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DIFFERENTIATED INSTRUCTION IN MATHEMATICS EDUCATION: A SYSTEMATIC LITERATURE REVIEW OF STRATEGIES, CHALLENGES, AND SUPPORT

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ABSTRACT

Although differentiated instruction has been increasingly implemented in mathematics education, existing evidence remains fragmented regarding how it is implemented, the challenges affecting its implementation, and the support required to sustain its practice. Therefore, this systematic literature review aimed to synthesize recent evidence on differentiated instruction in mathematics education. The review used PRISMA 2020 as the reporting and study-selection framework and searched Scopus, ERIC, and Google Scholar to obtain comprehensive coverage of research in mathematics education from broad scholarly and education-focused sources. The search covered studies published between 2019 and 2025 using predefined keywords related to differentiated instruction, mathematics education, implementation, strategies, challenges, and support. The search identified 240 records, and 15 eligible studies were included in the analysis. The findings indicate that differentiated instruction is implemented through four interconnected dimensions based on Tomlinson's framework: content, process, product, and learning environment differentiation. The review also identifies four major categories of implementation challenges, including teacher-related challenges, student-related challenges, resource and time constraints, and institutional support challenges. Furthermore, the synthesized evidence highlights that sustainable implementation depends on continuous professional development, adequate instructional resources and technology, collaborative school cultures, and supportive educational policies. Overall, the findings demonstrate that differentiated instruction should be understood as a comprehensive pedagogical framework rather than a collection of isolated instructional strategies. This review provides an integrated synthesis of current evidence and offers practical insights for teachers, school leaders, policymakers, and researchers seeking to promote more equitable, responsive, and inclusive mathematics learning.

Keywords: Differentiated Instruction, Mathematics Education, Systematic Literature Review, Implementation.

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PRELIMINARY

In mathematics classrooms, differences in students' readiness, prior knowledge, and learning profiles create instructional challenges because teachers need to respond to students' diverse learning needs while implementing differentiated instruction (Pozas et al., 2020). Students differ in their readiness, prior knowledge, interests, and learning profiles, requiring teachers to design instruction that accommodates diverse learning needs (Letzel et al., 2020). This challenge is particularly evident in mathematics, where learning is cumulative and inadequate mastery of foundational concepts can hinder students' understanding of more advanced topics (Rach & Ufer, 2020). The urgency of addressing learner diversity is reflected in the PISA 2022 results, which reported a gap of more than 135 score points between students at the 90th and 10th percentiles in mathematics performance across participating education systems (OECD, 2023). These findings underscore the need for instructional approaches that promote equitable learning opportunities for students with diverse learning needs.

Differentiated instruction has been increasingly applied to address learner diversity in mathematics education and has evolved from being viewed as a set of separate instructional practices toward an integrated pedagogical approach that responds to students' diverse learning needs (Gheyssens et al., 2023). It allows common learning goals to be pursued through adaptations that consider students' readiness, interests, and learning profiles, including changes in content, process, product, and learning environment (Tomlinson, 2017). Recent evidence also associates differentiated instruction with improved engagement, motivation, achievement, and classroom inclusivity (Ramaila, 2025). This positions differentiated instruction as a coherent pedagogical approach rather than a set of disconnected techniques, motivating the present review's aim of synthesizing evidence on how this integrated approach is implemented, the challenges it presents, and the support it requires.

Recent research has reported differentiated practices in mathematics through adapted materials, flexible grouping, technology-supported learning, formative assessment, and varied student products (Marks et al., 2021; Noviyanti et al., 2025; Setambah et al., 2025). The evidence reflects adaptations across instructional content, learning processes, student outputs, and classroom environments. However, these findings remain distributed across different contexts and research focuses, limiting an integrated view of how differentiated instruction is implemented in mathematics education (Adiguzel et al., 2021).

Previous research has reviewed differentiated instruction in mathematics education, particularly its development and implementation across different research contexts (Maryani et al., 2025). However, limited attention has been given to synthesizing implementation strategies together with the challenges encountered and support required for sustained implementation.

