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What factors are barriers and enablers to implementing differentiated mathematics instruction in elementary schools?

Delia Indrawati *
* Elementary Teacher Education, PSDKU Magetan, Universitas Negeri Surabaya
deliaindrawati@unesa.ac.id

Ramadhan Kurnia Habibie *
* Elementary Teacher Education, Faculty of Education, Universitas Negeri Surabaya
ramadhanhabibie@unesa.ac.id

Budiyono *
* Elementary Teacher Education, Faculty of Education, Universitas Negeri Surabaya
budiyono@unesa.ac.id

Ulhaq Zuhdi *
* Elementary Teacher Education, Faculty of Education, Universitas Negeri Surabaya
ulhaqzuhdi@unesa.ac.id

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ABSTRACT
The implementation of differentiated instruction in mathematics learning in primary schools still faces challenges in meeting the needs of diverse students. This study investigates the barriers and enablers in applying differentiated mathematics instruction, providing insights into practical challenges and strategies for success. Using a qualitative case study design, data were collected through in-depth interviews, classroom observations, and document analysis in five primary schools, involving students, teachers, and school principals selected through purposive sampling. The data was then analyzed using thematic analysis technique to identify patterns, categories and themes relevant to the implementation of differentiated learning. The findings reveal that the primary barriers include limited teacher training on differentiation strategies, time constraints in lesson planning, and inadequate support systems, such as resources and collaboration opportunities. On the other hand, key enablers include strong leadership support, flexible teaching materials, and professional learning communities that foster peer knowledge sharing. The study highlights the interplay between institutional support and teacher agency as critical for successful implementation. Its novelty lies in offering actionable recommendations, such as incorporating differentiation-focused training into professional development and promoting collaborative educator networks. These findings contribute to the discourse on differentiated instruction, offering practical strategies and systemic changes to enhance equity and engagement in primary mathematics education.
Keywords*: Barriers and Enablers; Differentiated Instruction; Mathematics Education; Primary Schools*

ABSTRAK
Implementasi pembelajaran berdiferensiasi dalam pembelajaran matematika di sekolah dasar masih menghadapi tantangan dalam memenuhi kebutuhan siswa yang beragam. Penelitian ini menyelidiki

hambatan dan faktor pendukung dalam mercaptan pembelajaran matematika berdiferensiasi, memberikan wawasan tentang tantangan praktis dan strategi untuk mencapai keberhasilan. Dengan menggunakan desain studi kasus kualitatif, data dikumpulkan melalui wawancara mendalam, observasi kelas, dan analisis dokumen di lima sekolah dasar, yang melibatkan siswa, guru, dan kepala sekolah yang dipilih secara purposif. Data tersebut kemudian dianalisis menggunakan teknik analisis tematik untuk mengidentifikasi pola, kategori, dan tema yang relevan dengan implementasi pembelajaran berdiferensiasi. Temuan menunjukkan bahwa hambatan utama yang dihadapi guru adalah terbatasnya pelatihan guru mengenai strategi diferensiasi, keterbatasan waktu dalam perencanaan pembelajaran, dan sistem pendukung yang tidak memadai, seperti sumber daya dan peluang kolaborasi. Di sisi lain, faktor pendukung utama meliputi dukungan kepemimpinan yang kuat, bahan ajar yang fleksibel, dan komunitas pembelajaran profesional yang mendorong pertukaran pengetahuan antar rekan sejawat. Studi ini menyoroti interaksi antara dukungan kelembagaan dan agensi guru sebagai hal yang sangat penting untuk keberhasilan implementasi. Kebaruannya terletak pada rekomendasi yang dapat ditindaklanjuti, seperti memasukkan pelatihan yang berfokus pada diferensiasi ke dalam pengembangan profesional dan mempromosikan jaringan pendidik yang kolaboratif. Temuan-temuan ini berkontribusi pada pengajaran berdiferensiasi, menawarkan strategi praktis dan perubahan sistemik untuk meningkatkan kesetaraan dan keterlibatan dalam pendidikan matematika sekolah dasar melalui komunitas belajar.
Kata Kunci: Hambatan dan Pendukung; Pembelajaran Berdiferensiasi; Pendidikan Matematika; Sekolah Dasar

