Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

Differentiated instruction: A systematic literature review on implementation guidelines in mathematics education

Mohd Afifi Bahurudin Setambah [1, *], Sathish Rao Appalanaidu [1], Syaza Hazwani Zaini [1], Mohd Syaubari Othman [1], Ahmad Ridwan [2], Muhammad Alhaji Ibrahim [3]

[1]*Department of Educational Studies, Universiti Pendidikan Sultan Idris, Tg Malim, Malaysia*
[2]*Departement of Educational Management, Universitas Islam Negeri Sulthan Thaha Saifuddin Jambi, Jambi, Indonesia*
[3]*Department of Science Education, Sule Lamido University Kafin Hausa, Jigawa State, Nigeria*

ARTICLE INFO

Article history:
Received 12 November 2024
Received in revised form
9 February 2025
Accepted 25 February 2025

Keywords:
Differentiated instruction
Mathematics education
Student achievement
Teaching strategies
PRISMA framework

ABSTRACT

This systematic literature review examines high-impact research on differentiated instruction (DI) in mathematics education from 2014 to 2024. The study aims to (1) explore how DI is implemented in mathematics teaching and learning, (2) assess its effects on students, and (3) investigate the guidelines used for its implementation. Following the PRISMA protocol, the review follows a structured process of identification, screening, eligibility, and inclusion. Findings from 11 empirical studies highlight key methods of DI implementation, including collaborative learning, technology integration, and student-centered approaches. The results indicate that DI positively influences mathematics achievement, student motivation, and interest. The analysis also identifies the Tomlinson model as the primary framework guiding DI implementation in mathematics. The study emphasizes the importance of continuous professional development for teachers and highlights the need for a comprehensive DI framework. Future research should explore DI in relation to other factors, such as 21st-century skills.

1. Introduction

Mathematics is essential to help students develop critical thinking and academic skills. The subject promotes logical reasoning, problem-solving, and analysis of information that are crucial in succeeding in the contemporary world. Arisoy and Aybek (2021) added that the math curriculum was designed by Jamil et al. (2024) to be incrementally developed to improve understanding and critical thinking skills. In mathematics, it includes statement evaluation, proof making, and identification of different arguments. Reasoning and logic-oriented teaching strategies develop critical thinkers. Developing critical thinking through mathematics is crucial in preparing students to face modern-world challenges (Barakaev et al., 2020). However, teachers can develop mathematical ability by being aware of the differences in their students within the classroom setting.

Student diversity in mathematics classes brings challenges and opportunities for the teachers. Students vary in their abilities, styles of learning, interests, socio-economic backgrounds, and experiences. Some may see this as a challenge to be overcome; however, it equally provides an opportunity to enhance the learning of all students as a whole (Askew, 2015). Teachers sometimes struggle to meet such diverse needs. Success in mathematics would then be a matter of adjustment to the prevailing educational structure. However, the latter has inherent weaknesses in failing to take into account individual differences in the talents and interests of students (Herzig, 2005). Ferguson (2009) urged teachers to re-examine their teaching abilities to make the best possible adjustments, while Askew (2015) reflected on how the curriculum itself could be part of the problem. Understanding individual differences in cognitive aspects, motivation, attitudes, and learning styles will enable the teacher to help develop each student's potential in mathematics. Therefore, reflection of teaching approaches is carried out by the teacher to ensure that the approaches being used are no longer traditional teaching methods.

There are a number of disadvantages to traditional teaching methods, which are frequently

* Corresponding Author.
Email Address: mohdafifi@fpm.upsi.edu.my (M. A. B. Setambah)
https://doi.org/10.21833/ijaas.2025.03.011
Corresponding author's ORCID profile:
https://orcid.org/0000-0001-7550-0278

defined by teacher-centered approaches and low levels of student engagement. These approaches might not actively engage students, which would lower their motivation and academic performance. Due to their inability to adapt to their own learning methods, they may also cause students to retain less information. While listening, when students are only copying notes, the "chalk and talk" method may cause cognitive overload (Setambah et al., 2021). Also, this method probably will not provide students with the useful skills needed in practice. Using active learning strategies in large lecture sessions can be difficult, despite the fact that they have been found to improve student engagement and knowledge retention. According to certain experts, it may be more successful to combine conventional methods with two-way communication (Madaminova, 2021). Nonetheless, it is acknowledged that new pedagogical approaches are required to overcome the shortcomings of the existing teaching strategies (Khalaf, 2018).

