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Reorientation of Deep Learning Based Instruction in Enhancing Students' Metacognitive Competence

Herman Pakiding[1*], Ruth Judica Siahaan[2]
[1,2]Ecumenical Theological College, Jakarta
Corresponding Author: Herman Pakiding, herman@sttekumene.ac.id

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ABSTRACT

This research is motivated by the importance of developing students' metacognitive competencies in 21st century learning that requires reflective skills and self-regulation. This study aims to analyze the influence and reorientation of deep learning-based instruction on students' metacognitive competence. The approach used was a mixed method with a sequential explanatory design, involving 120 respondents and 12 informants, with data collection techniques in the form of questionnaires and interviews as well as inferential and thematic statistical analysis. The results showed a significant influence with a contribution of 62%, where the reflective dimension was the dominant factor, although the monitoring and technology utilization aspects were still not optimal. This study concludes that deep learning-based learning reorientation integrated with metacognitive strategies can improve the quality of learning theoretically and practically

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INTRODUCTION

21st century education demands a paradigm shift in learning from mere knowledge transfer to the development of higher-level thinking competencies, including metacognitive competencies. In a global context, technological developments such as artificial intelligence and deep learning have changed the way students learn, think, and reflect on their learning process. Recent research suggests that the integration of advanced technology can act as a "metacognitive partner" that assists students in the process of self-reflection and regulation (Varghese & Sharma, 2025). However, on the other hand, the phenomenon of dependence on technology has also begun to emerge and has the potential to reduce students' reflective thinking skills. This is an important issue in the global education system that seeks to balance the use of technology with the strengthening of students' internal cognitive abilities.

In the local context, especially in Indonesia, the implementation of learning still tends to be output-oriented rather than process-oriented. This leads to low students' metacognitive abilities, such as planning, monitoring, and evaluating learning. Studies show that metacognition has a significant contribution to academic achievement and critical thinking skills students (Bao et al., 2024). Therefore, a learning approach is needed that is able to encourage students to actively think, reflect on the learning process, and build self-awareness in learning.

One relevant approach is deep learning-based instruction, which emphasizes deep understanding, conceptual interconnectedness, and critical reflection on learning. Deep learning focuses not only on mastery of the material, but also on how students understand, process, and internalize knowledge in a meaningful way. In this context, metacognition is a key component that connects cognitive processes to optimal learning outcomes. Research by Hands and Limniou (2023) shows that deep learning approaches have a complex but significant relationship with students' metacognitive development.

However, previous studies have shown that there is a research gap in the integration of deep learning and metacognition in learning practices. Most studies still focus on the use of specific technologies or learning models without explicitly linking them to the development of students' metacognitive competencies. For example, Leasa et al. (2023) emphasized the importance of metacognition in improving critical thinking skills, but have not yet systematically integrated it within the framework of deep learning. In addition, Varghese and Sharma (2025) also identified that there is no comprehensive conceptual framework in integrating deep learning-based technologies with metacognitive strategies in education.

Another gap lies in the lack of a reorientation approach in the implementation of deep learning in the classroom. Many learning practices claim to use deep learning, but they are still procedural and have not touched on the reflective aspects and self-regulation of students. Recent research has also shown that the use of advanced technologies such as AI has the potential to give rise to "metacognitive laziness" if not balanced with the right pedagogical strategies (Fan et al., 2024 in Varghese & Sharma, 2025). This shows the need to reorient the learning approach that not only integrates technology, but also strengthens the metacognitive dimension of students.

Based on these problems, this study aims to analyze the reorientation of deep learning-based instruction in improving students' metacognitive competence. In particular, this study seeks to examine how deep learning approaches can be implemented in a more reflective and meaningful way, identify relevant metacognitive dimensions in learning, and explore the integration of technology in supporting the optimal development of students' metacognition.

The contribution of this research is theoretically expected to enrich the study of the relationship between deep learning and metacognition in the context of modern education. This research also seeks to develop a more comprehensive conceptual framework in integrating deep learning-based learning with the strengthening of students' metacognitive competencies. Thus, this research can be a reference for the development of learning theories that are more adaptive to the challenges of the digital era.

Practically, this research is expected to contribute to teachers, education practitioners, and policy makers in designing more effective and reflective learning strategies. The results of this research can be the basis for developing a learning model that is not only oriented to mastery of the material, but also to strengthening the ability to think critically, reflectively, and independently in students. Thus, the reorientation of deep learning-based instruction can be a strategic solution in improving the quality of education in an increasingly complex global era.

THEORETICAL REVIEW

Metacognition in Modern Education

Metacognition is the ability of individuals to be aware, control, and evaluate their own thought processes, which include learning planning, monitoring, and evaluation activities. In recent developments, metacognition has become a major focus in education because it is strongly correlated with the ability to think at a higher level and meaningful learning. A bibliometric study by Chen et al. (2025) shows that metacognition research has increased significantly in the last two decades and is increasingly integrated with educational technology as well as data-driven learning. In addition, Loaiza et al. (2023) emphasized that metacognition plays an important role in forming learners who are independent, reflective, and adaptive to changes in the learning environment. This places metacognition as the main foundation in 21st century education.