Therefore, this study conducts a systematic literature review following the PRISMA 2020 guidelines to synthesize recent evidence on the implementation of differentiated instruction in mathematics education, with particular attention to instructional strategies, implementation challenges, and required support. Specifically, the review addresses three research questions: (1) What differentiated instruction strategies have been implemented in mathematics education? (2) What challenges have been reported in implementing differentiated instruction? and (3) What forms of support facilitate its differentiated instruction implementation? By integrating evidence across recent empirical studies, this review provides a comprehensive understanding of differentiated instruction implementation and offers practical implications for teachers, school leaders, policymakers, and future research.

METHODS

We conducted an SLR to synthesize empirical evidence on differentiated instruction implementation in mathematics education. The review used the PRISMA 2020 framework to guide the reporting and study-selection process (Page et al., 2021). While narrative thematic synthesis was applied to compare and integrate findings across the included studies (Booth et al., 2021).

The literature search was conducted using Scopus, ERIC, and Google Scholar. These sources were selected to provide complementary coverage of the literature relevant to differentiated instruction in mathematics education. Scopus was used to obtain broad coverage of scholarly literature across disciplines, ERIC was selected for its education-focused coverage, and Google Scholar was used as a supplementary source to broaden the identification of potentially relevant studies beyond the coverage of the indexed databases. Combining these sources was intended to improve the comprehensiveness of the literature search.

The searches and source verification were completed on 7 June 2026. Publish or Perish was used to facilitate the retrieval and extraction of search results, after which the retrieved records were verified against the original web sources. For Scopus and ERIC, the

search strategy combined terms related to differentiated instruction, mathematics education, implementation, strategies, challenges, and support using the Boolean operators AND and OR. The search string used for Scopus and ERIC was: "(Differentiated Instruction" OR "Differentiated Learning") AND ("Mathematics Education" OR "Mathematics Teaching") AND (implementation OR strategy OR challenge OR support)". For Google Scholar, three separate searches were conducted to address the implementation, challenges, and support dimensions of differentiated instruction. The three search queries were, respectively: "Differentiated Instruction" AND "mathematics implementation" AND "teachers"; "Differentiated Instruction" AND "mathematics challenges" AND "teachers"; and "Differentiated Instruction" AND "mathematics support" AND "teachers". The searches were limited to studies published between 2019 and 2025, consistent with the predefined eligibility criteria. The complete search strategies and search limits are reported to support transparency and reproducibility of the review. Inclusion and exclusion criteria for the studies were established to ensure the relevance of the literature to the research objectives, as summarized in Table 1.

Table 1. Inclusion-Exclusion

Criteria	Inclusion	Exclusion
Topic	Implementation, strategies, challenges, or support for differentiated instruction in mathematics education.	General differentiated instruction without a mathematics implementation focus.
publication type	Peer-reviewed journal articles	Proceedings, books, theses, dissertations.
Language	English	Besides English
Year	2019-2025	Before 2019
Subject	Teachers, students, prospective teachers	Subjects not related to mathematics learning
Method	Qualitative, quantitative, mixed methods	Editorials, opinion papers, conceptual papers, and literature reviews.
Text	Full text available	Full text not available

The search yielded 240 records, comprising 30 records from Scopus, 38 from ERIC, and 172 from Google Scholar. After eight duplicate records were removed, 232 records underwent screening. Following the screening and full-text eligibility assessment, 15 studies were included in the review. The complete study-selection process is presented in the PRISMA flow diagram in Figure 1.

Data were extracted using a structured matrix that recorded publication details, research context, participants, research design, and key findings. The extracted data were synthesized through narrative thematic analysis to address the three research questions.

Differentiated instruction strategies were classified according to Tomlinson's four dimensions, while implementation challenges and support were synthesized into recurring themes across the included studies.