Research has shown that traditional mathematics lectures often fail to engage students or address their varied learning needs. Studies also indicate that lectures can lead to decreased motivation and lower academic performance. Teacher support and conceptual teaching strategies positively influence student motivation and mathematics achievement (Yu and Singh, 2018). Factors such as course structure, teaching methods, and teacher attitudes contribute to student motivation in mathematics (Makamure, 2021). Student motivation is significantly related to perceptions of teaching practices and resource use (Hossein-Mohand and Hossein-Mohand, 2023). Overall, studies suggest that implementing diverse student-centered teaching approaches can enhance motivation, engagement, and academic achievement in mathematics (Tella, 2007).

Differentiated Instruction (DI) is a teaching approach that addresses the diverse needs of students by varying content, processes, and products (Musasa, 2024). DI is highly relevant in teaching mathematics due to its ability to enhance mathematical understanding and address diversity. It can improve students' mathematics achievement (Insorio, 2024) and boost their confidence in problem-solving (Aguhayon et al., 2023). By tailoring teaching approaches to individual needs, interests, and learning styles, DI creates optimal conditions for student development. Teachers see DI as significant for enhancing student achievement and teaching effectiveness. However, implementing DI poses challenges such as time constraints, resource limitations, and classroom management issues (Hatmanto and Rahmawati, 2023; Insorio, 2024). Strategies to address such challenges are: Team teaching, technology integration, and flexible scheduling (Smets and Struyven, 2018). A guide concerning DI is hence greatly required for the teachers comprising frameworks, models, and specific modules on mathematics.

Despite these, DI still promises a lot in terms of mathematical comprehension and addressing student needs. Through the exploration of its implementation, this study seeks to develop an in-depth understanding of how DI can enhance comprehension in mathematics and support students from all walks of life. The study also hopes to find whether there are any clear-cut and practical guidelines on applying DI in teaching mathematics. The study addresses three major questions: i) How is differentiated instruction implemented in teaching and learning mathematics? ii) What are the effects of differentiated instruction on students? iii) Are there any specific guidelines for teachers to implement differentiated instruction, especially in mathematics?

2. Methodology

This study is a systematic literature review (SLR) using comprehensive search techniques related to relevant articles (Bodolica and Spraggon, 2018; Elmashhara et al., 2022). The SLR is conducted to ensure that the identified literature review information can be systematically analyzed. Thus, this study will use the Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines with predefined research questions. Based on PRISMA, the process of identifying articles, screening article selections, guiding the data collection process, and focused data analysis are carried out. The four steps of PRISMA are conducted to thoroughly review the literature to draw conclusions. Article search steps are performed based on the keywords "Diffentiated Instruction," "Differentiated Instruction" and "Mathematics." To ensure the validity of the data and the relevance of the study, specific screening criteria are used based on the year of publication, language, type of reference language, and field of research. Table 1 provides a summary of the inclusion and exclusion criteria used during the article selection process.

Table 1: Article inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Article title and content	Title that is appropriate and meets research needs	Title that is irrelevant and does not meet research needs
Year of publication	Latest 10 years (2014 to 2024)	Outside the study period range
Type of publication	Only empirical studies and journal articles are accepted	Non-empirical, review, and editorial
Language	English	Others
Field of study	Mathematics education	Others
Accessibility	Full article	Requires payment or preview only

Table 1 outlines the criteria for publication years, limited to the most recent 10 years, from 2014 to 2024. Regarding language, only articles in English are accepted for this study. This requirement is intended to simplify the data analysis process. The materials used are journal articles specifically related to mathematics, but they encompass all levels of education. Therefore, the title and abstract of each journal article are analyzed to eliminate those that are not relevant to this study. Fig. 1 shows the flowchart for the PRISMA protocol used in this study.

2.1. Identification

To identify articles that meet the criteria outlined in Table 1, a search was conducted using four main databases: Scopus, ERIC, JSTOR, and Springer Link. These databases offer options to refine the results of each article search. Keywords, as mentioned above, were entered into the search engines. The findings show that there are 11,872 articles related to differentiated instruction across these four databases. Specifically, the results include 1,386 articles from Scopus, 43 articles from ERIC, 9,852 articles from Springer Link, and 591 articles from JSTOR.

