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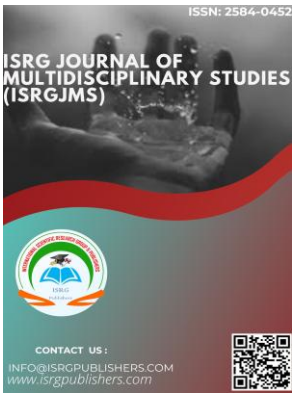

Mathematics Teachers' Competence in Implementing Deep Learning Approaches in Algebra Instruction: A Case Study at SMP Negeri 1 Tana Toraja

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Abstract

The growing demand for twenty-first-century competencies has highlighted the importance of deep learning approaches that foster conceptual understanding, critical thinking, and meaningful learning experiences. However, the implementation of deep learning in mathematics classrooms remains challenging, particularly in algebra instruction. This study aimed to analyze mathematics teachers' competence in implementing deep learning approaches in algebra teaching at SMP Negeri 1 Tana Toraja, Indonesia. A qualitative case study design was employed to gain an in-depth understanding of teachers' perceptions and instructional practices. Data were collected through semi-structured interviews, classroom observations, and document analysis involving five mathematics teachers selected using purposive sampling. The data were analyzed using the interactive model of Miles, Huberman, and Saldaña, consisting of data reduction, data display, and conclusion drawing. The findings revealed that teachers' understanding of deep learning varied considerably. Two teachers demonstrated a comprehensive understanding by emphasizing conceptual understanding and contextual learning, whereas the remaining teachers associated deep learning primarily with higher-order and more complex exercises. Although some teachers attempted to integrate real-life contexts into algebra instruction, classroom practices were still predominantly characterized by teacher-centered approaches, lectures, and routine exercises. Several challenges were identified, including limited pedagogical competence, insufficient professional development opportunities, administrative workload, and students' dependence on conventional learning practices. The study concludes that the implementation of deep learning approaches in algebra instruction remains at a developmental stage and is influenced by both internal and external factors. Strengthening teachers' pedagogical competence, providing continuous professional development, and reducing administrative burdens are essential to support meaningful mathematics learning. These findings contribute to the growing body of literature on deep learning implementation in mathematics education and provide practical implications for educational policy and teacher professional development.

Keywords: *deep learning approach; teacher competence; algebra instruction; mathematics education; qualitative case study.*

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1. INTRODUCTION

The rapid transformation of education in the twenty-first century requires learning environments that promote critical thinking, creativity, collaboration, and problem-solving skills. Consequently, educational systems worldwide have shifted their focus from knowledge transmission toward the development of deep understanding and meaningful learning experiences. Within this context, the concept of deep learning has emerged as a prominent pedagogical approach that emphasizes conceptual understanding, knowledge construction, and the application of learning across diverse situations (Fullan & Langworthy, 2020).

In mathematics education, deep learning is particularly important because mathematical understanding extends beyond procedural fluency. Students are expected to develop conceptual knowledge, connect mathematical ideas, and apply their understanding to real-world situations. Algebra, as one of the fundamental domains of mathematics, requires students to comprehend abstract relationships, patterns, and symbolic representations. However, many students continue to experience difficulties in algebra because classroom instruction often prioritizes procedural skills over conceptual understanding.

In Indonesia, educational reforms introduced through the Merdeka Curriculum encourage meaningful, student-centered, and context-based learning experiences. These reforms align closely with the principles of deep learning. Nevertheless, the successful implementation of such approaches largely depends on teachers' pedagogical competence and instructional practices. Previous studies have reported that mathematics instruction in Indonesian classrooms remains predominantly teacher-centered, focusing on routine exercises and procedural problem-solving rather than conceptual exploration (Sari et al., 2021).

Empirical evidence also indicates that teachers encounter challenges in designing and facilitating learning experiences that promote deep understanding. Prasetyo and Nugroho (2021) found that many mathematics teachers struggle to connect abstract mathematical concepts with authentic contexts. As a result, students often exhibit limited conceptual understanding and weak higher-order thinking skills. These findings suggest a persistent gap between curriculum expectations and actual classroom practices.

The situation becomes even more complex in regional contexts such as Tana Toraja, where educational practices are influenced by cultural, geographical, and institutional factors. Preliminary observations indicated that mathematics teachers face several challenges, including limited access to professional development programs, insufficient instructional resources, and substantial administrative responsibilities. Such conditions may hinder teachers' ability to implement innovative pedagogical approaches effectively.

Although studies on deep learning have increased in recent years, most existing research has focused on student achievement outcomes using quantitative methods. Limited attention has been given to exploring teachers' perspectives, experiences, and instructional practices through qualitative inquiry. According to Hidayat et al. (2022), qualitative approaches are essential for understanding the complexity of classroom practices and contextual factors influencing instructional decision-making. Therefore, there remains a need for in-depth investigations that examine how mathematics teachers understand and implement deep learning approaches in authentic educational settings.

This study aims to analyze mathematics teachers' competence in implementing deep learning approaches in algebra instruction at SMP Negeri 1 Tana Toraja. Specifically, the study investigates teachers' conceptual understanding of deep learning, instructional strategies employed in algebra teaching, and challenges encountered during implementation. The findings are expected to contribute both theoretically and practically to the development of meaningful mathematics learning and teacher professional development.

2. METHODS

This study employed a qualitative approach using a case study design to explore mathematics teachers' competence in implementing deep learning approaches in algebra instruction. A qualitative case study was considered appropriate because it enables researchers to investigate educational phenomena within their natural settings and gain an in-depth understanding of participants' experiences, perceptions, and practices (Yin, 2021).