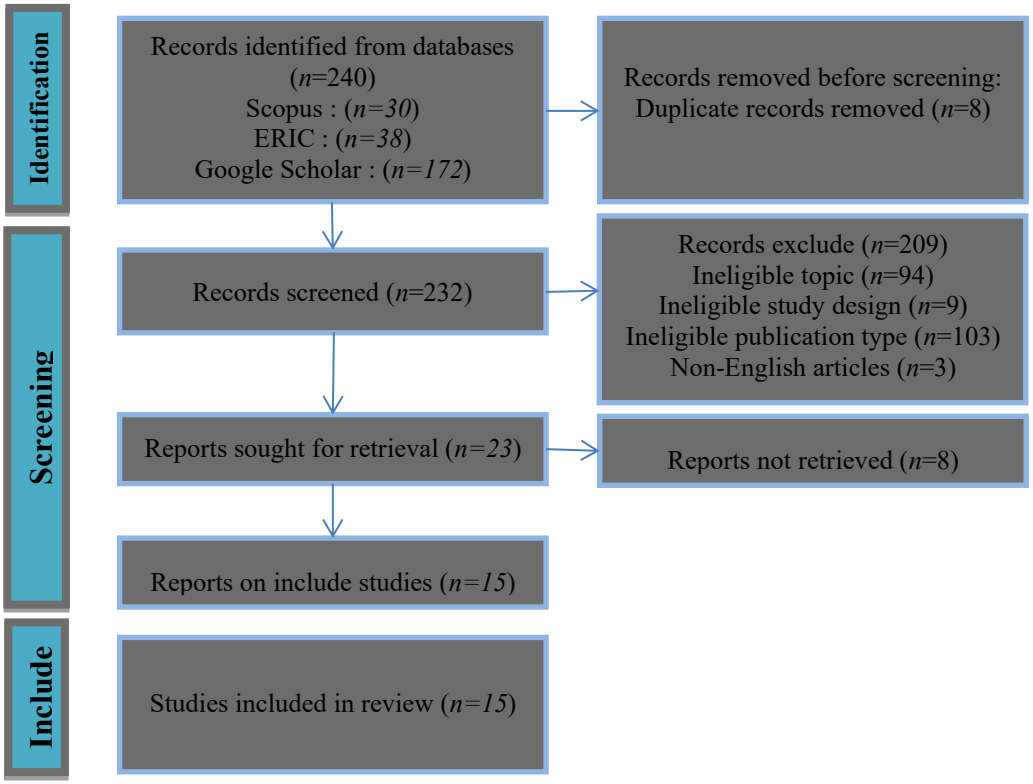


Figure 1. PRISMA Flowchart

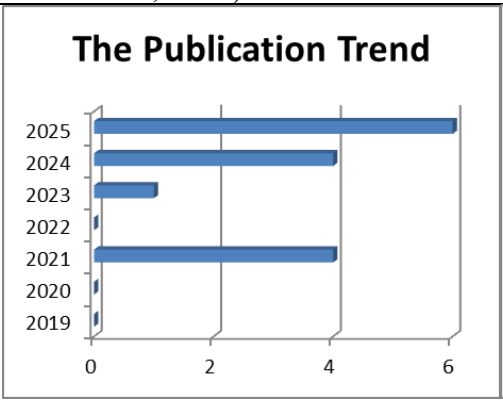
RESULTS AND DISCUSSION

A total of 15 empirical studies published between 2019 and 2025 satisfied the predefined eligibility criteria and were included in the review. Table 2 summarizes the characteristics of the selected studies, whereas Figures 2 and 3 illustrate publication trends and the distribution across educational levels.