2.2. Screening

The researcher did an automatic check using filters from search engines, looking at year, language, publication type, and study field. The results showed 253 articles fit the criteria. The researcher also found some duplicate articles in databases, like those in both Scopus and Springer Link. The results were adjusted according to the PRISMA rules. The researcher sorted the details by title, author, publication year, and content relevant to the research questions.

The titles of the articles had to relate to differentiated instruction in math. The publication years were set to 2014 to 2024 to keep the results relevant. Only original scholarly journals were accepted, while magazines, books, newspapers, review journals, and other types were not included. Also, the researcher only picked articles in English to keep the research consistent. Full-text access was necessary, and articles without full access were left out. This included permissions from the University of Education, and all articles were reviewed carefully.

2.3. Eligibility

A total of 238 findings from the previous round were excluded because they did not meet the established standards. This exclusion was based on initial criteria such as irrelevant titles or content that did not align with the study's objectives. As a result, only 13 findings advanced to the next phase for further evaluation. At this stage, a more in-depth review was conducted, focusing on the abstracts of the articles to assess their eligibility. To ensure this was an efficient and thorough process, all authors were actively involved in the manual review, dividing the articles equally among themselves.

The key criteria of selection used in this review include the relevance of the title to the research topic, the relevance of the content to the issues being studied, and the appropriateness of the keywords. Many articles did not satisfy the aforementioned criteria, particularly in their titles, which were mostly general or not related to the DI in mathematics education. In fact, articles were included in this review if they provided explicit explanations of how DI could be implemented in a mathematics education setting. This is a systematic approach toward research results filtration to focus on the really relevant and quality articles. Eventually, after all the processes involving inclusion and exclusion, there remained 13 articles that would form the backbone of the review.

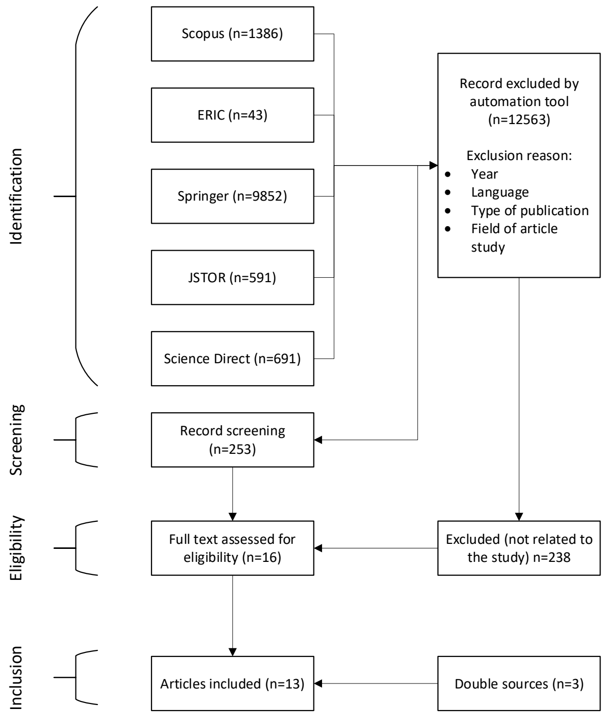

Fig. 1: PRISMA protocol in this study

2.4. Inclusion

The quality of the selected articles and the review process are essential elements in order to ensure validity and reliability in this study. This was done carefully to avoid any bias, hence increasing the accuracy of the results based on the established inclusion criteria in accordance with the PRISMA protocol. The screened articles were reviewed for an in-depth understanding of how differentiated instruction in mathematics is implemented, the effects of DI, and guidelines used during teaching and learning mathematics.

This review further assisted the authors in answering the research questions and identifying the key findings for the reporting section. In addition, forward and backward citation tracking analysis was performed on the studies identified during the initial search. This strategy helped in the identification of other records through the analysis of related references, either preceding or succeeding the main study. This process ensures that only relevant and high-quality articles will be selected, hence enhancing the overall findings of the study.

2.5. Data analysis

The data analysis or findings primarily answer the research questions. This study tries to combine and connect data from various studies and find ways to improve previous research. Besides, thematic analysis is one of the methods used in identifying patterns or themes in qualitative data. The selected data comes from the screened studies, which resulted in 13 papers. Abstracts, introductions, methods, results, and discussions from these studies contain all the elements or data. The findings were classified as qualitative data; therefore, descriptions and explanations from these studies were considered to comprehend and integrate them into the themes of this review.

