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Comparative study of mathematics teachers' challenges in implementing differentiated instruction and deep learning in the merdeka curriculum

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Abstract

Background: Background: The Merdeka Curriculum emphasizes student-centered learning by encouraging mathematics teachers to implement differentiated instruction and deep learning. Although both approaches aim to enhance meaningful learning experiences, their differing characteristics pose varied challenges in classroom practice.
Aims: This study aims to analyze and compare the challenges faced by mathematics teachers in implementing differentiated instruction and deep learning within the context of the Merdeka Curriculum.
Methods: This study used a qualitative approach with an exploratory comparative design within a single school context. Participants included five (N=5) mathematics teachers selected via purposive sampling. Data were gathered through observation, semi-structured interviews, and documentation, then analyzed using the Miles and Huberman interactive model. The analysis focuses on uncovering analytical patterns of teacher experience rather than broad statistical generalizations.
Result: The findings indicate that differentiated instruction presents challenges related to limited instructional time for preparing varied learning materials, insufficient supporting resources, and complex classroom management due to diverse student activities. Meanwhile, challenges in implementing deep learning include limited teacher competency and preparedness, inadequate facilities and learning resources, insufficient technological skills, and the complexity of lesson planning. The fundamental difference lies in the type of load: DI emphasizes efficiency in time and resource management, whereas DL requires technological readiness and a deeper level of understanding.
Conclusion: This study concludes that teacher readiness is shaped by the tension between workload and pedagogical depth. Success requires structural shifts such as block scheduling and collaborative design hubs to allow teachers to transition from being classroom logisticians to architects of deep reasoning.

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INTRODUCTION

The rapid rollout of the Merdeka Curriculum has created significant policy pressure, often leading to an overwhelming teacher workload and a mismatch between idealistic goals and actual school capacity. This disconnect is particularly evident in mathematics education, where the mandate for innovation often clashes with limited resources (Geiger et al, 2023; Iyamuremye & Burns, 2025).

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While this curriculum is designed to provide teachers with flexibility to design student-centered learning through adaptive, contextual, and meaningful approaches (Bhardwaj et al. 2025; Martin-Alguacil et al. 2024), the practical execution remains a challenge. The Merdeka Curriculum aims to improve the quality of education by allowing schools to choose learning methods that best align with students' characteristics. According to Hakim et al. (2024), Merdeka Curriculum is built upon three core pillars: project-based learning, character strengthening, and differentiated instruction. These elements are intended to create learning experiences that are engaging, relevant, and meaningful. Among the approaches that have gained considerable attention in this implementation are differentiated instruction and deep learning. In this context, deep learning refers to pedagogical deep approaches to learning aimed at conceptual mastery and meaningful engagement, rather than computational machine learning or artificial intelligence. These two approaches are expected to work in tandem to address diverse student needs while fostering higher-order thinking skills.

Differentiated instruction is an approach that focuses on adjusting learning content, processes, and products based on students' readiness, interests, and learning profiles (Fajariyah et al., 2023; Ramaila, 2025). Differentiation is not merely an instructional strategy but a comprehensive framework that encompasses the learning environment, assessment, curriculum, and classroom management (Hatmanto & Rahmawati, 2023; Demirci-Ünal & Öztürk, 2025). Challenges arise when teachers lack sufficient understanding and skills to implement differentiation effectively across multiple groups of students simultaneously. In mathematics education, this approach provides teachers with the flexibility to tailor materials and activities so that each student can progress according to their potential. Research indicates that differentiated instruction can enhance motivation, independence, and mathematics learning outcomes (Rijal & Waluyo, 2025; Vakolia et al., 2025).

