated and culturally responsive teaching.	Few studies examine how school quality assurance systems support these reforms.
3	Variyan and Edwards Groves (2024)	Australia	Conceptual analysis	Practice architecture theory remains useful for understanding educational change despite theoretical criticisms.	Lacks empirical testing within school quality assurance implementation.
4	Gardner et al. (2016)	Australia	Qualitative case study	Institutional arrangements strongly influenced teaching quality and student learning experiences.	Single institution limits transferability to other educational systems.
5	Mustafa (2024)	Global	Comprehensive review	Technology integration and learner-centred approaches improve mathematics education.	Review does not evaluate quality assurance mechanisms guiding implementation.
6	Mustafa (2023)	Global	Literature review	Interactive teaching strategies increase learner engagement and achievement.	Empirical evidence from African secondary schools remains scarce.
7	McClain and Cobb (2024)	United States	Qualitative study	Institutional support significantly influences teacher professional development.	Student academic performance was not directly assessed.
8	Li et al. (2024)	International	Edited scholarly volume	Multiple instructional innovations enhance mathematics teaching effectiveness.	Comparative evidence across African educational contexts is limited.
9	Cobb et al. (2015)	International	Conceptual chapter	School policies, curriculum and accountability structures determine instructional effectiveness.	Requires empirical verification in secondary education quality assurance systems.
10	Goodyear et al. (2017)	United Kingdom	Qualitative study	Sustainable curriculum renewal depends on enabling institutional environments.	Limited evidence from low-income educational settings.
11	Mageed (2025)	International	Conceptual review	Cultural responsiveness strengthens mathematics teaching and learning outcomes.	Limited empirical studies linking cultural practices with formal quality assurance systems.
12	Kemmis (2015)	Australia	Conceptual analysis	Teaching practices are shaped by social, cultural and institutional relationships.	Theoretical emphasis without quantitative evidence.

13	Lamsal (2025)	Nepal	Systematic review	Critical pedagogy improves engagement, conceptual understanding and equity.	Need longitudinal studies examining implementation effectiveness.
14	Wondem et al. (2023)	Ethiopia	Qualitative case study	Weak institutional support hinders implementation of mathematics education reforms.	Small sample reduces generalizability beyond Ethiopian schools.
15	Stein and Coburn (2018)	United States	Longitudinal qualitative study	District-level collaboration enhances teacher learning and instructional improvement.	Focuses primarily on teachers rather than student achievement outcomes.
16	Fowler et al. (2023)	Australia	Conceptual paper	Practical knowledge empowers teachers to respond effectively to educational reforms.	Requires empirical validation across different school contexts.
17	Agbata et al. (2024)	Africa	Literature review	Mathematics education in Africa is constrained by inadequate resources, weak teacher preparation, limited access to quality education, and cultural barriers; technology integration, culturally responsive pedagogy, collaboration and professional development are recommended.	Broad continental recommendations do not directly synthesize context-specific evidence through TPA.
18	Pinias (2025)	International	Systematic literature review	Transformative STEAM education improves interdisciplinary teaching and innovation.	Limited implementation evidence in developing countries.
19	Kusi and Bonyah (2025)	International	Systematic review	Ethnomathematics improves student engagement and conceptual understanding.	More intervention studies are required to measure long-term impact.
20	Guler and Celik (2023)	Türkiye	Observational correlational study	Teacher beliefs about mathematics and learning showed relationships with classroom practices, although the relationships were not uniformly strong.	Further research is needed to explain how belief-practice relationships develop across contexts.
21	Mahon and Galloway (2017)	Australia	Qualitative study	Institutional restructuring influences critical pedagogical practice.	Higher education context limits application to secondary schools.
22	Escudero Cabarcas and González Velasco (2025)	International	Scoping review	Artificial intelligence and situated cognition can support mathematics instruction.	Few empirical studies evaluate policy and quality assurance integration.
23	Fazio et al. (2024)	Canada	Conceptual and empirical study	Professional development and school conditions jointly influence curriculum implementation.	Longitudinal evidence from developing countries is lacking.
24	Oxley (2024)	International	Theoretical study	Institutional meanings support students' conceptual understanding through effective instructional mediation.	Empirical classroom validation remains limited.
25	Jamil et al. (2025)	International	Systematic literature review	Student-centred teaching strategies significantly improve algebraic thinking.	Additional classroom intervention studies are required across diverse educational systems.