3. Findings and discussion

The data findings need to answer all three research questions. The results from the data analysis of the 13 identified articles related to differentiated instruction (DI) in mathematics are summarized. The information from these articles is based on Table 2.

Table 2: Information of the article

Year	Frequency	Country	Frequency	Database	Frequency
2014	1	Australia	7	ERIC	2
2015	0	Netherland	3	JSTOR	2
2016	1	South Korea	1	Scopus	5
2017	0	USA	1	Springer	2
2018	1	Cyprus	1	Science Direct	2
2019	1	Belgium	1		
2020	2				
2021	6				
2022	1				
2023	0				
2024	0				

Over the 10 years from 2014 to 2024, articles on differentiated instruction (DI) in mathematics show a low frequency, with values of 0 or 1 for almost all years. The years 2015, 2017, 2023, and 2024 have no DI articles in mathematics found within the searched databases. However, the year 2021 showed a remarkable increase to the highest frequency with n=6 (Bobis et al., 2021; Mellroth et al., 2021; Courtney, 2021; Gervasoni et al., 2021; Hubbard and Livy, 2021; Herner-Patnode and Lee, 2021; Mellroth et al., 2021). The year 2020 presents 2 articles (n=2) (Iterbeke et al., 2020; Maulana et al., 2020). The years 2014, 2016, 2018, 2019, and 2022 each recorded a frequency of 1 (n=1) (Konstantinou-Katzi et al., 2013; Ritzema et al., 2016; Prast et al., 2018; Good and Ottley, 2019; van den Kieboom and Groleau, 2022), indicating the presence of DI in mathematics. Overall, DI in mathematics has been underpublished in the specified databases over the past decade.

Australia recorded the highest frequency with n=7 (Bobis et al., 2021; Courtney, 2021; Gervasoni et al., 2021; Hubbard and Livy, 2021; Herner-Patnode and Lee, 2021; Mellroth et al., 2021; van den Kieboom and Groleau, 2022). This suggests that, relative to other countries, Australia has a greater interest in DI research, in general, and in mathematics in particular. It is followed by the Netherlands, with n=3 (Ritzema et al., 2016; Maulana et al., 2020; Prast et al., 2018), and then South Korea (Maulana et al., 2020), the USA (Good and Ottley, 2019), Cyprus (Konstantinou-Katzi et al., 2013), and Belgium (Iterbeke et al., 2020) with a frequency of n=1. This is an indication of a research gap for other countries, especially Malaysia, to probe further into DI in mathematics. Since Malaysia is a significant country in Southeast Asia, the absence of data in the databases searched raises a number of questions as to whether DI is under-researched or underemphasized, or if other factors are at play. This is notable since the topic of DI has been a focus of the Malaysian Ministry of Education since 2019.

3.1. How differentiated instruction is implemented in teaching and learning, specifically in mathematics?

The first research question relates to the implementation of teaching and learning, specifically in mathematics. The findings show that 13 articles explain the implementation of differentiated instruction (DI) in mathematics teaching (Table 3). Six articles (n=8) use a collaborative approach in the teaching and learning process of mathematics using DI. The collaborative approach includes group work and discussions based on ability (Konstantinou-Katzi et al., 2013; Ritzema et al., 2016; Prast et al., 2018; Iterbeke et al., 2020; Maulana et al., 2020; Herner-Patnode and Lee, 2021; Hubbard and Livy, 2021; van den Kieboom and Groleau, 2022). This suggests that collaboration acts as an important ingredient in DI in mathematics.

Another important focus in implementing DI in mathematics is the use of technology, with four articles (n=4). Examples include the latest technology and graphic organizers used by van den Kieboom and Groleau (2022), Courtney (2021), Good and Ottley (2019), and Konstantinou-Katzi et al. (2013). This indicates that technology-assisted learning is an important and growing element in the implementation of DI, especially in mathematics.

Student-centered approaches, such as differentiated instructions, assignment choices, inquiry, constructivism, and problem-based learning, are also employed by the researchers at a frequency of six (n=6) (Good and Ottley, 2019; Maulana et al., 2020; Bobis et al., 2021; Courtney, 2021; Mellroth et al., 2021; Gervasoni et al., 2021). This indicates that active learning remains significant in developing meaning in the learning process for students. Besides that, the other approaches done in mathematics DI are the didactic and systematic approach: Structured teaching format and didactic situation, n=2 (Bobis et al., 2021; Konstantinou-Katzi et al., 2013). It has been noted that the key elements when dealing with DI in mathematics involve these two elements. For questioning techniques, there were 2 (n=2), respectively (Bobis et al., 2021; Good and Ottley, 2019).