INTRODUCTION

Mathematics education plays a central role in equipping students with critical thinking, problem-solving, and analytical skills, which are essential in a rapidly changing world. Primary school mathematics is foundational in setting up students for future learning and shapes how they can handle complex concepts and challenges. However, achieving this foundation requires instructional approaches that not only focus on content mastery but also foster engagement and accommodate individual learner differences. The big challenge lies in delivering fair and effective mathematics instruction, bearing in mind the students' different ability levels, learning styles, and socio-cultural backgrounds. Such diversity calls for flexible, responsive, and inclusive teaching strategies; hence, differentiated instruction is one promising way to handle diverse learner needs in primary mathematics classrooms.

Differentiated instruction involves using varied instructional strategies, materials, and assessments to meet the needs of different learners, which promotes equal access to learning opportunities (Aguhayon et al., 2023; Bobis et al., 2021; Habibie & Turmudi, 2021). Differentiated instruction in mathematics learning presents unique challenges due to the subject's inherent structure and complexity (Tomlinson, 2017a). Much research has highlighted benefits that may accrue from this approach in terms of increased student engagement, better comprehension of mathematical concepts, and greater inclusion of diverse learners. Mathematics often builds on sequential concepts, requiring teachers to address gaps in prior knowledge while simultaneously introducing new material. This can be particularly demanding in classrooms with wide variations in students' proficiency levels. Additionally, designing activities and assessments that cater to individual learning needs without compromising the rigor of mathematical standards requires significant effort and expertise. The abstract nature of mathematics also means that students may require varied representations, such as visual models, hands-on activities, or real-world applications, to fully grasp concepts, adding to the

complexity of differentiation (Carreira & Baioa, 2018). These factors, compounded by large class sizes and limited preparation time, make implementing effective differentiation in mathematics both a pedagogical and logistical challenge. For instance, differentiation creates a responsive and supportive classroom environment (Tomlinson, 2017b), and it helps to narrow achievement gaps (Lai et al., 2020; Small, 2020). In a real sense, differentiated instruction is very difficult in practice. The teachers face numerous challenges trying to balance the demands of the standardized curriculum with addressing the limitations of the resources while dealing with the unique characteristics of each student (Foster et al., 2021; Olivares et al., 2021).

The existing literature has identified important potential barriers to successful implementation: shortages of teacher training, time, and resources are the most commonly cited (Genc & Erbas, 2020; Mailizar et al., 2020; Schoenfeld, 2022). Moreover, many are based on general classroom practices and do not address the specific subject-based challenges of differentiation. Mathematics presents unique challenges because of the hierarchical nature of the subject and wide disparities in students' foundational knowledge (Elizarov et al., 2022; Ellis et al., 2022; Goldin, 2020). Therefore, most challenges in the nuanced implementation of differentiated instruction in primary mathematics classrooms need to be topics of research that, first, merge the chasm between theoretical recommendations and classroom realities (Y. D. Kurino et al., 2023).

This study, therefore, tries to fill this gap by looking into the barriers and enablers of differentiated instruction in primary mathematics education. It brings together the unique combination of teachers', administrators', and curriculum coordinators' perceptions for a holistic understanding of the systemic, institutional, and classroom-level factors that influence differentiation practices. By highlighting the interaction of teacher agency with institutional support and classroom dynamics, this research extends the existing literature while offering new insights (A. Kurino, 2022). Unlike previous studies, which often focus on the barriers, this research also highlights enabling factors that facilitate successful implementation, thereby providing a more balanced perspective on differentiation.