In addition, the Merdeka Curriculum emphasizes deep learning, an approach that fosters a conscious, meaningful, and joyful learning process. Deep learning highlights conceptual depth, integration across concepts, and the development of higher-order thinking skills as well as contextual problem-solving (Mystakidis, 2021). Within the educational context, deep learning involves activities such as critical thinking, reflection, and applying concepts to real-world situations (Han et al., 2022), thereby requiring teachers to employ effective pedagogical practices (Brenya, 2024). Insufficient pedagogical competence can hinder students' ability to achieve deeper understanding (Wang & Manda, 2025; Nguyen & Lai, 2025). Numerous studies report that deep learning contributes positively to critical thinking, problem-solving abilities, and mathematics learning outcomes (Laird et al., 2014; Duan, 2022; Tian et al., 2022; Du & Hu, 2024). However, although both approaches are considered promising, numerous studies indicate that teachers often lack the time (Abdykerimova & Assainova, 2024; Haji et al., 2025) and resources necessary to implement them effectively (Mouton & Malumbete, 2023; Umayroh & Wahyudin, 2024; Cahyuni & Purbani, 2025; Irsyad et al., (2025). This finding aligns with Onyishi and Sefotho (2020), Gibbs (2023), and Osae and Papadopoulos (2024) who reported that limited instructional time and insufficient hands-on experience in designing differentiated learning are major challenges for teachers. Meanwhile, even when teachers understand and intend to implement deep learning, they often face several challenges, including diverse levels of student readiness, limited instructional time, rigid curricular content, and insufficient supporting infrastructure (Sølvik & Glenna, 2022; Arlinwibowo et al., 2023; Tang, 2024). With the introduction of the Merdeka Curriculum in Indonesia, the challenges teachers face in meeting individual student needs have become increasingly complex. Preliminary observations and initial interviews at SMAN 8 Pontianak suggested that mathematics teachers encountered significant pedagogical frictions when attempting to integrate these two approaches.

Although both aim to improve student learning outcomes, Differentiated Instruction (DI) and Deep Learning (DL) face different implementation challenges. DI is often constrained by the complexity of instructional design and time management in diverse classrooms (Glock & Kleen, 2019; Gibbs, 2023; Trisnani et al., 2025), whereas DL is more limited by students' low initial readiness and teachers' insufficient pedagogical content knowledge (Sodikin, 2025; Abdulah et al., 2025; Pahrudin et al., 2025). However, direct comparative qualitative evidence examining both approaches within Indonesian mathematics classrooms remains scarce, as most existing studies address DI and DL separately (Agustina et al., 2025). Therefore, this research was conducted to analyze and compare the challenges faced by mathematics teachers in implementing differentiated learning and deep learning within the Merdeka Curriculum. The results of this study are expected to provide a comprehensive overview of the implementation gaps between the two approaches, as well as serve as a basis for improving teacher competencies and developing more effective learning strategies.

METHOD

Research Design

This study employs a qualitative approach using a comparative qualitative research design. The comparison is structured around five mathematics teachers within one school context who implement two instructional approaches Differentiated Instruction (DI) and Deep Learning (DL) under the Merdeka Curriculum. The participating teachers vary in teaching experience and age, allowing the study to capture differences in pedagogical responses shaped by professional background. Thus, the unit of comparison is not different schools or different teacher groups, but the challenges experienced by the same teachers across two pedagogical approaches, while also considering variations in their professional experience.

Analytically, the study proceeds in two stages. First, within-case coding was conducted to identify and categorize challenges associated with DI and DL for each teacher individually, including how differences in experience and age influenced instructional decision-making. Second, cross-case comparison was carried out to examine recurring patterns, contrasts, and divergences across teachers and across the two approaches. Comparative themes were derived by systematically contrasting codes related to workload demands, instructional design, epistemic shifts, and technological requirements. Through this analytic strategy, the study moves beyond description to explain how and why the nature of constraints differs between DI and DL within the same institutional setting, and how teacher experience mediates these challenges.

Participant and Methods of Sampling

The participants consisted of five (N=5) mathematics teachers at SMAN 8 Pontianak, selected through purposive sampling to represent cross-generational perspectives: senior (≥50 years; n=2), mid-career (≥40 years; n=2), and early-career teachers (≥30 years; n=1). Selection criteria required at least three years of experience and active involvement in implementing both DI and DL under the Merdeka Curriculum. The sample size was determined by theoretical saturation (Moser & Korstjens, 2018). Following an iterative analysis process that commenced after the second interview, data collection was concluded when the final two sessions yielded no new unique codes or thematic insights. This confirmed that the categories particularly regarding the influence of professional background on pedagogical adaptation had reached conceptual density.

Instrument

The primary research instruments consisted of semi-structured interview protocols, classroom observation guidelines, and document analysis checklists. The interview protocol was structured around six key domains: (1) differentiated content strategies, (2) resource and infrastructure needs, (3) deep learning instructional design, (4) classroom management dynamics, (5) technological integration, and (6) cognitive assessment of thinking processes. Observation guidelines focused on capturing the "enacted curriculum," specifically monitoring time allocation, student engagement patterns, and the real-time execution of exploratory tasks. Furthermore, document analysis was performed on lesson plans (RPP/Modul Ajar) and assessment rubrics, selected based on their relevance to the observed lessons, to evaluate the consistency between planned instructional sequences and actual classroom implementation.