Table 3: Article analysis

Reference	DI implementation	DI effect	DI guide	DI theory
Konstantinou-Katzi et al. (2013)	• Collaborative learning activities • Integration of latest technology • Provision of differentiated instructions • Systematic teaching structure • Student-responsive approaches • Tiered activities • Flexibility in implementation	Student engagement motivation and mathematics achievement	Tomlinson framework	Theory of the zone of proximal development
Ritzema et al. (2016)	• Whole class instruction • Extended instruction-some student receive • Extended instruction, the other student does seatwork • Seatwork- individually, small group exercises	Mathematics Achievement Reading comprehension	Tomlinson framework	-
Good and Ottley (2019)	• Organizing small instructional groups • Using graphic organizers • Questioning with varied levels of difficulty • Creating materials and games • Providing wait time • Offering choices Choice	Knowledge interest	-	Bloom taxonomy
Maulana et al. (2020)	• Group discussions based on ability • Assigning differentiated tasks • Implementation outside the classroom	-	Tomlinson framework	-
Herner-Patnode and Lee (2021)	Group work	Mathematics achievement cultural background	Tomlinson framework	The theory of multiple intelligences the theory of thinking styles
Hubbard and Livy (2021)	• Collaborative Planning Structure • Focus on Context-Based Approaches	Teaching content student learning	Tomlinson framework	-
Bobis et al. (2021)	• Didactical Situations • Student-Centered Approach • Problem-Based Learning • Interaction and Observation • Questioning Techniques)	belief	-	Theory of didactical situations
Gervasoni et al. (2021)	Constructivist-based	Achievement	Tomlinson framework	Constructivism theory
Courtney (2021)	Problem-based Learning Technology Approach (Web)	Achievement	-	Thompson and Harel's theory of meanings
Mellroth et al. (2021)	Inquiry based	-	Tomlinson framework	Cultural-historical activity theory
van den Kieboom and Groleau (2022)	• Pair/Group work • Various examples according to level (tutoring) • Reteaching • Technology	-	Tomlinson framework	-
Iterbeke et al. (2020)	• Pair/group work • Different levels of teaching material	Achievement	Cycle of differentiation	-
Prast et al. (2018)	• Pair/group work	Achievement	Cycle of differentiation	-

The final conclusion is that collaborative and student-centered approaches are the most common in the implementation of DI in mathematics. This is followed by the use of technology to assist teachers in enhancing teaching effectiveness. This indicates that mathematics education is increasingly becoming active, technology-driven, and student-centered. Therefore, it is recommended that DI in mathematics be implemented based on the findings. However, there are gaps in implementation. The results indicated a lack of research using game-based approaches and outdoor elements. Therefore, it is recommended that DI in mathematics should focus on creative elements in learning activities, for instance, game materials and interactive activities. Teachers can also enhance the use of creative materials in helping students comprehend math concepts and deal with students' diversity in the classroom.

3.2. What are the effects of differentiated instruction in mathematics on students?

Table 3 shows the effects of differentiated instruction (DI) in mathematics as studied by 13 researchers in the Scopus, JSTOR, Springer Link, Science Direct, and ERIC databases. Based on the findings, five articles (n=7) examined the impact on mathematics achievement. DI showed a positive effect on this variable (Konstantinou-Katzi et al., 2013; Ritzema et al., 2016; Prast et al., 2018; Iterbeke et al., 2020; Herner-Patnode and Lee, 2021;

Gervasoni et al., 2021; Courtney, 2021). This proves that DI can enhance mathematics achievement. The implementation also had effects on motivation, confidence, culture, and interest, each with a frequency of one (n=1) (Konstantinou-Katzi et al., 2013; Good and Ottley, 2019; Bobis et al., 2021; Herner-Patnode and Lee, 2021).

These findings also represent a gap in research, particularly in human capital. DI in mathematics is still being studied in terms of thinking skills, leadership skills, communication skills, and digital knowledge. When it comes to the implementation of DI in mathematics, these variables can be deeply studied since most implementations done by other researchers in the area of DI, especially in mathematics, have been of a collaborative approach. This approach has a high correlation with these variables. Many studies which applied active learning, such as Setambah et al. (2023a; 2023b; 2019) demonstrated positive effects. Regarding these variables, more in-depth studies should be conducted in the future. This would have a greater implication for the educational structure, especially in Malaysia, to solve the problem of diversity among students in the classroom.

