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Mathematics Teachers' Understanding of the Deep Learning Approach in Instructional Module Development

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Abstract
The era of disruption, characterized by rapid change and an overwhelming flow of information, demands a transformation in educational paradigms, particularly in the development of deep learning mindsets among elementary school teachers. This study aims to analyze mathematics teachers' understanding of the deep learning approach as reflected in the preparation of teaching modules in Keerom Regency, Papua. A mixed methods approach with a sequential explanatory design was employed. Quantitative data were collected through a Likert scale questionnaire administered to ten elementary mathematics teachers, followed by qualitative data gathered through in depth interviews with selected teachers and document analysis of teaching modules. Quantitative data were analyzed using descriptive statistics, while qualitative data were analyzed using the interactive model of Miles and Huberman. The results indicate that 20% of teachers demonstrated a high level of understanding of deep learning, 60% were categorized at a moderate level, and 20% showed a low level of understanding. Teachers with a high level of understanding were able to integrate meaningful, mindful, and joyful learning elements into their teaching modules through student centered activities, authentic assessments, and reflective practices. In contrast, teachers with moderate and low levels of understanding tended to rely on procedural activities and conventional assessments, indicating limited implementation of deep learning principles. The integration of quantitative and qualitative findings reveals a strong consistency between teachers' conceptual understanding and the quality of the teaching modules they developed. These findings highlight the need for continuous professional development and targeted mentoring to enhance teachers' capacity to implement deep learning effectively in mathematics instruction.

Keyword: deep learning approach; teaching modules; elementary school, mixed methods

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Introduction

The era of disruption, characterized by rapid changes and an overwhelming flow of information, necessitates a transformation of educational paradigms. In this context, a deep learning mindset has become increasingly essential for elementary school teachers in responding to the growing complexity of contemporary challenges. The focus of 21st century education has shifted from the mere memorization of information toward the ability to understand concepts, analyze problems, and generate knowledge based solutions (Hattie, 2012). Deep learning oriented instructional processes prepare students to face global challenges by actively engaging them in meaningful learning experiences (Feri et al., 2025). As the primary facilitators of learning, teachers play a strategic role in cultivating this mindset, particularly in mathematics instruction, which is often perceived as abstract and challenging by students.

In line with this perspective, the Indonesian Minister of Primary and Secondary Education, Abdul Mu'ti (2025) emphasized that the implementation of deep learning aims to enhance the quality of education for all learners. He highlighted deep learning as an approach designed to foster innovative instructional practices through three core elements: meaningful learning, mindful learning, and joyful learning. Through this approach, the learning process is expected to honor learners' diverse abilities and competencies while providing an engaging and enlightening educational experience.

Within the context of mathematics education, meaningful learning plays a particularly critical role. According to Ausubel, meaningful learning occurs when learners are able to connect new information with their existing cognitive structures (Koskinen & Pitkäniemi, 2022). Rather than focusing solely on memorizing formulas, students are encouraged to apply mathematical concepts to real life situations, such as managing simple budgets or calculating the volume of objects in their surroundings. This process must be supported by mindful learning, which emphasizes students' full awareness and focused engagement, as well as joyful learning, which creates a positive learning atmosphere that fosters creativity and cognitive flexibility (Fredrickson, 2000).

Despite these theoretical and policy driven expectations, classroom realities reveal a significant gap between conceptual ideals and instructional practice. Observations of teaching modules and interviews conducted during a Teacher Working Group activity at MIN Keerom on February 15, 2025, indicate that many teachers continue to rely on conventional, teacher centered approaches. These approaches are often perceived as more practical and less complex, allowing teachers to maintain full control over instruction and ensure that curricular targets are met within limited time frames. However, this tendency frequently comes at the expense of students' deep understanding of fundamental mathematical concepts.

Previous studies have identified major challenges in implementing deep learning–oriented instruction, including limited access to professional development, varying levels of teacher readiness, and disparities in educational resources (Hammond et al., 2017; Hattie, 2012). Conversely, Fullan et al., (2018) emphasized the transformative potential of deep learning in creating meaningful educational experiences by engaging students in critical thinking, collaboration, creativity, and problem solving. Unlike prior studies that primarily relied on literature-based analyses, the present study offers a novel contribution by focusing specifically on mathematics instruction and employing a mixed methods approach to examine teachers' understanding of deep learning through the development of instructional modules in Keerom Regency.

Accordingly, the primary objective of this study is to examine the extent to which mathematics teachers understand the deep learning approach. Practically, the findings are expected to provide a foundation for schools and teachers in Keerom Regency to formulate strategic efforts aimed at improving instructional quality, while also fostering greater student motivation and engagement in learning mathematics.