Data trustworthiness was ensured through source and technique triangulation, combining interview data, classroom observations, and document analysis. Member checking was conducted by returning interview transcripts and preliminary interpretations to participants to verify accuracy. Additionally, a dependability audit was carried out by maintaining an audit trail of coding procedures, analytic memos, and comparison matrices to ensure consistency and transparency throughout the research process.

Procedures and Time Frame

The study was conducted at SMAN 8 Pontianak over a four-week period from October 15 to November 10, 2025, during the first semester of the 2025/2026 academic year. Data were gathered through moderate participant observation, in which the researcher maintained a balanced role by observing classroom dynamics without intervening in the primary instructional flow, while engaging in informal pedagogical dialogues with teachers during non-instructional hours. Each participant was observed for two full sessions (2×90 minutes), with the observation focus specifically targeting instructional grouping management, exploratory sequences in deep learning, time allocation for differentiated tasks, and formative assessment practices. These activities were documented through structured fieldnotes consisting of both descriptive accounts of classroom events and reflective insights. This procedure was complemented by in-depth semi-structured interviews lasting 45–60 minutes to explore teachers' internal perspectives regarding the implementation of Differentiated Instruction (DI) and Deep Learning (DL) strategies within the Merdeka Curriculum framework. Furthermore, document analysis was performed on lesson plans (RPP/Modul Ajar), student worksheets, and teacher reflective notes to verify the alignment between planned strategies and the observed classroom reality. Ethical integrity was ensured through written informed consent, the total anonymization of participant identities, and official institutional permission from the school.

Analysis plan

Data analysis followed the interactive model of Miles and Huberman (1994), integrated with systematic thematic analysis. The process began with data condensation, where interview transcripts and fieldnotes were categorized using a structured codebook based on the six research domains and refined inductively as new themes emerged. To ensure a rigorous synthesis, data were organized into comparison matrices and spatial displays to cross-reference teacher reports with observed practices and documentary evidence. This matrix-based approach facilitated the visualization of alignments or discrepancies between planned strategies and their actual implementation. Finally, conclusion drawing and verification were performed by testing identified themes such as teacher readiness and assessment challenges against the entire dataset to ensure consistency, transparency, and credibility through technique triangulation.

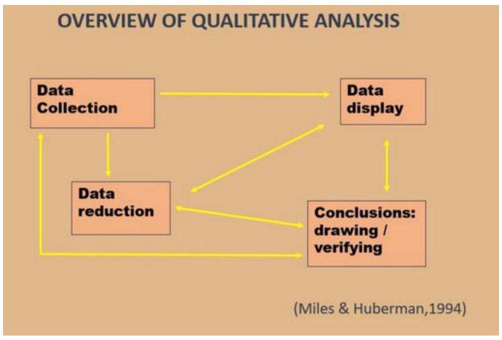

Figure 1. Components Of Data Analysis: Interactive Model (Miles & Huberman, 1994)

RESULTS AND DISCUSSION

Results

Implementation of the Differentiated Approach in Mathematics Learning

Implementation at SMAN 8 Pontianak follows a sequential three-stage cycle comprising diagnostic planning, modular development, and reflective evaluation aimed at bridging the gap between curriculum standards and diverse student readiness. Based on interviews and document analysis of teaching modules and lesson plans (RPP), the implementation begins with a formally documented planning phase. G1 and G3 explained that they gather data on learners' readiness and interests, which is evidenced by teaching modules that include student learning profiles as the basis for group differentiation. Analysis of the lesson plans further shows that teachers establish Learning Objectives Achievement Criteria (KKTP) using descriptive rubrics tailored to different competency levels. In the implementation stage, G5 emphasized the use of diagnostic pre-tests to refine these groups, a process that is explicitly outlined in the instructional scenarios within the modules. The cycle concludes with a reflection stage, which is recorded in teacher reflection logs to measure progress. As G5 noted: "We treat this as a cycle; the results of today's post-test become the diagnostic data for our next planning stage."

The consistency between interview data and documentary evidence confirms that differentiation at SMAN 8 Pontianak is a deliberate and systematic framework. By documenting the mapping of needs and establishing rubric-based criteria (Aegustinawati & Sunarya, 2023), teachers create a structured environment that attempts to adjust content and process. This documented cycle of initial assessment and targeted intervention indicates that the implementation is not incidental but systematically embedded in the school's formal pedagogical standards.