Table 2. The Characteristics of Included Studies

Study	Country	Educational Level	Research Design
(Marit et al., 2025)	Norway	Elementary and lower secondary school	Qualitative
(Ramdhani et al., 2025)	Indonesia	Elementary school	Didactical Design Research
(Shodiq et al., 2024)	Indonesia	Higher education	Quasi-experimental
(Maphumulo & Biccard, 2025)	South Africa	Elementary school	Qualitative
(Herner-Patnode & Lee, 2021)	Amerika Serikat	Higher education	Qualitative
(McIntosh, 2024)	Jamaica	Lower secondary school	Qualitative
(Gervasoni et al., 2021)	Australia	Elementary school	Qualitative

Study	Country	Educational Level	Research Design
(Courtney, 2021)	USA	Lower and upper secondary school	Qualitative
(Trisnani et al., 2025)	Indonesia	Elementary school	Qualitative
(Baybayon & Lapinid, 2024)	Philippines	Lower secondary school	Quasi-experimental
(Mićanović et al., 2023)	Montenegro	Elementary school	Quasi-experimental
(Kurnila et al., 2025)	Indonesia	Lower secondary school	Quasi-experimental
(Hubbard & Livy, 2021)	Australia	Elementary school	Qualitative
(Tshering, 2024)	Bhutan	Lower secondary school	Qualitative
(Balkist et al., 2025)	Indonesia	Lower secondary school	Design Research



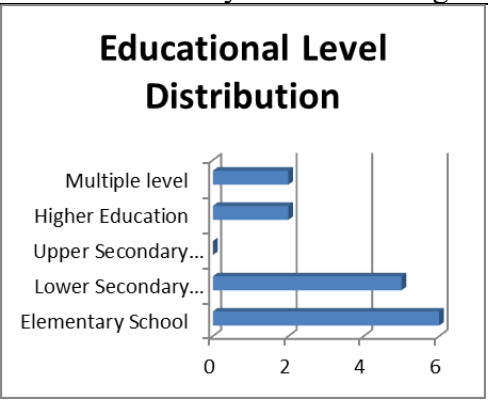
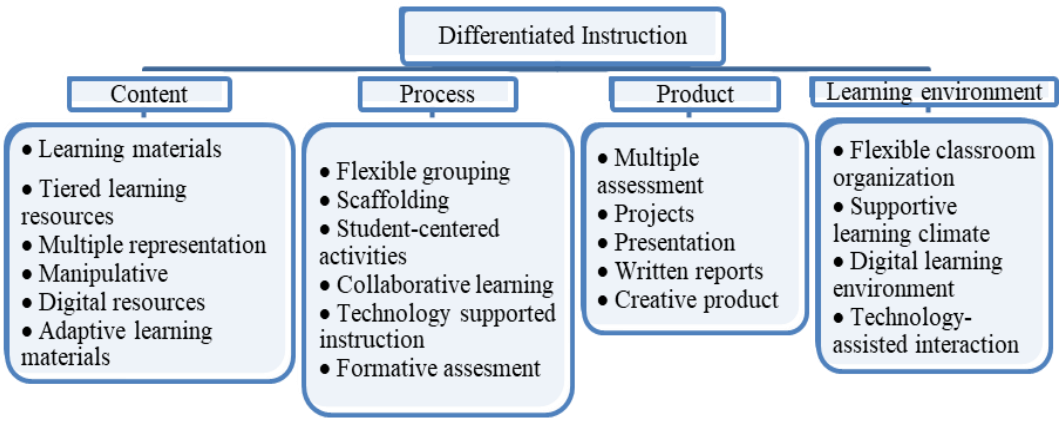


Figure 2. The Publication Trend **Figure 3. Educational Level Distribution**

The reviewed studies originated from nine countries: Indonesia, Norway, Australia, the United States, Jamaica, the Philippines, Montenegro, Bhutan, and South Africa. As shown in Figure 2, publications increased over the review period and reached their highest number in 2025. Across educational settings, lower secondary education was the most frequently represented level, although studies also involved elementary, upper secondary, and higher education (Figure 3). Most studies adopted qualitative approaches, followed by quasi-experimental designs, while design research and Didactical Design Research were reported less frequently. Although the evidence spans diverse educational contexts, its distribution across educational levels and research designs remains uneven. This diversity provides evidence of how differentiated instruction is applied across varied mathematics learning contexts.

