Al Ibtida: Jurnal Pendidikan Guru MI

DOI: https://doi.org/10.24235/al.ibtida.snj.v13i1.24096

Journal homepage: https://journal1.uinssc.ac.id/index.php/ibtida

Rethinking Differentiated Mathematics Instruction: Teachers' Readiness and Instructional Challenges in Elementary Schools

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a r t i c l e i n f o

Article history:
Received: March 28, 2026
Received in revised form: May 16, 2026
Accepted: June 12, 2026
Available online: June 30, 2026

Keywords:
Differentiated instruction;
Elementary mathematics;
Teacher readiness;
Instructional challenges.

Published by Department of Madrasah Ibtidaiyah Teacher Education, Universitas Islam Negeri Siber Syekh Nurjati Cirebon, Indonesia in Collaboration with the Indonesian Islamic Elementary Education Lecturers Association

a b s t r a c t

Background: Differentiated instruction has become increasingly important in addressing students' diverse learning needs, particularly in elementary mathematics classrooms characterized by varying levels of numeracy readiness and learning abilities. Previous studies have rarely examined teachers' pedagogical readiness and implementation challenges simultaneously, although both may shape whether conceptual understanding translates into adaptive classroom practice.

Aims: This study aims to analyze teachers' readiness and instructional challenges in differentiated mathematics instruction within elementary school contexts, as well as the relationship between them.

Methods: This study employed a mixed methods approach involving elementary school teachers in Bali Province, Indonesia. Quantitative data were analyzed using descriptive statistics and Pearson's correlation analysis, while qualitative data from open-ended responses were analyzed using thematic analysis.

Results: The findings indicated that teachers' readiness was generally at a moderate level. Conceptual readiness obtained the highest mean score, whereas assessment readiness showed the lowest level among the readiness dimensions. Classroom heterogeneity challenges emerged as the most dominant instructional challenge. The study also revealed a significant negative relationship between teachers' readiness and instructional challenges. Thematic findings further showed that teachers experienced difficulties in managing diverse mathematical abilities, conducting differentiated assessment, and implementing adaptive instruction within limited instructional time.

Conclusions: Differentiated mathematics instruction requires not only conceptual understanding but also stronger pedagogical readiness and institutional support to foster more adaptive mathematics learning practices in elementary schools. Examining readiness and challenges together clarifies the factors shaping its implementation in elementary schools.

How to cite this article: Diputra, K. S., Julianto, I. P., Tristiantari, N. K. D., Trisna, G. A. P. S., & Rohman, K. (2026). Rethinking Differentiated Mathematics Instruction: Teachers' Readiness and Instructional Challenges in Elementary Schools. *Al Ibtida: Jurnal Pendidikan Guru MI*, *13*(1), 1-15. https://doi.org/10.24235/al.ibtida.snj.v13i1.24096

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1. Introduction

Diversity in students' learning abilities has become one of the major challenges in elementary mathematics education. Differences in learning readiness, numeracy skills, conceptual understanding, and learning characteristics make uniform instructional approaches increasingly difficult to implement effectively. This condition has become more prominent within the implementation of Indonesia's Merdeka Curriculum, which emphasizes students' learning needs as a central component of the instructional process. Mathematics instruction is therefore no longer solely oriented toward curriculum coverage, but also toward teachers' capacity to facilitate diverse learning needs through more adaptive and flexible instructional practices (Conway-Turner et al., 2023; Johnston et al., 2016). Within this context, differentiated instruction has gained increasing attention as an approach designed to adjust learning processes according to students' readiness, needs, and learning characteristics (Graham et al., 2021; Hu, 2024; Tomlinson, 2017). The growing heterogeneity of mathematics classrooms further requires teachers to design instruction that is more responsive to students' individual learning needs (Eikeland & Ohna, 2022; Gabaldón-Estevan, 2020).

Differentiated instruction in elementary mathematics education extends beyond simply assigning different tasks to students. The approach requires teachers to adjust learning activities, instructional strategies, and assessment practices according to students' learning needs (Moon et al., 2020; Tomlinson, 2017). In mathematics classrooms, differentiation is also closely related to teachers' ability to regulate task complexity, provide appropriate scaffolding, and adapt the pace of instruction based on students' numeracy readiness (Bal, 2023; Prast & Hickendorff, 2023). As a result, differentiated mathematics instruction is strongly associated with adaptive teaching and responsive assessment practices within the learning process (Corno, 2008; Parsons et al., 2018). Implementing differentiated mathematics instruction in elementary schools therefore requires pedagogical readiness that is not only conceptual in nature but also practical and sustainable (Kalinowski et al., 2024; Pozas & Letzel, 2020). In this study, differentiated mathematics instruction refers to mathematics teaching practices that adapt learning processes, activities, assessment, and instructional support according to students' learning needs and readiness.