Implementation of the Deep Learning Approach in Mathematics Learning

The implementation of Deep Learning (DL) at SMAN 8 Pontianak is officially documented through the "Meaningful, Mindful, and Joyful" pillars; however, field data shows a discrepancy between the intended deep conceptual engagement and the structural pressures of time and classroom norms. Based on interviews and document analysis of teaching modules, the DL approach is integrated into three essential stages: understanding, applying, and reflecting. Analysis of RPP reveals that "Meaningful" learning is planned through contextual topics like Statistics and Matrices. However, observations indicate that outdoor learning intended to strengthen this pillar is episodic, occurring only 1–2 times per semester due to the 15-minute logistical transition required for 36 students. Regarding the Mindful principle, teachers pose open-ended questions to foster metacognition. Yet, observations show a "discourse gap" where participation is dominated by high-achievers. G2 explained that this is not due to a lack of student ability, but rather a structural pressure: "Guiding students through reasoning requires considerably more time; often, the fast pace of the syllabus forces us to move on before everyone can reflect." To achieve the Joyful principle, analysis of modules shows the planned use of GeoGebra, Quizizz, and Kahoot. While these tools successfully increase engagement, G4 noted that the transition from "digital fun" to "deep reflection" remains the hardest phase to document and execute consistently.

The consistency between teaching logs and interview data confirms that while the framework for deep learning is formally established, its execution faces "pedagogical friction." Linking math to daily experiences aligns with DL principles (Polman et al., 2021), but logistical barriers limit its frequency (Kusmaryono & Wijayanti, 2023). Furthermore, the participation gap suggests that "Mindfulness" is often stifled by classroom discourse norms that prioritize speed over depth. Consequently, the "Joyful" and "Mindful" pillars, though present in documentation, are frequently compromised by traditional instructional pressures and the time-sensitive nature of the Merdeka Curriculum.

Differences in the Challenges Faced by Mathematics Teachers in Implementing the Differentiated Approach and Deep Learning Approach

Based on the previous explanation, the implementation of differentiated instruction and the deep learning approach both show positive impacts on students' learning processes and outcomes. Nevertheless, the implementation of these two approaches is inseparable from various challenges that teachers must face in instructional practice, particularly in mathematics. Each approach presents its own distinctive set of challenges, whether in terms of planning, implementation, or classroom management.

Interviews with five mathematics teachers at SMAN 8 Pontianak (G1–G5) revealed distinct patterns of challenges in implementing differentiated instruction and the deep learning approach. In general, the challenges in differentiated instruction are more closely related to the diverse needs of students and the complexity of classroom management. Meanwhile, the deep learning approach requires a higher level of cognitive depth and student readiness to actively engage in mathematical problem-solving. The following is a summary of the challenges identified by teachers in implementing both approaches in mathematics instruction.

1. Challenges Faced by Mathematics Teachers in Differentiated Instruction
   a. Limited Time to Prepare Varied Learning Materials

   Mathematics teachers stated that differentiated instruction requires significantly more preparation time, both for identifying students' prior abilities and for designing varied materials that align with their needs. At the beginning of instruction, time is often insufficient to conduct an in-depth assessment of students' abilities, especially because the number of students in a class is quite large (more than 30 students), making it increasingly difficult to distinguish their levels of understanding. As a result, teachers must prepare multiple versions of instructional materials at once ranging from remedial, regular, to enrichment which demands extensive preparation time. This is supported by interview results with mathematics teachers at SMAN 8 Pontianak, where G2 stated:

   "If we want to create different materials, the preparation time becomes very long. Differentiating tasks for fast learners and those who are still struggling is quite time-consuming."

   In line with that, G1 added:

   "For topics such as matrices or equations, students' basic abilities vary greatly. Some still need to review basic operations, while others are already ready to move on to advanced concepts. These differences in ability require me to carefully examine each student's prior knowledge."

   G5 also emphasized:

   "Mathematics material is sequential. If a student does not understand the initial concept, I have to prepare additional materials again. As a result, the preparation becomes very extensive."

   b. Limited Resources to Support Learning Variations

   Teachers acknowledged that they did not always have access to media, supplementary modules, or examples of concept representations that could support differentiation of content or process. As a result, the differentiation implemented was limited to simple adjustments, such as changing the number of questions, rather than offering a rich variety of activities. This is reinforced by the interview results with the mathematics teacher at SMAN 8 Pontianak, where G1 stated:

   "For geometry material, I actually really need GeoGebra, three-dimensional teaching aids, or interactive diagrams so that the activities can be differentiated between students who grasp the material quickly and those who still need remediation. However, the availability of computers and teaching aids is very limited, so I cannot provide different activities based on each student's needs."