The synthesis revealed four interrelated dimensions of differentiated instruction in mathematics education: content, process, product, and learning environment differentiation. Guided by Tomlinson's framework, these dimensions describe how instruction is adapted to accommodate diverse student learning needs. Figure 4 presents the distribution of implementation strategies across the four dimensions.



Note. Adapted and synthesized from the reviewed studies based on Tomlinson's differentiation framework.

Figure 4. Synthesized Implementation Strategies of Differentiated Instruction

Content differentiation was reflected in the use of varied learning materials and resources to address students' readiness and learning needs. The reviewed studies reported strategies such as tiered resources, multiple representations, manipulatives, digital resources, and adaptive learning materials (Marit et al., 2025; Marks et al., 2021; Ramdhani et al., 2025; Shodiq et al., 2024). Rather than simplifying mathematical content, these strategies provided multiple pathways for students to achieve the same learning objectives, consistent with Tomlinson's differentiation framework.

Process differentiation was implemented through flexible grouping, scaffolding, student-centered learning, collaborative activities, technology-supported instruction, and formative assessment (Courtney, 2021; Gervasoni et al., 2021; Herner-Patnode & Lee, 2021; McIntosh, 2024; Shodiq et al., 2024). These strategies enabled teachers to adapt learning activities and instructional support to students' needs while continuously monitoring learning progress, highlighting instructional flexibility as a key feature of differentiated instruction.

Product differentiation allowed students to demonstrate mathematical understanding through multiple forms of assessment, including projects, presentations, written reports, and creative products (Kurnila et al., 2025; Marit et al., 2025; Ramdhani et al., 2025). The findings emphasize variation in how learning is demonstrated while maintaining common learning objectives for all students.

Learning environment differentiation involved flexible classroom organization, supportive learning climates, digital learning environments, and technology-assisted interaction (Courtney, 2021; Maphumulo & Biccard, 2025; Marit et al., 2025; Shodiq et al., 2024). These strategies created inclusive learning conditions that enhanced participation and supported the implementation of other differentiation dimensions.

Overall, the findings show that differentiated instruction in mathematics education is implemented through the integration of content, process, product, and learning environment differentiation. These dimensions operate as interconnected components of a comprehensive pedagogical approach, requiring teachers to coordinate multiple instructional strategies to address learner diversity. Their successful integration depends on teachers' ability to balance diverse student needs while maintaining common learning objectives. This interconnectedness also contributes to the implementation challenges discussed in the following section.

The analysis of the reviewed studies identified four interrelated categories of challenges affecting the implementation of differentiated instruction in mathematics education: teacher-related challenges, student-related challenges, resource and time constraints, and institutional and professional support challenges. As illustrated in Figure 5, these challenges indicate that the implementation of differentiated instruction is influenced not only by teachers' instructional practices but also by the characteristics of learners and the broader educational conditions in which mathematics instruction takes place. These findings demonstrate that the successful implementation of differentiated instruction requires addressing challenges across multiple dimensions rather than focusing solely on classroom teaching practices.