3.3. Are there specific guidelines for implementing differentiated instruction (DI) by teachers, especially in mathematics?

Table 3 also highlights the specific guidelines used by researchers for DI in mathematics. Eight out of 11 articles (n=8) reference Tomlinson's model for implementing DI, particularly in mathematics classes. Tomlinson emphasizes significant differentiation in four main elements: Content, process, product, and environment (Marks et al., 2021). Tomlinson stresses effective adaptation to meet the diverse needs of students. Content refers to the learning materials taught to students. In this study's context, it is mathematics. In DI, the mathematics content needs to be adjusted to the students' levels. This can be done by modifying the complexity of materials according to the students' abilities (Good and Ottley, 2019). Process refers to how students learn the mathematics content. Here, teachers diversify their strategies, techniques, and teaching approaches (Pozas et al., 2020). Product refers to the evidence showing that students have achieved the learning outcomes. The products they create demonstrate their learning in various ways, such as through projects, written tests, presentations, and performances, tailored to their abilities (Ginja and Chen, 2020). The environment refers to the classroom setup, creating an inclusive and positive atmosphere that allows students to thrive in their own ways. Continuous training related to Tomlinson's model is essential, especially in mathematics, in Malaysia. The research gap in DI, particularly in mathematics, needs to be addressed by the Malaysian Ministry of Education. The cycle of differentiated instruction is used in two articles. This cycle is also based on Tomlinson's four. However, include a component such as the student's needs analysis. The Cycle of Differentiation is a structured, iterative model for tailoring education to diverse student needs, involving identification of educational needs, setting differentiated goals, adapting instruction and tasks, and evaluating outcomes to inform continuous improvement (Prast et al., 2018).

4. Conclusion

Differentiated instruction in mathematics has been effective in improving student learning. From the analysis of the studies conducted, collaborative, student-centered, and technology-based approaches are the major strategies for implementing DI in mathematics. Recommended activities such as group work, paired discussions, and group collaboration based on ability levels have been crucial in facilitating understanding and increasing student engagement in mathematics teaching. In addition, the inclusion of technology such as digital applications and graphic organizers has successfully supported teaching and learning. The approaches using differentiated instructions, problem-based learning methods, and inquiry activities have also positively impacted students in terms of learning. However, it is suggested that DI in mathematics should also include game-based teaching and learning. The creative elements and interactive activities have not been given enough attention. Therefore, there is a dire need to further emphasize these aspects in order to enhance the effectiveness of DI in mathematics.

The study also found that DI in mathematics positively affects mathematics achievement. However, there is still a lack of research on human capital skills, particularly 21st-century skills such as communication, leadership, and critical thinking. Only elements related to motivation, interest, and confidence have been given attention. Therefore, further research on DI concerning other variables, especially through experimental studies, is necessary. Regarding the guide to implementation, Tomlinson's model has also been regarded as the most referable model to ensure implementation is effective. The elements highlighted are content, process, product, and environment. Considering this model will give guidance to educators on how they should implement DI, math, in particular. For now, there is also a lack of models and frameworks or learning modules presented with the basis of the theory of DI.

Currently, there is only one model acting as a guide for implementation. Hence, further research on the matter is needed for the future. Especially, the areas that show ample room for improvement using creative elements and further research that may be done on how DI influences human capital elements. This is a research gap that needs special attention from the Ministry of Education of Malaysia. The Ministry should implement continuous training that equips teachers with skills in teaching mathematics through DI to address diverse student needs in the classroom.

Acknowledgment

This research was supported by the Ministry of Higher Education (MoHE) through the Fundamental Research Grant (FRGS/1/2023/SSI07/UPSI/03/3).