In line with this, G3 also stated:

"When facilities or learning materials are limited, it becomes difficult to create different activities that truly match each student's needs."

c. The Complexity of Managing a Classroom with Diverse Activities

In practice, teachers often feel overwhelmed when monitoring several groups working on different activities simultaneously. In mathematics learning, students frequently require procedural guidance, which means the teacher has to constantly move around to supervise these groups. This is supported by interview results with a mathematics teacher at SMAN 8 Pontianak, where G4 stated:

"If I create different activities for example, one group works on enrichment problems involving more complex elementary row operations, while another group is still learning to determine the order and perform basic matrix addition—I have to make sure both groups are following the correct procedures. The class becomes much noisier, and I have to move back and forth checking each group. The students also often get noisy or wander to other groups, which makes classroom management even more challenging."

In line with this, G2 also expressed:

"Students who are still struggling need continuous support, while those who are quick learners must be given additional challenges. Managing both at the same time is what requires effort."

2. Challenges for Mathematics Teachers in Deep Learning

a. Limited Teacher Competence and Readiness

Teachers acknowledged that they were not yet accustomed to designing activities that require exploration, reasoning, and deep problem-solving. They were more familiar with procedural exercises, making the development of high-order-thinking activities still a challenge. This is supported by interview results with a mathematics teacher at SMAN 8 Pontianak, where G3 stated:

"What is difficult is not the mathematical concept itself, but how to design activities that truly prompt high school students to think deeply. Starting from creating exploratory questions, building an investigative flow, to guiding them toward discovering concepts on their own. Sometimes students need a long time to grasp these ideas, and not all of them understand right away, so we as teachers have to be very patient and guide them gradually so they can think deeply."

G1 also stated:

"Deep learning requires high-level thinking activities. We still need to learn how to design the sequence so that students can truly explore."

b. Limited Facilities, Learning Resources, and Teachers' Technological Skills

Teachers emphasized that deep learning requires media such as mathematical applications, simulations, and contextual examples. However, the available facilities are limited. In addition, some teachers admitted that they are not yet proficient in using technology such as GeoGebra or other digital-based applications. This is supported by interview results with a mathematics teacher at SMAN 8 Pontianak, where G2 stated:

"To create deep learning, we really need contextual examples and media such as GeoGebra or visual simulations, especially for geometry and function topics. For instance, when teaching geometric transformations or quadratic function graphs, it would be much easier if students could see the movement of points or curves interactively. But unfortunately, such facilities are limited, so we often have to rely only on the whiteboard."

G4 also emphasized:

"Without exploratory media, deep learning is difficult to carry out. Students quickly become bored if the concepts are only explained on the whiteboard."

In line with that, G5 also stated:

"In addition, sometimes the new applications needed for certain topics are not yet familiar to us. GeoGebra or other simulation software cannot be used immediately without learning how to operate them first. If we have to learn while also preparing the material, the preparation time becomes longer and actually slows down the teaching process. So even though we want to provide a deep learning experience, we are often limited by our own technological skills and the availability of facilities."

c. Complexity of Learning Planning (Lesson Plans, Activities, and Assessment)

Teachers feel that planning deep learning is more complex because it requires designing a sequence of concept exploration, reflection activities, and assessments that measure not only the final answers but also the thinking process. This is supported by interview results with a mathematics teacher at SMAN 8 Pontianak, where G1 explained:

"An instructional plan (RPP) for deep learning is different. I have to prepare a sequence starting from exploratory questions, investigative activities, up to reflection. For example, when teaching limits, I have to think through steps that allow students to discover limit patterns on their own, discuss them in groups, and then present the results. Creating this is much more detailed compared to simply preparing routine exercises."

This is also in line with what G4 stated:

"What I find most difficult is the assessment. It's not enough to just look at whether the answer is right or wrong. We have to assess how students think, the strategies they use, and whether they can connect the concept of limits with derivatives or functions. Sometimes a special rubric is needed, and preparing it takes a lot of time."

The following is a summary of the challenges identified in the implementation of both approaches in mathematics instruction, as presented in Table 1.