Despite its growing importance, the implementation of differentiated mathematics instruction in elementary schools continues to face various challenges in classroom practice. Teachers generally recognize the importance of addressing students' diverse learning needs, yet the actual implementation of differentiated instruction has not always been optimal (Graham et al., 2021; Hu, 2024). Difficulties often emerge when teachers are required to manage substantial differences in students' mathematical abilities within limited instructional time. Additional challenges are associated with conducting diagnostic assessment, designing adaptive learning activities, and adjusting evaluation practices according to students' learning readiness (Aba-Wajji et al., 2026; Moon et al., 2020). The implementation of differentiated mathematics instruction is also influenced by broader instructional challenges, including pedagogical and systemic factors such as time constraints, classroom heterogeneity, institutional support, and the availability of instructional resources that support differentiated learning practices (Estaiteyeh & DeCoito, 2024; Gibbs & Webster, 2026; Onyishi & Sefotho, 2020; Otwate et al., 2025). These conditions suggest that differentiated mathematics instruction

is closely connected not only to teachers' conceptual understanding but also to their readiness to implement flexible instruction within complex classroom environments (Parsons et al., 2018; Röhl et al., 2025). Furthermore, limited institutional support, instructional resources, and professional training continue to influence the implementation of differentiated mathematics instruction in elementary schools (Frerejean et al., 2021; Kahmann et al., 2022; Valiandes & Neophytou, 2018).

Previous studies have extensively examined differentiated instruction within elementary education contexts. Some studies have focused on teachers' perceptions of differentiated learning, while others have investigated the general implementation of differentiated instruction in classroom settings (Graham et al., 2021; Hu, 2024). However, research specifically addressing differentiated mathematics instruction in elementary schools remains relatively limited, particularly studies that simultaneously examine teachers' readiness and instructional challenges within mathematics education contexts. Several studies have explored differentiated instruction in mathematics classrooms, yet most have primarily focused on instructional effectiveness or students' learning outcomes (Bal, 2023; Keuning et al., 2019; Rijal & Waluyo, 2025). Other studies have investigated teachers' differentiation practices in elementary mathematics instruction but have not specifically examined the relationship between teachers' pedagogical readiness and the complexity of instructional challenges encountered during the implementation of differentiated learning (Prast & Hickendorff, 2023; Trisnani et al., 2025). Teachers' readiness and instructional challenges are closely interrelated factors that may influence the successful implementation of differentiated mathematics instruction in elementary classrooms (Kalinowski et al., 2024; Pozas & Letzel, 2020). Therefore, the relationship between teachers' readiness levels and the various challenges arising during the implementation of differentiated mathematics instruction still requires further explanation.

This study aims to analyze teachers' readiness and instructional challenges in differentiated mathematics instruction within elementary school contexts. It also examines the relationship between teachers' readiness and the instructional challenges encountered during the implementation of differentiated mathematics instruction. To obtain a more comprehensive understanding, quantitative analyses of the levels and relationships among the variables were combined with thematic analysis of teachers' open-ended responses regarding their implementation experiences. Beyond providing a descriptive overview of teachers' readiness and classroom challenges, this study is expected to contribute to the development of more adaptive differentiated mathematics instruction practices in elementary mathematics education. The findings may also provide implications for strengthening teacher professional development, improving differentiated assessment practices, and supporting the implementation of differentiated instruction within the context of the Merdeka Curriculum.

2. Methods

2.1 Research Design

This study employed a mixed methods approach to examine teachers' readiness and instructional challenges in differentiated mathematics instruction within elementary school contexts (Creswell & Creswell, 2017). The approach was selected because the study not only aimed to identify the levels of teachers' readiness and instructional challenges and examine the

relationships between the study variables through quantitative data, but also sought to explore teachers' pedagogical experiences and reflections more deeply through open-ended responses. The quantitative and qualitative data were analyzed separately and subsequently integrated during the interpretation stage by relating the statistical patterns to the themes identified from teachers' responses. This integration enabled a more comprehensive understanding of the implementation of differentiated mathematics instruction in elementary mathematics classrooms.