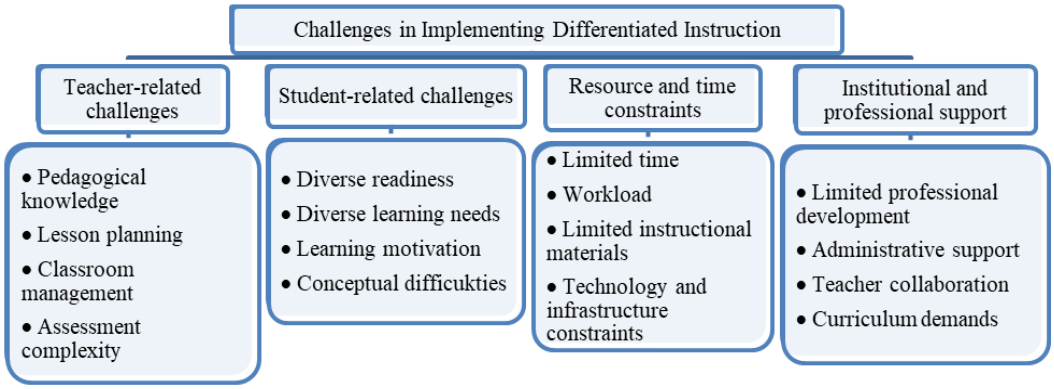


Figure 5. Synthesized Challenges in Implementing Differentiated Instruction

Teacher-related challenges were among the most frequently reported barriers. Teachers experienced difficulties in lesson planning, classroom management, differentiated assessment, and selecting instructional strategies to address diverse learning needs (Herner-Patnode & Lee, 2021; Maphumulo & Biccard, 2025; McIntosh, 2024; Ramdhani et al., 2025). Limited pedagogical knowledge and experience further reduced teachers' confidence and capacity to implement differentiated mathematics instruction.

Student-related challenges reflected variations in readiness, prior knowledge, learning profiles, motivation, and conceptual understanding. Such diversity required teachers to continuously adjust instructional strategies and provide different levels of support to achieve common learning objectives (Herner-Patnode & Lee, 2021; Maphumulo & Biccard, 2025; Marit et al., 2025; McIntosh, 2024). Thus, student diversity represents both the foundation of differentiated instruction and a major source of implementation complexity.

Resource and time constraints were also reported across the reviewed studies. Limited instructional time, heavy workloads, insufficient learning materials, and restricted access to technology reduced teachers' capacity to prepare and implement differentiated activities, particularly in schools with limited infrastructure (Herner-Patnode & Lee, 2021; Maphumulo & Biccard, 2025; McIntosh, 2024; Shodiq et al., 2024). These constraints indicate that the implementation of differentiated instruction requires adequate time, instructional resources, and technological access.

Institutional and professional support challenges included limited professional development, inadequate administrative support, weak teacher collaboration, and curriculum-related demands (Herner-Patnode & Lee, 2021; Maphumulo & Biccard, 2025; McIntosh, 2024). In addition, limited teacher collaboration and insufficient school leadership support hindered the adoption of differentiated practices, particularly when teachers were expected to implement curriculum changes within existing institutional constraints (Herner-Patnode & Lee, 2021). These conditions restricted teachers' opportunities to strengthen their knowledge and sustain differentiated instructional practices over time. Consequently, successful implementation depends not only on individual teacher competence but also on supportive school leadership, collaboration, and continuous professional learning.

Overall, the identified challenges are closely interconnected. Student diversity, teacher competence, resource availability, and institutional support collectively shape the implementation of differentiated instruction in mathematics education. This interconnectedness highlights the need for comprehensive support, which is discussed in the following section.

Synthesis of the reviewed studies identified four key areas supporting differentiated instruction in mathematics: professional development, instructional resources and technology, school collaboration and leadership, and policy and organizational support (Figure 6). Sustainable implementation requires coordinated support beyond individual

teacher effort, with teacher competence in responding to learner diversity also being emphasized in mathematics education research (Epran et al., 2025).