The novelty of this study lies in its actionable focus and dual purpose. On the one hand, it validates and expands upon existing findings by confirming known barriers such as inadequate training and time pressures. On the other hand, it uncovers underexplored enablers, including leadership support, professional learning communities, and resource-sharing practices. This study contributes to the ongoing discourse in equitable and inclusive mathematics education by identifying strategies that could overcome the barriers and highlighting the systemic changes needed to sustain differentiation. Its findings are meant to inform evidence-based practices and policy decisions so that the quality of primary mathematics instruction is enhanced for diverse learners and the gaps in education equity are closed.

METHODS

Type and Design

This article used qualitative research and a case study approach to explore the barriers and enablers in implementing differentiated mathematics instruction in primary schools. A qualitative approach was, therefore, considered proper since it allowed rich and nuanced

research into the lived experiences, perceptions, and practices of participants in complex and context-dependent educational settings (Tai & Ajjawi, 2016; Walther et al., 2017). Specifically, the case study design enabled them to delve into the phenomenon in its natural setting and thereby understand comprehensively how differentiation is approached in the real-world classroom and institutional contexts. This approach toward the cases captured how factors distinctively interacted with one another in their effect on differentiation: teacher practices, leadership support, and systemic challenges.

Another reason a case study design was chosen is that it allowed an integration of multiple sources of data, including interviews, observations, and document analysis, to develop a nuanced picture of the issues being investigated (Guetterman & Fetters, 2018; Smith, 2018). This allowed researchers to delve into the dynamics between individual educators and their agency with the larger institutional structures that either support or remain in friction to practices of differentiation. Furthermore, the case study design enabled an in-depth look into the contextual factors peculiar to each of the selected schools: their resources, professional development programs, and collaborative practices. All these bring out practical realities of differentiated instruction and carry implications for policy and practice that are grounded and actionable.

Data and Data Sources

The primary data sources for this study were students, teachers, and school principals from five purposively selected primary schools. The researcher selected five primary schools purposively, with criteria including school experience in the differential use of DI to ensure diverse perspectives. The total number of participants was 15: 10 teachers, and 5 school principals. Supporting data were noted from classroom observation notes, in-depth interviews, and lesson plans to triangulate findings and enhance the credibility of the study.

Data collection technique

Multiple methods of data collection were used to capture comprehensive insights. To learn about the experiences, perceptions, and challenges of differentiated instruction, semi-structured interviews with teachers and all school principals were conducted, focusing on aspects such as their understanding of differentiation, strategies used in practice, perceived benefits, and obstacles encountered in its implementation. Moreover, classroom observations during mathematics lessons examined indicators such as the use of varied instructional strategies, teacher-student interactions, differentiation in task design, and student engagement levels to learn about the actual implementation and contextual factors at play influencing teaching practices. In addition, document analysis of lesson plans focused on the inclusion of differentiation strategies, alignment with curriculum standards, and evidence of planning for diverse learner needs to provide further evidence of how differentiation was planned and supported at an institutional level. Three months for data gathering was selected to allow adequate time for iterative exploration and validation of findings.

Data analysis

The data was analyzed using thematic analysis, as this allowed for an in-depth look at recurring patterns and themes associated with barriers and enablers of differentiated mathematics instruction. Transcription, coding, and categorization were performed using NVivo software for interview, observation, and document data. Analysis was conducted by a

process of six steps: familiarization with data, initial coding, theme generation, theme review, theme definition, and final reporting. Triangulation across data sources and member-checking with participants ensured the validity and reliability of the findings. The analysis was designed with the express intention of bringing out common challenges and creative strategies that could usefully inform improvements in practice and policy recommendations.

RESULTS AND DISCUSSION

Barriers to Implementing Differentiated Mathematics Instruction

One of the greatest barriers found in this study was that teachers were not trained enough on strategies of differentiation. Data from interviews with teachers has shown that while many were familiar with differentiated instruction, they felt a lack of practical skills and confidence in their implementation. NVivo coding found that 32% of the references coded were for "insufficient training" and 28% for "unclear strategies". For example, one teacher stated:

> "*We know differentiation is important, but the workshops we've attended focus more on theory than on actionable techniques we can use in class.*"

This finding aligns with prior studies highlighting the need for hands-on training to bridge the gap between theoretical understanding and classroom application (Sibomana & Mukagihana, 2023). The data suggest that integrating practical, scenario-based training into professional development programs is essential to equip teachers with the skills needed to manage diverse classrooms.