Method

This study employed a mixed methods approach with a sequential explanatory design. In this design, the research began with the collection and analysis of quantitative data to obtain an overall overview of the phenomenon, followed by a qualitative phase aimed at explaining and deepening the quantitative findings (Berman, 2017). The integration of quantitative and qualitative data was conducted at the final interpretation stage to provide a comprehensive understanding of the research phenomenon. The study was carried out in elementary schools in Keerom Regency, Papua. This location was purposively selected due to ongoing efforts to enhance teachers' competencies in innovative learning practices despite existing geographical challenges. The research population consisted of all

elementary school mathematics teachers in Keerom Regency who were actively teaching under the Merdeka Curriculum.

Sampling was conducted using purposive sampling based on specific criteria, namely teachers who taught mathematics, independently developed teaching modules, and had at least one year of experience implementing the Merdeka Curriculum. Based on these criteria, ten teachers were selected as respondents for the quantitative phase using questionnaires. From this group, two teachers were chosen as key informants for in depth interviews in the qualitative phase, based on extreme score variation (very high and very low levels of understanding), in order to obtain rich and in-depth data.

Data were collected using three primary techniques: questionnaires, in depth interviews, and document analysis. The questionnaire was developed using a four-point Likert scale ranging from strongly agree to strongly disagree to measure teachers' understanding based on the indicators of meaningful, mindful, and joyful learning. Semi structured in depth interviews were then conducted to explore the underlying reasons behind the questionnaire responses and to identify practical challenges encountered in the field. In addition, document analysis was performed on the teachers' teaching modules to examine the alignment of learning objectives, instructional activities, and assessment strategies.

Data analysis was carried out in stages according to the type of data. Quantitative data from the questionnaires were analyzed using descriptive statistics to categorize teachers' levels of understanding into high, moderate, and low categories. Meanwhile, qualitative data were analyzed using the interactive model proposed by Miles and Huberman, which includes data reduction, data display, and conclusion drawing. The results of both analyses were subsequently integrated, with qualitative data serving to validate and explain the quantitative findings. To ensure data credibility and trustworthiness, source and method triangulation were applied, along with member checking conducted with key informants.

Result and Discussion

This study aims to analyze mathematics teachers' understanding of the deep learning approach as reflected in the development of teaching modules in Keerom Regency. The participants consisted of ten elementary school mathematics teachers selected through purposive sampling. Data were collected using a teacher understanding questionnaire consisting of 20 Likert scale items, semi structured interviews with three teachers representing high, moderate, and low levels of understanding, and observation of the teaching modules developed by the teachers. The data were analyzed using a mixed methods approach with an explanatory sequential design, in which quantitative data were analyzed first to obtain an overall description, followed by qualitative analysis to deepen and explain the quantitative findings, and finally integrated to provide a comprehensive interpretation of the results.

Quantitative Data Analysis

The results of the quantitative data analysis were obtained from a questionnaire on teachers' understanding of the deep learning approach, which was completed by 10 elementary school mathematics teachers.

Table 1. Descriptive Statistics of Teachers' Understanding of the Deep Learning Approach)

Statistics	Value
Sample Size (N)	10
Mean	67,3
Ideal Score	100
Standard Deviation	14
Maximum Score	90
Minimum Score	48
Range	42

The data summary shows that the teachers' mean understanding score was 67.3 out of an ideal score of 100, with a standard deviation of 14. The respondents' scores varied, ranging from a minimum of 48 to a maximum of 90, resulting in a range of 42. These findings indicate a variability in the teachers' levels of understanding regarding the deep learning approach.

Based on the mean and standard deviation, the levels of teacher understanding were categorized using the Mean ± SD criteria. Specifically, scores above 81.3 were categorized as high, scores between 53.3 and 81.3 as medium, and scores below 53.3 as low. This classification was employed to provide a clearer overview of the distribution of teachers' understanding of the deep learning approach.

The categorization results indicate that 2 teachers (20%) were in the high category, 6 teachers (60%) were in the moderate category, and 2 teachers (20%) were in the low category. This distribution shows that the majority of teachers fall into the moderate category, implying that most teachers understand the basic concepts of deep learning but have not yet fully implemented them optimally in classroom practices.