Table 1. Differentiated Instruction vs. Deep Learning

Challenge Dimension	Differentiated Instruction (DI)	Deep Learning (DL)	Salience & Evidence IDs
Primary Focal Constraint	Logistical Complexity: Managing the breadth of student diversity (readiness & interests).	Cognitive Complexity: Facilitating the depth of student thinking (reasoning & exploration).	Shared Challenge. Both require a shift from "one-size-fits-all" to adaptive teaching. (G1, G2, G4, Obs)
Planning & Design	Time-intensive preparation for tiered materials (remedial to enrichment) and multi-level assessments.	Designing open-ended inquiry sequences and HOTS-based rubrics that trigger metacognition.	Dominant in DI. High administrative burden in creating 3+ versions of content. (G1, G5, Doc_Modul)
Resource Dependency	Lack of varied physical and digital aids to support content/process differentiation.	Dependency on high-end simulations (e.g., GeoGebra) and contextual outdoor access.	Shared Constraint. Both hindered by school infrastructure and tech-readiness. (G1, G3, Doc_RPP)
Classroom Dynamics	Supervisory Overload: Managing noise and procedural guidance across simultaneous group activities.	Discourse Gaps: Addressing student passivity in "mindful" reflection due to established speed-oriented norms.	Dominant in DL. Highly salient participation gap between high and low achievers. (G2, G4, Obs_02)
Systemic Barriers	Large class sizes (36+ students) making individual monitoring unsustainable.	Rigid curriculum timelines that penalize the "slow" time required for reflection and outdoor logistics.	Unique Constraints. DL is uniquely hindered by the "15-minute logistical tax." (G2, G4, Interview_Note)

As illustrated in Table 1, while both approaches share a high dependency on resources, the DI approach is more heavily hindered by logistical planning (Dominant), whereas DL faces greater challenges in breaking classroom discourse norms (Highly Salient).

Discussion

Limited Time to Prepare Varied Learning Materials

This study finds that time is the primary adversary for mathematics teachers at SMAN 8 Pontianak when attempting to implement Differentiated Instruction (DI). The issue is not merely a tight schedule, but a structural imbalance between what the curriculum demands and what teachers realistically have the capacity to prepare. While theorists such as Song et al. (2024) argue that teachers should view every student as a unique individual, in practice there is a substantial gap between this ideal and the actual capacity of teachers in real classroom settings. The findings indicate that limited time becomes a constraining force that ultimately "consumes" the quality of instruction itself. Teachers report feeling overwhelmed by the need to prepare multiple sets of materials, strategies, and assessments simultaneously for students with diverse readiness levels (Ledwaba, 2024). This burden is particularly pronounced in mathematics, where content is hierarchical and conceptually cumulative, requiring careful scaffolding and variation.

As a result, limited time to design truly responsive learning materials for each learner may trigger what can be described as a "self-protective mechanism". Teachers are compelled to revert to traditional whole-class instruction one method for all students even though they express a genuine desire to adopt more inclusive practices. Furthermore, this study argues that pedagogical transformation requires substantial cognitive effort and a shift in professional mindset. However, existing administrative demands do not adequately support this transition. When teachers expend excessive energy preparing documentation, paperwork, or multiple task variations, they have less cognitive and emotional capacity to focus on the quality of instructional interaction itself. In the context of the Merdeka Curriculum, therefore, time is not simply a matter of hours allocated; it is a structural challenge that demands systemic solutions such as shared resource banks or digital support tools to prevent teacher burnout and to ensure that differentiated instruction does not remain a mere formal formality on paper.

Limited Resources to Support Learning Variations

This study finds that limited facilities and resources constitute a major barrier for mathematics teachers at SMAN 8 Pontianak in creating meaningful variation in learning. Differentiated Instruction (DI) fundamentally requires diverse media, instructional tools, and learning materials so that students can engage with content in ways that best suit their readiness, interests, and learning profiles. In practice, however, teachers continue to face a longstanding challenge common in many Indonesian schools: insufficient and inadequate learning media (Alsulami, 2025). The findings highlight that the issue of facilities is not merely a matter of whether materials are physically available. Rather, it has a direct psychological impact on students' learning experiences. Limited facilities have been shown to reduce students' concentration and learning motivation (Abe & Hayashi, 2023). This suggests that the provision of adequate educational resources should be a central policy priority (Uline & Tschannen-Moran, 2008), rather than placing the burden solely on teachers to innovate without sufficient material support.

Another significant challenge concerns teachers' difficulties in integrating digital media into differentiated practices. Due to these constraints, teachers often revert to traditional teacher-centered instructional patterns. Yet, as Bhardwaj et al. (2025) argue, effective differentiation requires teachers to move beyond such conventional approaches. If resource limitations persist, teachers will continue to struggle to provide optimal learning experiences, and students' diverse potentials will remain underdeveloped because they are compelled to learn through a single, uniform instructional mode.