2.2 Research Procedures

The study was conducted through five sequential stages: instrument development, content validation, participant selection and data collection, quantitative and qualitative data analysis, and interpretation of the integrated findings. The research instrument was developed based on two primary variables, namely teachers' readiness for differentiated mathematics instruction and instructional challenges in differentiated mathematics instruction. Instrument development was guided by a synthesis of literature on differentiated instruction, adaptive teaching, differentiated assessment, and differentiated mathematics instruction (Corno, 2008; Graham et al., 2021; Hu, 2024; Tomlinson, 2017). In the second stage, the instrument was evaluated through expert judgment to assess the relevance and alignment of the items with the research constructs, and the items were refined based on the validation results. In the third stage, participants who met the predetermined criteria were selected through purposive sampling and invited to complete the research instrument. In the fourth stage, the quantitative responses and open-ended responses were organized and analyzed separately using the procedures described in the data analysis section. Finally, quantitative and qualitative findings were integrated during the interpretation stage by relating the statistical results to the themes emerging from teachers' responses, thereby generating a more comprehensive understanding of teachers' readiness and instructional challenges in differentiated mathematics instruction.

2.3 Participants

The participants consisted of 72 certified elementary school teachers from public elementary schools in Bali Province, Indonesia, who were teaching within the context of the Merdeka Curriculum. Participants were selected using purposive sampling based on their teaching experience in mathematics instruction and their involvement in differentiated learning practices at the elementary school level. The inclusion criteria required participants to be certified teachers, teach in public elementary schools, and have experience implementing differentiated mathematics instruction in elementary classrooms. Participation was voluntary. Prior to participation, all participants were informed about the purpose of the study and provided their consent to participate. Participants' identities were not disclosed, and the confidentiality of their responses was maintained throughout the study.

2.4 Data Collection

The research instrument was organized into eight dimensions consisting of 24 Likert-scale items based on two primary variables, namely teachers' readiness for differentiated mathematics instruction and instructional challenges in differentiated mathematics instruction. In addition to closed-ended items, the instrument included six open-ended questions to explore

teachers' experiences and challenges in implementing differentiated mathematics instruction in elementary mathematics classrooms.

Content validity was evaluated through expert judgment using Aiken's V to ensure the alignment of each item with the research constructs (Aiken, 1985). The analysis indicated that all items obtained Aiken's V values above 0.80, confirming acceptable content validity. Instrument reliability was examined using Cronbach's Alpha (Cronbach, 1951) with the assistance of SPSS version 26. The results showed reliability coefficients of 0.89 for teachers' readiness and 0.87 for instructional challenges, indicating good internal consistency.

2.5 Data Analysis

Quantitative data were analyzed using descriptive statistics and Pearson's correlation analysis to examine relationships among the research variables and dimensions. Statistical significance was determined at $p < 0.05$. Mean scores were interpreted using three categories, namely low (1.00–2.33), moderate (2.34–3.67), and high (3.68–5.00). Meanwhile, qualitative data obtained from open-ended responses were analyzed using thematic analysis through data reduction, coding, theme categorization, and interpretation processes (Braun & Clarke, 2006). The open-ended responses were read repeatedly, initial codes were assigned to meaningful units, similar codes were grouped into categories, and the categories were reviewed and refined into final themes. Quantitative and qualitative findings were subsequently integrated during the interpretation stage to generate a more comprehensive understanding of teachers' readiness and instructional challenges in differentiated mathematics instruction.

3. Results

3.1 Teachers' Readiness and Instructional Challenges in Differentiated Mathematics Instruction

Descriptive statistical analysis was conducted to identify the levels of teachers' readiness and instructional challenges in differentiated mathematics instruction within elementary mathematics classrooms. Teachers' readiness was examined across four dimensions: conceptual readiness, instructional readiness, assessment readiness, and adaptive teaching readiness. Instructional challenges were analyzed based on curriculum and time constraints, classroom heterogeneity challenges, institutional support challenges, and resource challenges.