These results are visualized through the following bar charts and pie charts

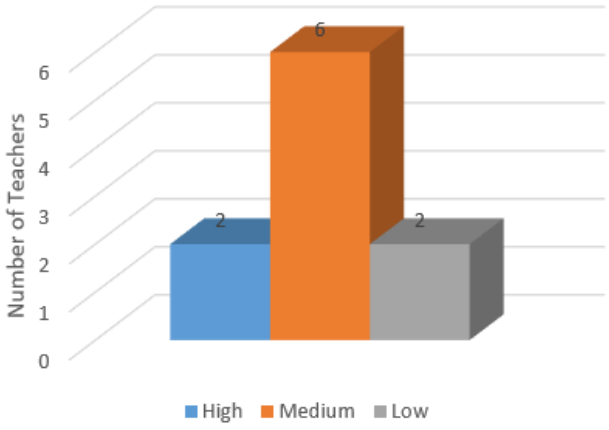

Figure 1. Number of Teachers by Category

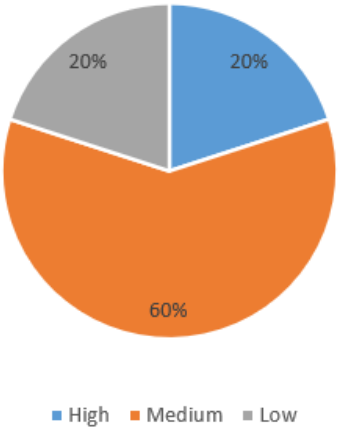

Figure 2. Percentage of Teachers by Category

The bar chart shows the dominance of teachers in the medium category, while the pie chart confirms that more than half of the respondents (60%) fall into this category. The proportions of teachers in the high and low categories are relatively balanced, each accounting for 20%.

Overall, these quantitative findings indicate that mathematics teachers' understanding of the deep learning approach in Keerom Regency is at a moderate level and can be considered fairly good; however, further improvement is still needed. Teachers with low levels of understanding require additional mentoring and training, whereas those who have reached the high category have the potential to serve as models or examples of best practices in the development of deep learning–based instructional modules.

Qualitative Data Analysis Results

The qualitative data analysis results were obtained through in depth interviews with teachers representing different levels of understanding based on the questionnaire results, namely high, medium, and low categories. Teachers in the high understanding category were able to explain the concept of deep learning comprehensively, relate it to 21st century competency-based learning, and had made efforts to integrate this approach into the development of instructional modules.

Meanwhile, teachers in the medium understanding category generally demonstrated an understanding of the basic concepts of deep learning but still experienced difficulties in applying them to instructional modules, particularly in designing learning activities that promote students' critical and reflective thinking.

In contrast, teachers in the low understanding category tended to perceive deep learning merely as the use of technology or project-based learning methods, and therefore had not yet grasped its essence as an approach that emphasizes deep understanding.

These findings indicate that teachers' levels of understanding are influenced by their participation in training programs, access to learning resources, and motivation for self-directed learning in developing their professional competencies.

Results of Instructional Module Analysis

Based on the analysis of 10 instructional modules, a summary of the results is presented in Table 2.

Table 2. Results of Instructional Module Analysis

Number of Modules	**High (20%)** **2 Modules**	**Medium (60%)** **6 Modules**	**Low (20%)** **2 Modules**
Quality of Learning Objective	Clear objectives, aligned with Learning Outcomes and the Pancasila Student Profile	Objectives are fairly clear but not yet fully operational	Objectives are unclear and largely copied from textbooks
Quality of Learning Objective	Clear objectives, aligned with Learning Outcomes and the Pancasila Student Profile	Objectives are fairly clear but not yet fully operational	Objectives are unclear and largely copied from textbooks
Learning Activities	Student centered activities, based on real world problems, with reflection components	Activities are varied but tend to be procedural; reflection is still limited	Activities are dominated by lectures and routine exercises
Assessment	Comprehensive assessment (formative, summative, and authentic)	Assessment is present but does not yet emphasize authentic assessment	Assessment is limited to written tests
Integration of Deep Learning	Well integrated: critical, creative, and collaborative aspects are evident	Only some aspects of deep learning are presen (e.g., critical thinking, but limited reflection)	Almost no implementation of deep learning
Conclusion	The instructional modules are of very good quality and align with the principles of the Merdeka Curriculum and deep learning	The instructional modules are fairly good but require improvement, particularly in reflection and authentic assessment	The instructional modules are of low quality and require intensive mentoring in their development

The findings show that most teachers (60%) are in the medium category, suggesting that their instructional modules align with the Merdeka Curriculum but lack optimal integration of deep learning.