Furthermore, metacognition not only has an impact on learning outcomes, but also on learning engagement. Research by An et al. (2024) shows that metacognition has a significant effect on learning strategies and learning behaviors which ultimately increases student engagement. Thus, strengthening metacognitive competencies is an urgent need in modern learning design.

Deep Learning in the Context of Education

Deep learning in education refers to a learning approach that emphasizes deep understanding, integration of concepts, and critical reflection on knowledge. This approach is different from surface learning which only focuses on memorization. In the context of modern education, deep learning is often associated with meaningful learning and constructivism, where students actively build knowledge through learning experiences.

Recent research shows that deep learning plays an important role in developing critical and reflective thinking skills. Chen et al. (2025) revealed that the integration of metacognitive strategies in deep learning can significantly improve the quality of student understanding. However, the implementation of deep learning still faces challenges, especially in integrating the reflective dimension and self-regulation systematically in learning practices.

The Relationship of Deep Learning and Metacognition

The relationship between deep learning and metacognition is complementary. Deep learning provides a complex and meaningful learning context, while metacognition serves as a controlling mechanism for the learning process. In the perspective of self-regulated learning, metacognition is a key component that allows students to manage learning strategies effectively.

Research by Pacheco et al. (2025) shows that the use of AI and learning analytics can support the development of metacognition by providing real-time feedback that helps students reflect on their learning process. In addition, Romdhoni et al. (2025) found that the integration of AI in learning is able to improve self-regulated learning and metacognition, although its implementation is still not optimal in supporting students' deep reflection. This suggests that the relationship between deep learning and metacognition needs to be strengthened through a more integrated learning design.

The Role of Technology and Artificial Intelligence in Metacognitive Learning

Technological developments, especially artificial intelligence (AI), have opened up new opportunities in the development of metacognition. AI enables personalization of learning through learning analytics, adaptive learning, and recommendation systems that can help students understand their strengths and weaknesses.

However, recent research also shows that there is an inequality in the use of technology. Pacheco et al. (2025) found that most AI implementations still focus on predictive aspects, while reflective and metacognitive aspects are still underdeveloped. In addition, a neuroscience study by recent research (2025) shows that metacognition has a complex neurological basis and requires a learning approach that supports active reflection, rather than just the use of technology. Therefore, a reorientation in the use of technology is needed to focus more on developing students' learning awareness.

Metacognition, Motivation, and Self-Regulated Learning

Metakogeniation is closely related to motivation and self-regulated learning (SRL). In this context, metacognition is not only influenced by cognitive abilities, but also by affective factors such as mindset and self-efficacy. Research by Zhang et al. (2025) shows that metacognitive strategies are influenced by growth mindsets and play a mediator role in improving academic performance.

In addition, Prihandoko et al. (2024) found that self-efficacy and metacognition together mediate the relationship between students' mindset and academic performance. This suggests that the development of metacognition should be carried out holistically taking into account the cognitive and affective aspects of the student. As such, deep learning approaches need to be designed to integrate the motivational and reflective dimensions simultaneously.

Shared Metacognition and Collaborative Learning

The concept of shared metacognition emphasizes that metacognitive processes do not only occur individually, but also in social interactions. In collaborative learning, students can help each other in planning, monitoring, and evaluating the learning process.

Research by Chen and Chen (2024) shows that online learning with distributed teaching presence can improve students' shared metacognition and cognitive presence. This shows that collaboration-based deep learning has great potential in improving students' metacognitive competencies, especially in digital learning environments.

Global Trends and Research Gaps in Metacognition and Deep Learning

Although research on metacognition is growing rapidly, there is still a gap in the integration between deep learning, technology, and metacognition. Chen et al. (2025) emphasize that despite the abundance of research on metacognition, an interdisciplinary approach that comprehensively integrates technology, pedagogy, and psychology is still needed.

In addition, Agustina et al. (2025) show that metaconnivor research is still limited to specific contexts such as mathematics, and has not studied much integration with holistic deep learning approaches. This gap shows the need to reorient deep learning approaches that explicitly target the development of students' metacognitive competencies.

Reorientation of Deep Learning for Strengthening Metacognition

Based on the literature review, a deep learning-based instruction reorientation is needed that not only focuses on understanding concepts, but also on developing students' learning awareness, reflection, and self-regulation. This approach must integrate metacognitive strategies, learning technologies, and social and emotional aspects of learning.

This reorientation also requires a paradigm shift from teacher-centered to learner-centered, where students become active agents in the learning process. Thus, deep learning is not only a pedagogical approach, but also a conceptual framework that supports the sustainable development of metacognitive competencies.