The Complexity of Managing a Classroom with Diverse Activities

This study reveals that the greatest obstacle in implementing Differentiated Instruction (DI) is not merely related to instructional materials, but to the complexity of managing an active classroom with multiple simultaneous activities. Consistent with Song et al. (2024), teaching students with diverse learning needs is an inherently complex task. At SMAN 8 Pontianak, this challenge becomes particularly visible when teachers must divide their attention among several groups working on different tasks at the same time. A central issue identified in this research is what may be termed the "fragmentation of teacher attention." Although teachers understand the theoretical principles of differentiation, they experience significant technical difficulties when handling multiple groups concurrently. In mathematics classes, this challenge is intensified because each group often requires detailed, step-by-step procedural guidance. When a teacher focuses on assisting one group, other groups frequently pause, lose momentum, or become disengaged while waiting for support.

Drawing on Goodnough (2010), managing a classroom with varied activities demands that teachers function as highly effective multitaskers. They must monitor and respond to the progress of groups with different needs within the same instructional timeframe. Without well-developed classroom management strategies or the support of a teaching assistant, such conditions can lead to a less conducive learning environment or incomplete curriculum coverage. Therefore, the success of differentiation depends heavily on the teacher's ability to orchestrate instructional "traffic," ensuring that all groups continue progressing without relying entirely on the teacher's constant physical presence at every table.

Teacher Readiness: Balancing Workload and New Teaching Approaches

Research findings at SMAN 8 Pontianak reveal that mathematics teachers are caught between two distinct types of challenges. The struggle in Differentiated Instruction (DI) is primarily a workload ecology (G1, G2, G5). Teachers feel overwhelmed by the need to prepare multiple versions of learning materials and supervise various groups within crowded classrooms of over 30 students. This aligns with findings by Agustina et al., (2025), which identify logistical hurdles and time management as the core problems of differentiation. On the other hand, the challenges in the Deep Learning (DL) approach are rooted in an epistemic and technological ecology (G1, G3). Here, the issue is no longer about the "quantity of tasks," but rather "how to transform teaching methods" from mere rote calculation to deep exploration. Teachers find it difficult to trigger student reasoning because classroom norms typically demand a fast-paced completion of the curriculum rather than pausing for deep reflection (Leek et al., 2026). Furthermore, the lack of facilities such as GeoGebra (G2, G4) makes abstract concepts even harder to visualize and explain.

The interaction between these two creates a difficult situation: teachers exhaust their energy managing the administrative demands of differentiation, leaving them with little capacity to focus on conceptual depth (Deep Learning). Ultimately, despite their desire to be effective facilitators, teachers are often forced to revert to traditional, procedural, and lecture-based methods just to meet curriculum targets.

Limited Facilities, Learning Resources, and Teachers' Technological Skills

This study confirms that the successful implementation of Deep Learning (DL) heavily depends on teachers' ability to integrate technology effectively. The challenge is that deep mathematics learning often requires visualization of abstract concepts something that is difficult to convey using only a whiteboard. An approach requires the support of digital devices, stable internet connectivity, and adequate online platforms (Wu, 2024; Zou et al., 2025; Çela et al., 2025). The findings suggest that technological barriers at SMAN 8 Pontianak are not merely about the absence of computers, but rather about the existence of a digital skills gap among teachers. As noted by Naidoo (2025), limited infrastructure is often compounded by teachers' insufficient proficiency in operating digital mathematics tools. This creates a double burden: teachers must grapple with conceptually demanding material while simultaneously struggling with technical issues related to digital applications. Furthermore, this research argues that without adequate technological support, the core objective of Deep Learning developing deep conceptual understanding becomes difficult to achieve. Teachers end up spending excessive time resolving technical problems or arranging facilities, thereby reducing opportunities for meaningful, in-depth discussions with students. In this sense, the combination of limited facilities, unstable internet access, and low levels of digital literacy among teachers forms a substantial barrier to transforming mathematics learning from mere calculation to deeper conceptual exploration.

Complexity of Learning Planning (Lesson Plans, Activities, and Assessment)

This study indicates that the primary obstacle in implementing Deep Learning (DL) lies in the complexity of the planning process. In DL-oriented mathematics instruction, teachers are no longer focused solely on obtaining the correct final answer; instead, they are expected to design activities that require students to explain their reasoning, connect concepts, and explore multiple solution strategies (Boaler, 2016). This shift from "memorizing formulas" to "understanding processes" demands greater precision and careful attention during the preparation stage. The findings identify a gap between conceptual understanding and actual practice. Consistent with Leek et al. (2026), most teachers at SMAN 8 Pontianak generally understand the concept of Deep Learning at a theoretical level, yet they struggle to translate it into concrete steps within lesson plans or teaching modules. Designing materials that are aligned with students' readiness levels while simultaneously challenging their reasoning requires a high degree of instructional precision.