Another prominent barrier was the lack of time to design and prepare differentiated lesson plans. Many teachers commented on the extra workload involved in producing multiple learning materials catering to the different needs of students. This is supported by observational data where lesson plans very rarely showed evidence of differentiation. Teachers explained that balancing their regular responsibilities with differentiation planning was overwhelming, with one noting:

> "*I want to create tailored activities, but the time needed to plan them is unrealistic with our current workload.*"

These results are in line with those who noted time constraints as the pervasive challenge in differentiated instruction (Schoenfeld, 2022). Systemic adjustments might be necessary, such as providing needed planning time or even collaborative planning sessions among teaching staff.

The analysis showed that insufficient resources and a lack of institutional support were significant barriers to implementing differentiated instruction. NVivo analysis identified these challenges as "resource limitations" (21% of references) and "lack of collaboration" (18%). Teachers expressed struggles in obtaining suitable teaching materials and felt that school leadership did not provide adequate support in overcoming these obstacles. One school principal noted:

> "*We need more structured support from the school to create materials and share best practices among teachers.*"

This aligns with findings highlighting the significance of a supportive ecosystem for effective differentiation (Tomlinson, 2017b). Improving institutional support through leadership training and better resource allocation could help address these challenges.

Enablers of Implementing Differentiated Mathematics Instruction

Effective leadership played a crucial role in schools that successfully implemented differentiated instruction. NVivo coding revealed that leadership support was mentioned in 42% of references related to enablers. In these schools, administrators actively promoted innovation and consistently offered feedback to teachers. One school principal highlighted:

> "*We try to create an environment where teachers feel supported and encouraged to try new strategies, even if it takes time to refine them.*"

These findings indicate that proactive leadership is essential in cultivating a culture of differentiation, which aligns with the research that highlights leadership's importance in driving pedagogical innovation (Li et al., 2024).

The creation of professional learning communities (PLCs) played a crucial role in this process. Educators in schools with vibrant PLCs expressed increased confidence in applying differentiated strategies, thanks to collaborative planning and the availability of shared resources. An NVivo analysis revealed that terms like "peer collaboration" (35%) and "shared materials" (29%) were commonly mentioned as key enablers. One teacher remarked:

> "*Collaborating with my peers has been a game-changer. We exchange ideas and adapt materials together, which saves time and improves the quality of our lessons.*"

This finding emphasizes the significance of building collaborative networks, in line with research that supports peer-supported professional development as a way to address challenges (Hollebrands & Lee, 2020).

Discussion

This study provides a detailed and multifaceted view of the intricate relationship between barriers and facilitators in implementing differentiated mathematics instruction in primary schools. Unlike earlier research that has generally pointed out challenges like limited resources and teacher readiness, this study goes further by exploring how these barriers appear in specific institutional and classroom settings. It highlights the dynamic interplay between individual teacher agencies and the support structures within the system. The findings fill a significant gap in the literature by placing the challenges of differentiation within the specific context of mathematics education, a subject that presents unique pedagogical challenges due to its hierarchical structure and the wide range of student abilities. This study also introduces new insights into the enabling factors that have not been thoroughly examined in previous studies, such as the crucial role of leadership, collaborative networks, and shared resources.