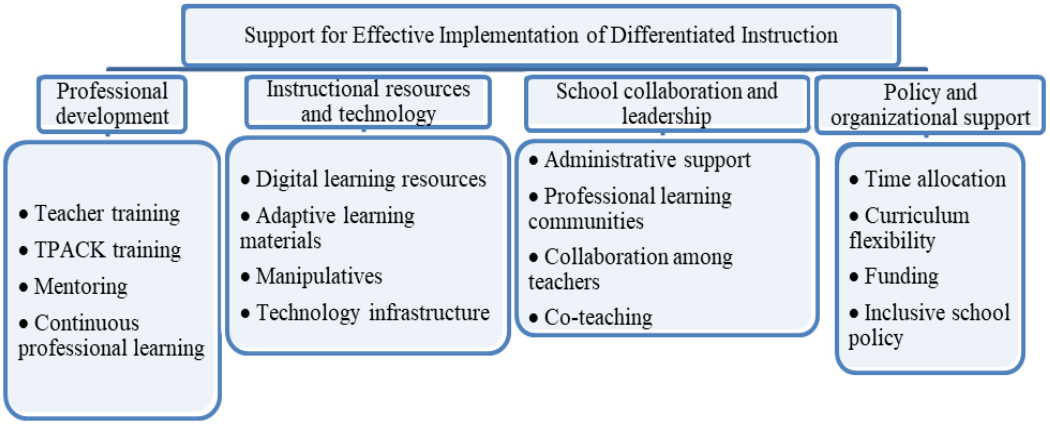


Figure 6. Synthesized Support of Differentiated Instruction

Professional development emerged as an important form of support for strengthening teachers' capacity to implement differentiated instruction. The reviewed studies identified teacher training, Technological Pedagogical Content Knowledge (TPACK) training, mentoring, and continuous professional learning as relevant forms of professional support. Structured professional development was reported as necessary for equipping teachers with practical knowledge and skills to plan, implement, and assess differentiated mathematics instruction (Maphumulo & Biccard, 2025; McIntosh, 2024). In addition, mentoring and professional learning communities provided opportunities for teachers to exchange experiences, reflect on their instructional practices, and collaboratively develop differentiated teaching strategies (Herner-Patnode & Lee, 2021; Marit et al., 2025). Technology-focused training, including TPACK-oriented professional development, further supported teachers in utilizing digital tools for differentiated mathematics instruction (Ramdhani et al., 2025; Shodiq et al., 2024). These findings suggest that professional development should be continuous and practice-oriented because the complexity of differentiated instruction requires teachers to continuously refine their pedagogical knowledge and instructional decision-making.

Instructional resources and technology were also identified as essential forms of support. The reviewed studies emphasized the importance of digital learning resources, adaptive learning materials, manipulatives, and adequate technology infrastructure in facilitating differentiated mathematics instruction. Digital and adaptive resources enabled teachers to provide learning materials that responded to students' varied readiness levels and learning needs (Ramdhani et al., 2025; Shodiq et al., 2024). The use of manipulatives and

appropriate technological infrastructure also supported students' conceptual understanding and expanded opportunities for more personalized learning experiences (Gervasoni et al., 2021; Marit et al., 2025). Furthermore, digital platforms and technology-supported learning environments helped teachers organize differentiated activities, monitor students' progress, and provide timely instructional support (Courtney, 2021; Ramdhani et al., 2025). Thus, the availability of instructional resources and technology can reduce the practical barriers identified in the previous section and support teachers in implementing differentiation more consistently.

School collaboration and leadership constituted another important form of support. The reviewed studies highlighted administrative support, professional learning communities, teacher collaboration, and co-teaching as mechanisms that strengthened the implementation of differentiated instruction. School leaders contributed by providing instructional guidance, allocating resources, and encouraging instructional innovation (McIntosh, 2024). Meanwhile, collaboration among teachers enabled the exchange of instructional experiences and resources as well as the joint development of strategies to address students' diverse mathematical needs (Herner-Patnode & Lee, 2021; Marit et al., 2025). Co-teaching was also identified as a collaborative practice that supported more individualized assistance, improved classroom management, and enhanced teachers' responsiveness to learner diversity (Marit et al., 2025). These findings indicate that a collaborative school culture can strengthen individual teacher capacity and make differentiated instruction more sustainable within everyday school practice.