Table 1. Descriptive Statistics of Teachers' Readiness and Instructional Challenges in Differentiated Mathematics Instruction

Variable	Dimension	N	M	SD	Category
Teachers' Readiness	Conceptual Readiness	72	3.79	0.47	High
	Instructional Readiness	72	3.47	0.60	Moderate
	Assessment Readiness	72	3.39	0.60	Moderate
	Adaptive Teaching Readiness	72	3.53	0.64	Moderate
	Overall	72	3.58	0.45	Moderate
Instructional Challenges	Curriculum and Time Constraints	72	3.82	0.46	High
	Classroom Heterogeneity Challenges	72	3.98	0.59	High

Institutional Support Challenges	72	3.36	0.72	Moderate
Resource Challenges	72	3.23	0.60	Moderate
Overall	72	3.62	0.43	Moderate

Note. N = number of participants; M = mean; SD = standard deviation.

Table 1 presents the descriptive statistics of teachers' readiness and instructional challenges in differentiated mathematics instruction. Overall, teachers' readiness was categorized as moderate, with a mean score of 3.58. Among the readiness dimensions, conceptual readiness obtained the highest mean score (M = 3.79) and was categorized as high, whereas assessment readiness showed the lowest mean score (M = 3.39) and remained within the moderate category. Instructional readiness and adaptive teaching readiness were also categorized as moderate. These findings indicate that teachers demonstrated stronger conceptual understanding of differentiated mathematics instruction than practical readiness related to assessment and adaptive instructional implementation.

Regarding instructional challenges, the overall mean score was 3.62, indicating a moderate level of challenge. Classroom heterogeneity challenges emerged as the most dominant challenge (M = 3.98), followed by curriculum and time constraints (M = 3.82), both categorized as high. Meanwhile, institutional support challenges and resource challenges remained within the moderate category. These findings suggest that variations in students' mathematical abilities, limited instructional time, and implementation support continue to present challenges in differentiated mathematics instruction within elementary mathematics classrooms.

3.2 Correlation Between Teachers' Readiness and Instructional Challenges

Correlation analysis was conducted to examine the relationship between teachers' readiness and instructional challenges in differentiated mathematics instruction within elementary mathematics classrooms. Additional analyses were also performed across several dimensions to identify more specific relationship patterns among the research variables.

Table 2. Correlation Between Teachers' Readiness and Instructional Challenges in Differentiated Mathematics Instruction

Correlation Pair	*r*	*p*	Interpretation
Teachers' Readiness and Instructional Challenges	-0.48	.000	Significant
Instructional Readiness and Classroom Heterogeneity Challenges	-0.45	.000	Significant
Assessment Readiness and Curriculum and Time Constraints	-0.46	.000	Significant
Adaptive Teaching Readiness and Classroom Heterogeneity Challenges	-0.46	.000	Significant
Conceptual Readiness and Institutional Support Challenges	-0.11	.362	Not Significant

Note. Correlations were considered statistically significant when $p < 0.05$.

Table 2 presents the correlation analysis between teachers' readiness and instructional challenges in differentiated mathematics instruction. The findings revealed a significant moderate negative relationship between teachers' readiness and instructional challenges (r = -0.48, $p < 0.05$). This result indicates that higher levels of teachers' readiness tended to be associated with lower levels of instructional challenges in implementing differentiated mathematics instruction. The magnitude of this relationship suggests that differences in teachers' readiness were meaningfully associated with variations in the instructional challenges they reported**.**

Significant negative relationships were also identified across several dimensions of the study variables. Adaptive teaching readiness showed a significant negative correlation with classroom heterogeneity challenges (r = -0.46, $p < 0.05$), suggesting that teachers with stronger adaptive teaching readiness experienced fewer difficulties in managing diverse mathematics classrooms. Assessment readiness was also negatively correlated with curriculum and time constraints (r = -0.46, $p < 0.05$). In addition, instructional readiness demonstrated a significant negative relationship with classroom heterogeneity challenges (r = -0.45, $p < 0.05$). These correlations indicate moderate relationships, demonstrating that the observed associations were not only statistically significant but also substantively meaningful in the context of classroom implementation. However, conceptual readiness showed only a weak and non-significant relationship with institutional support challenges (r = -0.11, $p > 0.05$).

3.3 Thematic Findings from Teachers' Open-Ended Responses

Qualitative analysis was conducted on teachers' open-ended responses to obtain deeper insights into their experiences and challenges in implementing differentiated mathematics instruction in elementary mathematics classrooms. The thematic analysis was conducted to identify major themes related to the implementation of differentiated mathematics instruction in elementary schools.