Integration of Quantitative and Qualitative Data

Based on both quantitative and qualitative findings, a consistent pattern emerges showing that the majority of teachers are at the medium level: they understand the basic concepts of the deep learning approach but are not yet able to implement it optimally in the development of instructional modules. Teachers in the high category provide evidence that strong conceptual understanding can promote the creation of more innovative instructional modules. Meanwhile, the low category highlights the need for mentoring programs and continuous professional development. The integration of quantitative and qualitative results regarding teachers' understanding of the deep learning approach is presented in Table 3.

Table 3. Integration of Quantitative and Qualitative Results on Teachers' Understanding of the Deep Learning Approach

Category	Quantitative Results	Qualitative Results	Integrative Interpretation
High	2 (20%)	Teachers are able to explain the concept of deep learning comprehensively, relate it to 21st century skills, and have attempted to implement it in instructional modules.	Indicates the presence of teachers with strong understanding who can serve as models or facilitators for other teachers
Medium	6 (60%)	Teachers understand the basic concept of deep learning but still experience difficulties in applying it to the development of instructional modules, particularly in designing critical thinking learning activities.	The majority of teachers are at a moderate level of understanding; further training is needed to improve implementation
Low	2 (20%)	Teachers still perceive deep learning merely as the use of technology or project based methods and have not yet understood its deeper meaning as a reflective learning approach.	Indicates a gap in understanding that requires intensive mentoring

Teachers' Understanding of the Deep Learning Approach

The quantitative findings reveal that mathematics teachers in Keerom Regency demonstrate varying levels of understanding of the deep learning approach, distributed across three categories: high (20%), medium (60%), and low (20%). The mean score of 67.3 (SD = 14) indicates that most teachers possess a foundational understanding of deep learning, although its implementation in instructional practice remains limited.

This pattern reflects Mezirow (2018) transformative learning theory, which suggests that deep understanding involves not only conceptual comprehension but also critical reflection on teaching practice. Teachers in the high understanding category appear to demonstrate reflective awareness in designing learning experiences, whereas those in the medium and low categories tend to emphasize procedural knowledge and surface level learning processes.

Instructional Module Analysis

The analysis of instructional modules further highlights qualitative differences across teacher categories.

Teachers in the high category developed modules with coherent alignment among learning objectives, instructional activities, and assessment strategies. Their modules incorporated student centered learning, contextual problem solving, collaborative activities, and reflective formative assessment. These practices are consistent with research indicating that interactive learning activities such as discussion, presentation, and project based work effectively foster deep learning (Fullan, Quinn, et al., 2018).

In the medium category, instructional modules contained essential components but lacked depth in implementation. Learning activities were often procedural, and assessment practices were still dominated by written tests or routine exercises. Previous studies emphasize that assessment practices promoting analysis, synthesis, and reflection are critical in supporting deep learning (Masuku et al., 2021).

Meanwhile, modules produced by teachers in the low category showed limited instructional variation and minimal support for student autonomy. Teacher centered instruction remained dominant, which may restrict opportunities for meaningful knowledge construction. Research on self directed learning suggests that learner autonomy is a key factor in promoting deep learning outcomes.

Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative data demonstrates a clear relationship between teachers' conceptual understanding and their instructional design practices. Teachers with stronger conceptual understanding tend to develop instructional modules that incorporate active learning strategies, authentic assessment, and opportunities for self directed learning. Conversely, teachers with moderate understanding often struggle to translate conceptual knowledge into instructional practice, particularly in designing reflective and critical learning activities. Teachers with limited understanding show a noticeable gap between theoretical awareness and pedagogical implementation.

These findings are consistent with the Pedagogical Content Knowledge (PCK) framework, which highlights the importance of integrating subject matter knowledge with pedagogical competence in effective teaching practice (Kaur et al., 2023; Shulman, 1987). Teachers' conceptual understanding of instructional approaches must be accompanied by the ability to translate that understanding into instructional design, assessment practices, and classroom implementation. Without this integration, instructional planning may remain theoretical rather than practical.

Conclusion

This study concludes that mathematics teachers' understanding of the deep learning approach in Keerom Regency varies across three levels high, medium, and low with the majority of teachers positioned at the medium level. This indicates that while most teachers are familiar with the concept of deep learning, its integration into instructional planning and module development remains incomplete.

Differences in understanding are reflected in the quality of instructional modules produced by teachers. Higher levels of understanding are associated with more coherent, contextual, and student centered module design, while lower levels of understanding correspond to more procedural and teacher centered instructional planning.

Overall, the convergence of quantitative and qualitative findings confirms that teachers' conceptual understanding plays a crucial role in shaping instructional design quality. Strong theoretical understanding supports the development of instructional modules that promote deep learning, whereas limited understanding constrains the alignment between pedagogical theory and classroom practice.

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