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Aguhayon H, Tingson R, and Pentang J (2023). Addressing students learning gaps in mathematics through differentiated instruction. International Journal of Educational Management and Development Studies, 4(1): 69-87. https://doi.org/10.53378/352967

Arisoy B and Aybek B (2021). The effects of subject-based critical thinking education in mathematics on students' critical thinking skills and virtues. Eurasian Journal of Educational Research, 92: 99-119. https://doi.org/10.14689/ejer.2021.92.6

Askew M (2015). Diversity, inclusion and equity in mathematics classrooms: From individual problems to collective possibility. In: Bishop A, Tan H, and Barkatsas T (Eds.), Diversity in mathematics education. Mathematics education library: 129-145. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-05978-5_8

Barakaev M, Shamshiev A, Shodiev S, Baxramov S, and G'iyosova Z (2020). Factors for developing students' critical thinking skills in the process of teaching mathematics. The American Journal of Applied Sciences, 2(7): 28-34. https://doi.org/10.37547/tajas/Volume02Issue07-05

Bobis J, Russo J, Downton A, Feng M, Livy S, McCormick M, and Sullivan P (2021). Instructional moves that increase chances of engaging all students in learning mathematics. Mathematics, 9(6): 582. https://doi.org/10.3390/math9060582

Bodolica V and Spraggon M (2018). An end-to-end process of writing and publishing influential literature review articles: Do's and don'ts. Management Decision, 56(11): 2472-2486. https://doi.org/10.1108/MD-03-2018-0253

Courtney S (2021). Differentiating mathematics instruction in remote learning environments: Exploring teachers' challenges and supports. Mathematics Teacher Education and Development, 23(3): 182-206.

Elmashhara MG, Silva J, Sá E, Carvalho A, and Rezazadeh A (2022). Factors influencing user behaviour in micromobility sharing systems: A systematic literature review and research directions. Travel Behaviour and Society, 27: 1-25. https://doi.org/10.1016/j.tbs.2021.10.001

Ferguson H (2009). Self-identity and everyday life. Routledge, London, UK. https://doi.org/10.4324/9780203001776

Gervasoni A, Roche A, and Downton A (2021). Differentiating instruction for students who fail to thrive in mathematics: The impact of a constructivist-based intervention approach. Mathematics Teacher Education and Development, 23(3): 207-233.

Ginja TG and Chen X (2020). Teacher educators' perspectives and experiences towards differentiated instruction. International Journal of Instruction, 13(4): 781-798. https://doi.org/10.29333/iji.2020.13448a

Good SC and Ottley JR (2019). Learning mathematics through everyday play activities. YC Young Children, 74(3): 73-78.

Hatmanto ED and Rahmawati F (2023). Unleashing the potential: Exploring attitudes and overcoming challenges in implementing differentiated instruction in the Philippines' English language classrooms. E3S Web of Conferences, 425: 02001. https://doi.org/10.1051/e3sconf/202342502001

Herner-Patnode L and Lee HJ (2021). Differentiated instruction to teach mathematics: Through the lens of responsive teaching. Mathematics Teacher Education and Development, 23(3): 6-25.

Herzig AH (2005). Connecting research to teaching: Goals for achieving diversity in mathematics classrooms. The Mathematics Teacher, 99(4): 253-259. https://doi.org/10.5951/MT.99.4.0253

Hossein-Mohand H and Hossein-Mohand H (2023). Influence of motivation on the perception of mathematics by secondary school students. Frontiers in Psychology, 13: 1111600. https://doi.org/10.3389/fpsyg.2022.1111600 **PMid:36743609 PMCid:PMC9893926**

Hubbard J and Livy S (2021). Self-study of a mathematics learning consultant: Supporting teachers to plan lessons for implementing differentiation in the classroom. Mathematics Teacher Education and Development, 23(3): 148-165.

Insorio AO (2024). Addressing student diversity to improve mathematics achievement through differentiated instruction. International Journal of Professional Development, Learners and Learning, 6(1): ep2406. https://doi.org/10.30935/ijpdll/14462

Iterbeke K, De Witte K, Declercq K, and Schelfhout W (2020). The effect of ability matching and differentiated instruction in financial literacy education: Evidence from two randomised control trials. Economics of Education Review, 78: 101949. https://doi.org/10.1016/j.econedurev.2019.101949

Jamil M, Bokhari TB, and Iqbal J (2024). Incorporation of critical thinking skills development: A case of mathematics curriculum for grades I-XII. Journal of Asian Development Studies, 13(1): 375-382. https://doi.org/10.62345/jads.2024.13.1.32

Khalaf AJ (2018). The effectiveness of using internet in TEFL learning. Theory and Practice in Language Studies, 8(9): 1114-1121. https://doi.org/10.17507/tpls.0809.02

Konstantinou-Katzi P, Tsolaki E, Meletiou-Mavrotheris M, and Koutselini M (2013). Differentiation of teaching and learning mathematics: An action research study in tertiary education. International Journal of Mathematical Education in Science and Technology, 44(3): 332-349. https://doi.org/10.1080/0020739X.2012.714491