Table 3. Thematic Findings from Teachers' Open-Ended Responses

Theme	Description	Representative Response
Difficulties in Managing Diverse Mathematics Classrooms	Teachers experienced difficulties in managing students with different mathematical abilities and learning readiness within the same classroom.	"Students' mathematical abilities in the classroom vary considerably, making it difficult to design instruction that is appropriate for all learners."
Limited Time for Designing Differentiated Mathematics Instruction	Teachers reported limited time for preparing differentiated mathematics instruction due to curriculum demands and administrative workload.	"Instructional time is limited, while teachers are also required to prepare administrative tasks and different learning materials."
Challenges in Conducting Differentiated Assessment	Teachers experienced difficulties in conducting diagnostic assessment and adjusting evaluation practices according to students' learning needs.	"Conducting initial assessment and designing different evaluations for each student remains difficult to implement consistently."

The Need for Practical and Institutional Support	Teachers expressed the need for practical guidance, collaborative discussion, and stronger institutional support in implementing differentiated mathematics instruction.	"Teachers still need more practical and applicable examples of differentiated instruction in classroom practice."

Table 3 presents the thematic findings derived from teachers' open-ended responses regarding the implementation of differentiated mathematics instruction in elementary schools. The findings indicate that elementary school teachers continue to experience various challenges in implementing differentiated mathematics instruction. The most dominant theme was related to difficulties in managing students with diverse mathematical abilities and learning readiness within the same classroom. Teachers reported that substantial variations in students' numeracy skills often made it difficult to determine instructional strategies that could effectively accommodate all learners.

Limited instructional time and administrative workload also emerged as important challenges affecting teachers' readiness to design differentiated mathematics instruction more effectively. In addition, differentiated assessment remained a significant concern in elementary mathematics classrooms, particularly in conducting diagnostic assessment and adjusting evaluation practices according to students' learning needs. Teachers further emphasized the need for more practical and contextual support through professional training, implementation examples, and collaborative discussion within school environments.

4. Discussion

4.1 Teachers' Readiness and Instructional Challenges in Classroom Practice

The findings indicate that elementary school teachers demonstrated relatively strong conceptual readiness in understanding differentiated mathematics instruction. However, assessment readiness obtained the lowest score, while instructional readiness and adaptive teaching readiness also remained at moderate levels. This condition suggests that understanding the concept of differentiated instruction does not necessarily translate directly into the ability to design assessments, adapt instruction, and respond to variations in students' learning readiness. This interpretation is consistent with differentiated instruction frameworks that position assessment and instructional adjustment as essential components in responding to students' needs (Moon et al., 2020; Tomlinson, 2017). The findings can also be understood through the concept of adaptive teaching, which emphasizes the need to adjust instruction according to students' differences and responses during the learning process (Corno, 2008; Parsons et al., 2018). In addition, the literature on differentiated instruction highlights the importance of teacher self-efficacy, enthusiasm, and preparedness in addressing student heterogeneity (Kalinowski et al., 2024; Pozas & Letzel, 2020). Therefore, teacher readiness should be understood as a multidimensional capacity that includes conceptual understanding, instructional readiness, assessment readiness, and the ability to adapt instruction.

Classroom heterogeneity emerged as the most dominant challenge, followed by curriculum and time constraints, which were also categorized as high. Differences in

mathematical ability, learning readiness, and numeracy skills increase the complexity of the decisions teachers must make to accommodate students' needs within a single classroom. Research on classroom diversity indicates that student composition is associated with classroom processes and academic outcomes (Conway-Turner et al., 2023; Gabaldón-Estevan, 2020), while differentiation research emphasizes the need for instructional approaches that respond flexibly to variations in students' learning needs (Eikeland & Ohna, 2022). In mathematics instruction, these conditions require teachers to adjust task difficulty, forms of support, instructional pacing, and presentation strategies. These challenges become more complex when teachers must make such adjustments within limited instructional time, curriculum demands, and other workload pressures. This finding is consistent with studies showing that school contexts and various implementation barriers influence differentiated instruction practices (Gibbs & Webster, 2026; Onyishi & Sefotho, 2020). Practically, the results suggest that managing heterogeneous classrooms should become a central focus in strengthening teachers' professional competence.

The lowest score for assessment readiness indicates that differentiated assessment remains difficult to implement. Teachers need not only to conduct initial assessments but also to use the information obtained to identify students' needs, adjust learning activities, and monitor learning progress. The importance of assessment is supported by Gezer et al. (2021), who demonstrated a relationship between formative and summative assessment in primary-grade mathematics classrooms. Literature on mathematics assessment also positions formative information as a basis for more responsive instructional decision-making (Polly et al., 2018; Taylor-Cox & Oberdorf, 2014). Therefore, teacher professional development should not focus solely on introducing the concept of differentiated instruction. Training should provide practical experience in designing diagnostic assessments, interpreting assessment results, and developing realistic follow-up instruction for classrooms characterized by diverse student abilities.