26	Daluma and Naval (2025)	International	Bibliometric analysis	Mathematics education research has shifted from emergency remote teaching to sustainable, technology-enhanced and equity-focused pedagogies.	Bibliometric evidence does not explain how institutional conditions influence classroom implementation.
27	Madi and Gusni (2025)	Global	Systematic literature review	Innovative pedagogical models improve learner engagement, inclusion and mathematics achievement, although implementation varies across contexts.	Limited context-specific evidence from low- and middle-income countries.
28	Rossa and Estevam (2022)	Brazil	Bibliographic review	Teacher practice develops through collaborative professional learning, continuous education and access to instructional resources.	More empirical evidence is needed to determine how institutional policies sustain collaborative practice.
29	Mukuka and Alex (2024)	Zambia	Quantitative cross-sectional survey	Mathematics teacher educators showed low-to-moderate familiarity with digital tools; technological support, proficiency and infrastructure influenced readiness for technology integration.	Further research is needed on sustainable institutional support for digital transformation.
30	Liu (2025)	China	Mixed methods	Interactive teaching, diversified assessment and educational technologies improved student engagement and practical problem-solving skills.	Institutional factors supporting long-term sustainability remain underexplored.
31	Villarin et al. (2024)	Philippines	Systematic literature review	Ethnomathematics enhances conceptual understanding, motivation and culturally responsive learning environments.	Limited evidence on institutional support required for successful implementation.
32	Aminifar et al. (2024)	Iran	Nine-month ethnographic study	Including students' first language in mathematics teaching created additional opportunities for participation, mathematical explanation and language-positive classroom interaction.	Further evidence is needed across multilingual educational contexts and institutional settings.
33	Putri et al. (2025)	International	Meta-analysis	Realistic mathematics education, ethnomathematics and technology integration significantly improve mathematical achievement.	Publication bias and limited regional representation reduce generalizability.
34	Balatti and Belward (2022)	Australia	Action research	Practice architectures provided an effective framework for improving first-year university mathematics teaching through collaborative reflection.	Research focused on higher education rather than primary or secondary schooling.
35	Salazar (2023)	United States	Qualitative study	Mathematics teaching can challenge institutional racism through inclusive classroom interactions and equitable participation.	Additional studies are required across diverse cultural and educational contexts.
36	Hopkins and Spillane (2015)	United States	Qualitative case study	Institutional guidance infrastructures influence teachers' beliefs through regulative, normative and cultural-cognitive mechanisms.	Student learning outcomes were not directly examined.
37	Erdoğan (2025)	International	Literature review	Digital technologies enhance mathematics learning, although teacher preparedness and inadequate infrastructure remain major barriers.	More empirical evidence is required from low-resource educational systems.
38	Winsløw et al. (2024)	Denmark and Belgium	Theoretical and empirical analysis	Institutional settings strongly influence mathematical modelling, curriculum implementation and students' conceptual development.	Limited application beyond university mathematics education.

39	Fatwana et al. (2024)	International	Systematic literature review	Technology integration is becoming central to mathematics teacher professionalism and continuous professional development.	Further research should evaluate long-term institutional support mechanisms for digital transformation.
40	Edwards Groves et al. (2020)	Australia	Conceptual and empirical analysis	Relational architectures strengthen teacher agency, solidarity and professional collaboration, supporting educational transformation.	More empirical investigations are required across diverse educational systems.
41	Şimşek and Clark Wilson (2025)	Türkiye	Multiple case study	The Structuring Features of Classroom Practice framework provides a useful lens for analyzing technology-integrated mathematics teaching.	Broader comparative studies across educational contexts are needed.
42	Roesken Winter et al. (2021)	Germany	Design-based implementation research	Successful implementation of mathematics reforms depends on coordinated professional development, curriculum materials and systemic support.	Evidence from developing countries remains limited.
43	Efron (2023)	United States	Conceptual chapter	Practical rationality offers a theoretical explanation of mathematics teaching by linking instructional practice with classroom realities.	Empirical validation in African educational contexts is still lacking.
44	Prediger and Selter (2024)	Germany	Implementation design research	Large-scale mathematics reforms require shared institutional vision, coordinated professional development and systemic adaptation.	Further evidence is needed from low-income education systems with limited institutional capacity.
45	García Martínez et al. (2018)	International	Systematic review	Strong instructional leadership positively influences teacher professionalism, instructional quality and student achievement in mathematics.	Few studies investigate leadership within African mathematics education systems.
46	Webb (2018)	United States	Conceptual and empirical dissertation	Practice-based professional development improves teachers' instructional competence through rehearsal of ambitious teaching practices.	Large-scale implementation across different educational contexts remains unexplored.
47	Cobb et al. (2017)	United States	Design research	Sustainable instructional improvement requires coherent systems involving curriculum, teacher collaboration, leadership and continuous professional development.	Findings require adaptation and validation in resource-constrained educational settings.
48	Uygun (2020)	Türkiye	Inquiry-based design research	Dynamic geometry software and inquiry-based learning significantly improve conceptual understanding of geometric transformations.	Studies examining institutional readiness for technology-supported inquiry learning remain limited.
49	Clark Wilson (2017)	United Kingdom	Professional development case study	Communities of practice enhance teachers' capacity to integrate digital technologies into mathematics instruction.	Further studies should evaluate scalability across different institutional contexts.
50	Visnovska and Zhao (2021)	Australia	Professional development design experiment	Mathematics teachers require sustained institutional support, including understanding of teaching context, to improve instructional practice effectively.	More evidence is needed to determine how institutional support influences long-term student achievement and reform sustainability.

Note. The 50-source corpus retains the original review scope while replacing sources whose publication dates fell outside the intended 2015–2025 eligibility window. The revised corpus includes empirical studies as well as relevant scholarly reviews, conceptual analyses and other research-based publications, consistent with the revised inclusion criteria.