Furthermore, this study argues that such complexity often leads teachers to feel cognitively burdened even before the lesson begins. When teachers find it difficult to design assessments that measure students' thinking processes rather than merely their computational results they tend to revert to more traditional and straightforward methods. Therefore, the challenge at SMAN 8 Pontianak extends beyond administrative demands; it reflects a pressing need for more technical and practice-oriented professional development that helps teachers transform the abstract theory of Deep Learning into concrete worksheets and actionable classroom activities.

Implications

The findings of this study demand shifts in policy and practice that are far more specific than generic teacher training. First, professional development programs must move away from theoretical seminars toward a long-term coaching model (minimum six months) that focuses on mastering specific tools like GeoGebra and dynamic geometry software. This training should equip teachers to design exploratory inquiry sequences that trigger student metacognition without increasing their daily administrative workload. Second, regarding infrastructure, school management must prioritize the procurement of mobile device labs or classroom-based digital hubs over general facility upgrades; this is crucial to overcoming the identified resource dependency (G1, G2), allowing students at different readiness levels to access digital modules independently. Third, to address systemic barriers related to rigid timing, schools should implement block scheduling with 100–120 minute sessions. This extended duration is vital for facilitating the "slow thinking" required in Deep Learning and the complex group transitions necessary for Differentiated Instruction. Finally, to mitigate the "workload ecology" burden (G2, G5), a strategy of collaborative planning within Subject Teacher Forums (MGMP) is required to collectively develop tiered material banks and HOTS rubrics. By sharing instructional design resources at the district or school level, the individual administrative tax on teachers can be reduced, allowing them to focus their cognitive capacity on managing classroom discourse.

Limitations

Despite its contributions, this study has several limitations. The focus on a single school may limit statistical generalization; however, SMAN 8 Pontianak serves as a critical case for this research. Ranked as the second-best public high school in Pontianak, it represents a typical case of a high-achieving urban school that possesses relatively better resources yet still faces significant workload and epistemic frictions. Therefore, the findings offer analytic transferability, providing a theoretical roadmap for other top-tier regional schools in Indonesia struggling with the Merdeka Curriculum transition. Additionally, while this study captures teachers' deep perceptions, it does not provide direct evidence of student achievement. Factors such as individual teacher backgrounds were also not examined in depth, which may further nuance the implementation challenges.

Suggestions

Future research is recommended to involve a larger number of schools and participants to obtain broader perspectives. Further studies may also integrate quantitative methods to examine the relationship between instructional approaches, teacher challenges, and students' learning outcomes. Policymakers and school administrators are encouraged to provide sustained professional training and improve infrastructure to support the effective implementation of both differentiated instruction and deep learning in mathematics education.

CONCLUSION

This study concludes that the primary challenges faced by mathematics teachers at SMAN 8 Pontianak are not merely a result of individual incompetence, but rather a clash between two distinct operational pressures. We categorize these as a Dual-Ecology Challenge Typology. First is the Workload Ecology of Differentiated Instruction (DI), where teachers are overwhelmed by the administrative and logistical burden of managing more than 36 students with diverse readiness levels. Second is the Epistemic Ecology of Deep Learning (DL), where teachers struggle to facilitate profound conceptual exploration due to rigid curriculum timelines and a lack of specialized technological tools like GeoGebra.

The most significant contribution of this research is the identification of the "Logistical-Cognitive Trade-off" phenomenon. This framework reveals that teachers' cognitive energy and instructional time are often exhausted by the technical demands of group management and material preparation (DI), leaving them with insufficient capacity to facilitate deep, reflective mathematical discourse (DL). Essentially, teachers are trapped between the systemic demand to "manage diversity" and the pedagogical goal to "teach for depth." Therefore, the solution must go beyond generic training; it requires structural intervention, such as the adoption of block scheduling for extended learning sessions and the creation of collaborative design hubs to share administrative loads. By decoupling these pressures, teachers can shift from being "classroom logisticians" to becoming true "architects of deep reasoning.

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AUTHOR CONTRIBUTIONS STATEMENT

Puput led the conceptualization of the study, prepared the original draft of the manuscript, and was responsible for the editing and visualization of the research data. Verminus conducted the data collection, performed the investigation process, and handled the data curation to ensure the integrity of the research materials. Nurul Azkiya contributed to the validation of the findings, managed the necessary resources, and provided critical input during the writing, review, and editing phases. Ahmad Yani T designed the methodological approach, performed the formal analysis, and was responsible for the validation and final review of the manuscript.

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