4.2 Relationships Between Teachers' Readiness and Instructional Challenges

The correlation results showed a moderate negative relationship between teachers' readiness and instructional challenges in differentiated mathematics instruction. This means that higher levels of readiness tended to be associated with lower levels of implementation challenges, although the relationship does not indicate causality. The magnitude of the correlation suggests that this association is sufficiently meaningful to be considered in classroom practice. This finding can be understood in the context of differentiated instruction research showing that its implementation involves several interrelated factors, including the analysis of student differences, instructional methods, assessment, and implementation conditions (Graham et al., 2021; Hu, 2024). Kalinowski et al. (2024) also showed that self-efficacy, enthusiasm, and assessment activities during instructional planning were associated with teachers' reported differentiated instruction practices. Meanwhile, Pozas and Letzel (2020) specifically positioned teacher preparedness as an important aspect of addressing student heterogeneity. Thus, the present findings indicate that teachers' readiness and instructional challenges should be understood as related aspects, although teacher readiness cannot be regarded as the sole factor determining the level of implementation difficulty.

The negative relationships between adaptive teaching readiness and classroom heterogeneity challenges, as well as between instructional readiness and classroom

heterogeneity challenges, indicate that teachers with stronger adaptive and instructional readiness tended to report lower levels of difficulty in managing classroom diversity. These findings are conceptually grounded in adaptive teaching, which emphasizes adjusting instruction in response to differences in students' needs and characteristics (Corno, 2008). Complementary evidence was reported by Röhl et al. (2025), who found that improvements in adaptive teaching were associated with more positive and more homogeneous student perceptions of several dimensions of teaching quality. Although their constructs differ from the classroom heterogeneity challenges examined in this study, both sets of findings demonstrate the relevance of adaptive capacity in responding to variation within classrooms. In the context of Indonesian elementary mathematics education, Trisnani et al. (2025) showed that differentiation practices involved student grouping, instructional methods, measurement and assessment, and adjustments to learning processes based on students' needs. Prast et al. (2023) also identified within-class achievement grouping as one form of differentiation used to respond to differences in learning needs. Therefore, the relationships identified in the present study do not imply that adaptive readiness directly eliminates heterogeneity-related challenges, but they do demonstrate a substantive association between teacher readiness and the management of classroom diversity.

The negative relationship between assessment readiness and curriculum and time constraints indicates that stronger assessment readiness tended to be associated with lower levels of curriculum and time-related challenges. Implementing differentiated assessment requires teachers to obtain information about student learning, interpret the results, and use them in instructional decision-making. Martin et al. (2016) examined elementary teachers' use of an internet-based formative assessment tool, whereas Yin et al. (2015) reported that professional development in formative assessment strengthened teachers' knowledge and self-efficacy in using assessment. Although these studies did not directly investigate curriculum and time constraints, their findings indicate that assessment readiness can be strengthened through structured professional development. In contrast, conceptual readiness showed a weak and non-significant relationship with institutional support challenges. This finding may be explained by the different levels of analysis involved: conceptual readiness represents an individual capacity, whereas institutional support depends on organizational conditions and collaboration within the school environment. Bi et al. (2026) showed that collaboration played a role in the relationship between teachers' individual beliefs and differentiated instruction practices, while Gibbs and Webster (2026) positioned the experiences of teachers and school leaders as important for understanding differentiated instruction implementation in primary school contexts. Therefore, improving teachers' conceptual understanding alone may not be directly associated with reducing institutional challenges.

4.3 Teachers' Experiences and Implications for Differentiated Mathematics Instruction

The thematic findings provide a more concrete explanation of the patterns identified through the quantitative analysis. Teachers' difficulties in managing students with diverse mathematical abilities and learning readiness reinforce the finding that classroom heterogeneity was the most dominant challenge. Reports of limited instructional time and administrative workload were also consistent with the high level of curriculum and time constraints, whereas

difficulties in conducting diagnostic assessment and adjusting evaluation practices corresponded with the lower level of assessment readiness. In addition, the need for practical guidance, collaborative discussion, and school support indicates that the implementation of differentiated mathematics instruction does not depend solely on teachers' individual capacities. Hayden et al. (2024), through their examination of teachers' perceptions following the implementation of a mathematics curriculum, also highlighted the importance of teachers' experiences in understanding the implementation of differentiation in the classroom. Although focusing on adaptive learning technologies, Simon and Zeng (2024) similarly identified teacher self-efficacy, enabling conditions, and implementation barriers as important considerations when adaptive approaches are applied in educational settings.