Madaminova DI (2021). Uzbekistan as a leading initiator in central Asia. Academicia: An International Multidisciplinary Research Journal, 11(3): 1045-1049. https://doi.org/10.5958/2249-7137.2021.00726.6

Makamure C (2021). Examination of pre-service teachers' error analysis skills in teaching differential calculus. Universal Journal of Educational Research, 9(11): 1826-1840. https://doi.org/10.13189/ujer.2021.091103

Marks A, Woolcott G, and Markopoulos C (2021). Differentiating instruction: Development of a practice framework for and with secondary mathematics classroom teachers. International Electronic Journal of Mathematics Education, 16(3): em0657. https://doi.org/10.29333/iejme/11198

Maulana R, Smale-Jacobse A, Helms-Lorenz M, Chun S, and Lee O (2020). Measuring differentiated instruction in the Netherlands and South Korea: Factor structure equivalence, correlates, and complexity level. European Journal of Psychology of Education, 35: 881-909. https://doi.org/10.1007/s10212-019-00446-4

Mellroth E, Bergwall A, and Nilsson P (2021). Task design for differentiated instruction in mixed-ability mathematics classrooms: Manifestations of contradictions in a professional learning community. Mathematics Teacher Education and Development, 23(3): 78-96.

Musasa A (2024). In pursuit of equal access to quality education: A guide to the implementation of differentiated teaching for diverse minds. Open Journal of Social Sciences, 12(3): 119-130. https://doi.org/10.4236/jss.2024.123011

Pozas M, Letzel V, and Schneider C (2020). Teachers and differentiated instruction: Exploring differentiation practices to address student diversity. Journal of Research in Special Educational Needs, 20(3): 217-230. https://doi.org/10.1111/1471-3802.12481

Prast EJ, Van de Weijer-Bergsma E, Kroesbergen EH, and Van Luit JE (2018). Differentiated instruction in primary mathematics: Effects of teacher professional development on student achievement. Learning and Instruction, 54: 22-34. https://doi.org/10.1016/j.learninstruc.2018.01.009

Ritzema ES, Deunk MI, and Bosker RJ (2016). Differentiation practices in grade 2 and 3: Variations in teacher behavior in mathematics and reading comprehension lessons. Journal of Classroom Interaction, 51(2): 50-72.

Setambah MAB, Jaafar AN, Saad MIM, and Yaakob MFM (2021). Fraction cipher: A way to enhance student ability in addition and subtraction fraction. Infinity Journal, 10(1): 81-92. https://doi.org/10.22460/infinity.v10i1.p81-92

Setambah MAB, Rajoo M, Othman MS, Habibi A, and Ibrahim MA (2023a). 3 in 1 effect when using adventure based learning approach in basic statistics class. Journal of Higher Education Theory and Practice, 23(14): 195-207. https://doi.org/10.33423/jhetp.v23i14.6394

Setambah MAB, Rajoo M, Othman MS, Shuib TR, and Ibrahim MA (2023b). Non-digital gamification: Effects of teaching on mathematics achievement and student behavior. Nurture, 17(4): 504-515. https://doi.org/10.55951/nurture.v17i4.388

Setambah MAB, Tajudin NAM, Yaakob MFM, and Saad MIM (2019). Adventure learning in basics statistics: Impact on students critical thinking. International Journal of Instruction, 12(3): 151-166. https://doi.org/10.29333/iji.2019.12310a

Smets W and Struyven K (2018). Realist review of literature on catering for different instructional needs with preteaching and extended instruction. Education Sciences, 8(3): 113. https://doi.org/10.3390/educsci8030113

Tella A (2007). The impact of motivation on student's academic achievement and learning outcomes in mathematics among secondary school students in Nigeria. Eurasia Journal of Mathematics, Science and Technology Education, 3(2): 149-156. https://doi.org/10.12973/ejmste/75390

van den Kieboom LA, and Groleau SV (2022). Pre-service teacher planning for differentiation of instruction in mathematics classrooms. Educational Studies in Mathematics, 111(2): 225-252. https://doi.org/10.1007/s10649-022-10149-1

Yu R and Singh K (2018). Teacher support, instructional practices, student motivation, and mathematics achievement in high school. The Journal of Educational Research, 111(1): 81-94. https://doi.org/10.1080/00220671.2016.1204260