Policy and organizational support was identified as a further condition for sustaining differentiated instruction over time. The reviewed studies emphasized the importance of adequate time allocation, curriculum flexibility, funding, and inclusive school policies. Sufficient instructional and planning time allowed teachers to design differentiated instruction activities and respond to students' diverse mathematical needs (Herner-Patnode & Lee, 2021; McIntosh, 2024). Curriculum flexibility and financial support were also considered necessary for providing instructional resources, professional development, and technology to support differentiated mathematics instruction (Ramdhani et al., 2025). In addition, inclusive school policies created organizational conditions that encouraged equitable learning opportunities and supported the consistent implementation of differentiated instruction across classrooms (Maphumulo & Biccard, 2025; Marit et al., 2025). This finding demonstrates that educational policy and organizational conditions

provide the systemic foundation for the long-term implementation of differentiated instruction.

Overall, the findings demonstrate that sustainable implementation of differentiated instruction in mathematics education requires support across multiple levels. Overall, sustainable implementation depends on coordinated support across professional, instructional, school, and policy levels. These conditions enable teachers to respond to learner diversity while maintaining consistent differentiated practices. Rather, its sustainability depends on coordinated support from teachers, schools, educational institutions, and policymakers to create enabling conditions for responding to students' diverse learning needs.

The integrated findings indicate that differentiated instruction functions as a multidimensional framework in which content, process, product, and learning environment are coordinated to address learner diversity. Its implementation is shaped not only by instructional decisions but also by teacher capacity, student characteristics, resources, and institutional conditions. The interaction among these factors suggests that differentiated instruction requires alignment between classroom practices and the broader conditions that support their implementation.

The synthesis further indicates that the challenges and support required for differentiated instruction are closely interconnected. Difficulties in planning, classroom management, and assessment are likely to be intensified when teachers have limited professional preparation, insufficient instructional time, or inadequate resources. Conversely, continuous professional development, access to instructional resources and technology, teacher collaboration, supportive school leadership, and appropriate organizational policies can create conditions that facilitate the implementation of differentiated instruction. This finding suggests that sustainable implementation requires a systemic approach in which teacher competence is supported by enabling school and policy environments.

These findings have important implications for mathematics education practice. Teachers need opportunities to develop the knowledge and skills required to identify diverse learning needs and coordinate differentiation across content, process, product, and learning environment. Schools and educational institutions should provide collaborative professional cultures, instructional resources, and leadership support to enable teachers to implement differentiated instruction consistently. At the policy level, professional development, adequate planning time, curriculum flexibility, and supportive organizational policies should

be considered important conditions for sustaining differentiated mathematics instruction. Overall, the integrated findings emphasize that promoting differentiated instruction requires coordinated efforts across multiple levels of the education system rather than relying solely on individual teacher initiative.

This systematic literature review has several limitations that should be considered when interpreting its findings. The scope of the review may have excluded relevant studies indexed in other academic databases or published in languages other than English. In addition, the 15 included studies varied in terms of educational context, participant characteristics, and research design. The predominance of qualitative studies and the uneven distribution of studies across countries and educational levels limited direct comparisons between contexts. Furthermore, the diversity of implementation strategies and reported findings made it difficult to identify consistent patterns in differentiated instruction practices across studies. Finally, the synthesis relied on the information reported in the included studies and was therefore influenced by the methodological scope and level of detail of the original research. These limitations should be considered when interpreting the findings of this review.

CONCLUSION

Based on the findings, differentiated instruction in mathematics education is implemented through four interconnected dimensions: content, process, product, and learning environment differentiation. These dimensions enable teachers to respond to diverse learning needs while maintaining common learning objectives. Implementation is challenged by teacher-related factors, student diversity, resource and time constraints, and institutional conditions. Sustainable implementation therefore requires continuous professional development, adequate instructional resources and technology, collaborative school cultures, and supportive organizational policies. Future research should examine differentiated instruction across broader educational contexts using longitudinal and mixed-method approaches.

DECLARATIONS

Author Contribution : Auliya Rahmatul Ulya: Conceptualization, Methodology, Investigation, Formal Analysis, Writing-Original Draft, and Visualization.

Ikrar Pramudya: Conceptualization, Methodology, Validation, Writing-Review & Editing, and Supervision.
Siswanto: Validation, Writing-Review & Editing, and Supervision.
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