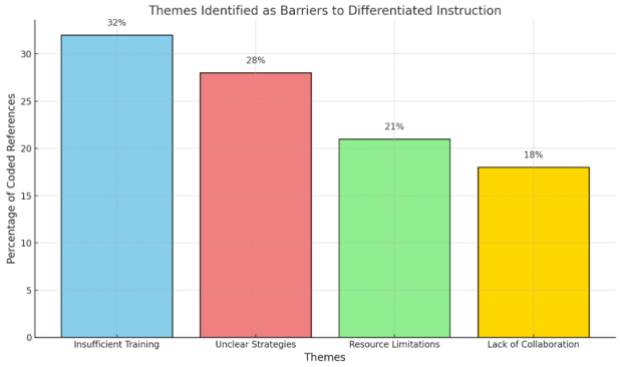

Figure 1. Barriers to Implementing Differentiated Mathematics Learning

The bar chart illustrates the main obstacles to implementing differentiated mathematics instruction. The most significant barriers are "Insufficient Training" at 32% and "Unclear Strategies" at 28%, highlighting the urgent need for practical, hands-on training for teachers. Additionally, "Resource Limitations" at 21% and "Lack of Collaboration" at 18% point to systemic issues, such as limited access to teaching materials and insufficient peer support. These results stress the necessity of incorporating practical strategies into professional development, enhancing resource distribution, and building collaborative networks to support effective differentiation in primary mathematics classrooms.

The findings of this study align with established theories on differentiated instruction, particularly Tomlinson's framework, which highlights the essential need for customized support at both individual and institutional levels to effectively meet diverse student needs (Alam & Mohanty, 2023; Root et al., 2022). However, this study adds to the current conversation by applying these theoretical principles specifically to primary mathematics instruction, a subject often seen as rigid due to its hierarchical structure and focus on sequential skill development. The data indicate that successful differentiation in mathematics necessitates not only a deep understanding of students' varying skill levels but also institutional mechanisms that actively promote innovative teaching practices. Leadership plays a crucial role, with proactive school leaders creating environments where teachers feel encouraged to experiment with and enhance differentiated strategies (Tomlinson & Imbeau, 2023; Zhang et al., 2022). Key leadership practices identified include providing regular feedback, supporting professional growth, and prioritizing resources for mathematics-specific differentiation, all of which help to alleviate the perceived rigidity of the subject. Furthermore, the importance of peer collaboration through professional learning communities (PLCs) is emphasized as a transformative element, allowing teachers to share resources, co-create lesson plans, and collaboratively adapt instructional materials. These findings highlight that effective differentiation in mathematics is more achievable when institutional and interpersonal support systems are in sync, providing practical ways to make even traditionally structured subjects more inclusive and responsive to diverse learner needs (Demo et al., 2021).

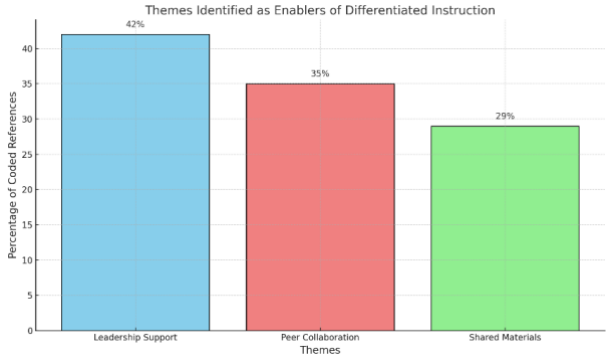

Figure 2. Enablers in Implementing Differentiated Mathematics Learning

The bar chart presents the main factors that enable differentiated instruction, as identified in the study, with "Leadership Support" standing out as the most important element, accounting for 42% of the coded references. This result underscores the essential role of proactive school leadership in creating a supportive atmosphere that encourages teachers to innovate and enhance their teaching methods.

Peer collaboration has emerged as a vital factor, accounting for 35% of the references in the NVivo analysis. Teachers frequently noted the significant benefits of working together in professional learning communities (PLCs), which offered a space for collaborative planning, resource sharing, and mutual assistance. These environments enabled educators to jointly create lesson plans, modify materials for various learning needs, and share creative strategies, ultimately enhancing their confidence in applying differentiated instruction. This observation supports that peer-supported professional networks enhance teacher effectiveness and encourage the use of inclusive teaching methods (Huang, 2023; Thurm et al., 2024). Additionally, the collaborative aspect of PLCs alleviates the individual pressures on teachers, fostering a team-oriented approach to tackling classroom challenges. The study highlights the importance of institutional backing for well-structured PLCs to fully realize their benefits, as they not only promote shared knowledge but also nurture a culture of ongoing improvement and innovation among educators (Acharya et al., 2022).