The study was conducted at SMP Negeri 1 Tana Toraja, South Sulawesi, Indonesia, between January and March 2026. The participants consisted of five mathematics teachers selected through purposive sampling. The selection criteria included: (1) having at least three years of teaching experience, (2) actively teaching algebra topics at the junior secondary level, and (3) having participated in professional development programs related to innovative teaching approaches. Snowball sampling was subsequently utilized to identify additional participants who met the research criteria and could provide relevant insights.

Data were collected through semi-structured interviews, classroom observations, and document analysis. Semi-structured interviews were conducted to explore teachers' understanding of deep learning, instructional strategies, and perceived challenges. Classroom observations focused on instructional interactions, teaching practices, and student engagement during algebra lessons. Document analysis included lesson plans, teaching modules, assessment instruments, and other instructional materials used by the teachers.

To ensure trustworthiness, the study employed triangulation of data sources and methods. Data obtained from interviews, observations, and documents were compared and cross-checked to enhance credibility. Member checking was also conducted by sharing preliminary findings with participants to verify the accuracy of interpretations. Furthermore, an audit trail was maintained throughout the research process to ensure transparency and dependability.

Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña (2020), consisting of data reduction, data display, and conclusion drawing. Data reduction involved selecting and organizing information relevant to the research objectives. Subsequently, data were displayed in the form of thematic narratives and summary tables. Finally, conclusions were drawn through continuous interpretation and verification of emerging themes and patterns.

3. RESULTS AND DISCUSSION

Analysis of the interview, observation, and document data generated three major themes: (1) teachers' understanding of deep

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learning, (2) instructional practices in implementing deep learning within algebra instruction, and (3) challenges encountered during implementation.

3.1 Teachers' Understanding of Deep Learning

The findings revealed substantial variation in teachers' understanding of deep learning. Two participants demonstrated a relatively comprehensive understanding of the concept. They emphasized conceptual understanding, critical thinking, and the connection between mathematical concepts and real-life situations.

One teacher stated:

"Learning is not only about students being able to solve problems; they also need to understand why a particular formula or procedure works." Another participant described deep learning as a process that encourages students to connect mathematical concepts with everyday experiences. In contrast, three teachers perceived deep learning primarily as the provision of more difficult exercises or higher-order thinking questions. Their responses indicated a limited understanding of the pedagogical principles underlying deep learning. This variation suggests that teachers' conceptual knowledge significantly influences how deep learning is interpreted and implemented in classroom practice.

3.2 Instructional Practices in Algebra Learning

Classroom observations indicated that some teachers attempted to incorporate contextual examples into algebra instruction. Real-life situations such as buying and selling activities, financial transactions, and daily calculations were occasionally used to introduce algebraic variables and equations. However, these contextual practices were not systematically integrated into lesson implementation. Most classroom instruction remained teacher-centered and heavily dependent on lectures, demonstrations, and routine exercises. Opportunities for collaborative learning, inquiry-based activities, and student reflection were limited. Document analysis further revealed inconsistencies between lesson planning and instructional practice. Although several lesson plans contained student-centered objectives, classroom implementation often reverted to conventional approaches. Consequently, students had limited opportunities to construct conceptual understanding independently.

3.3 Challenges in Implementing Deep Learning

Several challenges were identified during the implementation process. The most prominent obstacles included insufficient pedagogical knowledge, limited professional development opportunities, administrative workload, and students' dependence on traditional instructional methods.

One participant explained:

"We want to make learning more engaging, but limited time and administrative responsibilities make it difficult."

Teachers also reported difficulties in designing contextual learning activities that align with curriculum requirements. Additionally, students who were accustomed to teacher-centered instruction often struggled to adapt to more active learning approaches. These findings suggest that successful implementation of deep learning requires support at both individual and institutional levels.

The findings demonstrate that mathematics teachers' understanding of deep learning remains uneven. This result supports the argument of Fullan and Langworthy (2020), who emphasize that successful implementation of deep learning depends on teachers' ability to understand and translate its principles into classroom practice. Teachers with a stronger conceptual understanding were more likely to employ contextual examples and student-centered learning strategies. Despite growing awareness of innovative teaching approaches, algebra instruction continued to be dominated by procedural and teacher-centered practices. This finding is consistent with previous studies conducted in Indonesian mathematics classrooms (Sari et al., 2021), which reported that instructional practices frequently emphasize procedural fluency rather than conceptual understanding. Such practices may limit students' opportunities to develop critical thinking and problem-solving abilities. The findings also highlight the complexity of implementing educational innovations. Beyond teachers' individual competencies, factors such as institutional support, professional development opportunities, administrative responsibilities, and students' learning cultures significantly influence instructional practices. Similar challenges have been identified by Prasetyo and Nugroho (2021), who reported that inadequate pedagogical preparation and limited access to training often hinder teachers from adopting innovative instructional approaches. From a constructivist perspective, deep learning requires students to actively construct knowledge through meaningful experiences and social interaction. However, the observed classroom practices did not fully reflect these principles. Student participation remained relatively passive, and opportunities for collaborative inquiry and reflection were limited. This discrepancy indicates a gap between theoretical expectations and actual classroom implementation. The findings suggest that improving the implementation of deep learning requires comprehensive interventions. Professional development programs should focus not only on theoretical understanding but also on practical classroom applications. Furthermore, educational policymakers should consider reducing administrative burdens and providing resources that support innovative teaching practices. Such efforts may enhance teachers' capacity to create meaningful learning experiences that promote conceptual understanding and higher-order thinking skills

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