The integration of these findings indicates that teacher professional development should be directed toward practices that are contextual, continuous, and closely connected to classroom situations. Teachers require concrete examples of diagnostic assessment, student grouping, task adjustment, and follow-up mathematics instruction. Frerejean et al. (2021) demonstrated that differentiation skills in mathematics instruction can be developed through systematically designed professional development programs based on complex learning tasks. The meta-analysis conducted by Kahmann et al. (2022) also showed that professional development programs in differentiated instruction affected teachers' knowledge, attitudes, and practices. Valiandes and Neophytou (2018) showed that programs emphasizing practice, active participation, and authentic learning conditions can support teachers' professional learning. In a broader context, Estaiteyeh and DeCoito (2024) emphasized the importance of sustained training in maintaining knowledge and practices that are responsive to diversity. This finding is also relevant to Valiandes (2015), who demonstrated the potential of differentiated instruction to support both quality and equity in classrooms characterized by diverse student abilities.

Theoretically, this study indicates that teachers' readiness and instructional challenges are interrelated but represent different dimensions. Conceptual, instructional, assessment, and adaptive readiness describe teachers' capacities, whereas time constraints, classroom heterogeneity, resources, and institutional support represent implementation conditions. Practically, schools need to provide planning time, examples of differentiated mathematics instruction, teacher collaboration forums, and leadership support so that conceptual understanding can be implemented more consistently. Nevertheless, the findings should be generalized cautiously because they were derived from a particular elementary education context and relied on teachers' perceptions. The identified patterns may serve as a reference for elementary education contexts facing similar student diversity and demands for implementing differentiated instruction.

5. Limitations

This study is subject to several limitations that should be considered in interpreting the findings. The study was conducted among elementary school teachers in Bali Province, Indonesia, and therefore the findings may not be fully generalizable to different educational contexts. In addition, the data were obtained through questionnaires and open-ended responses that relied on participants' subjective perceptions and experiences. The study also employed descriptive and correlational analyses, which do not permit causal conclusions regarding the

implementation of differentiated mathematics instruction. Future research is therefore recommended to involve more diverse samples and develop more comprehensive analytical approaches related to differentiated mathematics instruction.

6. Conclusion

The findings of this study indicate that differentiated mathematics instruction in elementary schools continues to face considerable implementation challenges. Although teachers generally demonstrated relatively good conceptual understanding of differentiated instruction, readiness related to assessment practices and adaptive instructional implementation remained less developed. Classroom heterogeneity emerged as the most dominant challenge, particularly regarding variations in students' mathematical abilities and learning readiness. The findings also revealed a significant negative relationship between teachers' readiness and instructional challenges, suggesting that stronger pedagogical readiness tended to be associated with lower levels of instructional challenges in differentiated mathematics instruction. This study further highlights that the implementation of differentiated mathematics instruction requires stronger pedagogical and institutional support within elementary schools. Strengthening adaptive teaching practices, differentiated assessment, and contextually relevant professional development programs may support teachers in implementing more responsive mathematics instruction. The findings also emphasize the importance of collaborative school support systems in fostering sustainable differentiated learning practices within elementary mathematics classrooms.

Author Contributions

Komang Sujendra Diputra: Conceptualization, methodology, formal analysis, writing—original draft preparation. I Putu Julianto: Conceptualization, validation, supervision. Ni Ketut Desia Tristiantari: Conceptualization, formal analysis, investigation, writing—original draft preparation. Gusti Ayu Putu Sukma Trisna: Validation, data analysis, project administration. Khabibur Rohman: Methodology, investigation, data curation, visualization.

Acknowledgments

The authors gratefully acknowledge Universitas Pendidikan Ganesha for providing research funding and institutional support for this study. The support provided by the university contributed significantly to the implementation of the research and the completion of this manuscript. The authors also express their appreciation to all elementary school teachers who participated in this study and shared their experiences related to differentiated mathematics instruction in elementary classrooms.

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