Another key factor highlighted in the study is the availability of shared teaching materials, which made up 29% of the references. Teachers often emphasized the significance of having accessible, adaptable, and high-quality resources to minimize the time and effort needed for preparing differentiated lesson plans (Charalambous et al., 2023). Shared materials not only help reduce workload pressures but also promote consistency in instructional quality across different classrooms. This finding underscores the need for developing centralized resource repositories that enable teachers to access, modify, and share instructional tools tailored to the varied needs of their students. Collaborative resource-sharing platforms can further enhance this process by incorporating technology, allowing educators to refine and customize materials more effectively (Asogwa et al., 2023). By tackling resource-related challenges, schools can foster an environment where teachers have the necessary tools to provide effective differentiated instruction, ultimately improving student learning outcomes (Sati et al., 2024).

This study highlights the urgent need for systemic changes to tackle ongoing challenges like time constraints and limited resources. Allocating specific planning time in the school schedule can greatly reduce the stress teachers experience when preparing for differentiated

instruction. Additionally, incorporating training focused on differentiation into professional development programs can help bridge the gap between theory and practice, providing teachers with practical strategies and increasing their confidence (Wiryanto et al., 2024). Policies that encourage collaboration, such as organized Professional Learning Communities (PLCs) and established resource-sharing platforms, are crucial for creating a supportive environment for differentiation. These initiatives not only address current issues but also enhance the long-term capacity of schools, allowing educators to maintain differentiation practices over time. By aligning school structures with the needs of both teachers and students, such reforms can improve the overall quality and equity of mathematics education (Fernández et al., 2024; Hunter et al., 2020; Maher et al., 2022).

The study reveals a conceptual framework that combines systemic support with individual teacher agency as essential components for effective differentiation in primary mathematics instruction. Systemic support includes leadership practices that encourage innovation and provide consistent feedback, as well as access to flexible resources and organized collaboration opportunities. At the same time, individual teacher agency is strengthened through focused professional development and active involvement in Professional Learning Communities (PLCs). This combined approach emphasizes the relationship between institutional structures and teacher initiatives, indicating that differentiated instruction flourishes in settings where these factors are aligned. The proposed framework not only supports existing theories, like Tomlinson's focus on personalized support but also expands on them by highlighting the significant roles of leadership and collaboration in mathematics education. This framework lays the groundwork for future research and practical applications, guiding schools aiming to improve differentiation practices. By tackling both theoretical and practical challenges, the study plays a role in promoting equity, engagement, and excellence in primary mathematics education.

CONCLUSION

This study emphasizes the intricate relationship between barriers and facilitators in applying differentiated mathematics instruction in primary schools. The results indicate that the primary obstacles include a lack of teacher training, limited time for lesson planning, and insufficient institutional support. These issues arise from deficiencies in professional development, systemic inefficiencies, and resource constraints, which together impede teachers' capacity to effectively address the varied needs of their students. On the other hand, the study points out that leadership support, peer collaboration through professional learning communities, and access to shared teaching resources are vital enablers. Strong leadership cultivates an atmosphere of innovation and support, while collaborative networks provide teachers with shared resources and collective knowledge. These elements not only help to mitigate some of the challenges but also lay the groundwork for sustainable practices in differentiated instruction. The findings add to the wider conversation on differentiated instruction by connecting theoretical concepts with the practical realities faced in primary education. This research highlights the necessity of a systemic approach that combines teacher autonomy with institutional backing to achieve fair and effective learning outcomes. By tackling the identified barriers through focused interventions—such as scenario-based training, dedicated planning time, and the promotion of collaborative networks—educators

and policymakers can improve the implementation of differentiated mathematics instruction. These initiatives have the potential to transform classrooms into more inclusive, engaging, and responsive learning environments, ultimately promoting educational equity and excellence. Future research might investigate the potential impact of these interventions on student results and participation in learning, how to make them equally effective in different conditions of teaching.

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