METHODOLOGY

This study uses a mixed method approach with a sequential explanatory design, which combines quantitative and qualitative methods sequentially to obtain a comprehensive understanding of the reorientation of deep learning-based instruction in improving students' metacognitive competence. The quantitative approach is used to test the relationship between learning variables and metacognitive competence, while the qualitative approach is used to deepen the interpretation of quantitative results through the exploration of students' learning experiences and teachers' pedagogical practices. This design was chosen because it is able to provide a more holistic picture of complex educational phenomena (Creswell & Creswell, 2021). In addition, a blended approach is considered effective in contemporary educational research involving the integration of technology and cognitive processes (Johnson et al., 2022).

The population in this study is all students in grades VII and VIII in one of the junior high schools who have implemented deep learning-based learning. The sampling technique uses non-probability sampling, specifically purposive sampling, taking into account student involvement in learning that integrates metacognitive strategies. The quantitative sample consisted of 60 students, while the qualitative sample consisted of 12 students, 6 teachers, and 2 supporting informants (vice principal for curriculum and BK teachers). The selection of this sample number is based on the principle of data adequacy and information representation for in-depth analysis (Patton, 2021). The purposive technique is used because it allows researchers to select participants who are relevant to the research objectives.

The data collection technique was carried out through a combination of questionnaires, interviews, observations, and documentation. The questionnaire instrument was developed based on metacognitive competency indicators that include planning, monitoring, and evaluation, adapted from Schraw and Dennison's research and developed in a recent context (Zhang, 2025). The validity test was carried out using confirmatory factor analysis (CFA), while the reliability was tested using Cronbach's alpha coefficient with a value of ≥ 0.70 as a feasibility criterion (Hair et al., 2021). Semi-structured interviews were used to explore students' and teachers' experiences in the application of deep learning, while observations were conducted to identify metacognitive behaviors during the learning process. Documentation in the form of lesson plans, student work results, and school policies is used to strengthen contextual data.

The research procedure is carried out systematically in several stages. The initial stage includes preliminary studies, instrument preparation, and research permit management. The next stage is the collection of quantitative data through the distribution of questionnaires to students, followed by initial analysis to identify patterns of relationships between variables. Furthermore, the qualitative stage is carried out through in-depth interviews and classroom observations to reinforce and explain quantitative findings. The final stage includes data integration, interpretation of results, and preparation of research reports. This procedure follows the principles of mixed research that emphasizes data integration at the interpretation stage (Creswell & Plano Clark, 2021).

Quantitative data analysis techniques were carried out using Structural Equation Modeling (SEM) assisted by SmartPLS 4 software, to test the relationship between deep learning-based instruction variables and students' metacognitive competence. This analysis was chosen because it is able to test structural models simultaneously and complexly (Hair et al., 2021). Meanwhile, qualitative data were analyzed using thematic analysis techniques with the help of NVivo software, through open, axial, and selective coding stages to identify key themes (Braun & Clarke, 2021). The integration of the analysis results was carried out with a triangulation approach to increase the validity and credibility of the research findings.

RESEARCH RESULTS

Implementation Level of Deep Learning-Based Instruction

The results of the descriptive analysis showed that the implementation *of deep learning-based instruction* was in the high category with an average value (mean) of 3.87 on a scale of 5. The dimensions measured include meaningful *learning*, reflective *learning*, and integrative *learning*.

Table 1. Description of Deep Learning-Based Instruction Implementation

Dimensions	Red	Category
Meaningful Learning	3,92	Height
Reflective Learning	3,75	Height
Integrative Learning	3,94	Height
Total Average	3,87	Height

These findings suggest that learning practices have begun to lead to deep understanding, although the reflective dimension is still relatively lower than the other dimensions. This is reinforced by the results of interviews with teachers (G-02, interview March 10, 2025) which stated, "Learning has used a lot of discussions and projects, but not all students are used to deep reflection after learning activities."

Students' Metacognitive Competency Level

Students' metacognitive competence is measured through three main indicators, namely *planning*, monitoring, and *evaluation*. The results showed that metacognitive competence was in the medium to high category with an average score of 3.65.

Table 2. Students' Metacognitive Competencies

Indicator	Mean	Category
Planning	3,70	Height
Monitoring	3,58	Medium
Evaluation	3,66	Medium
Total Average	3,65	Medium–High

The monitoring indicator is the weakest aspect, showing that students still have difficulty in controlling the thinking process during learning. This is in line with the results of the student interview (S-11, interview March 16, 2025) which stated, "I usually only realize that my study method is not right after the assignment is finished, not when I am studying."

The Influence of Deep Learning on Metacognitive Competencies

The results of multiple linear regression analysis showed that *deep learning-based instruction* had a significant influence on students' metacognitive competence.

Table 3. Regression Test Results

Independent Variables	β (Beta)	Sig. (p-value)	Remarks
Meaningful Learning	0,312	0,004	Signifikan
Reflective Learning	0,428	0,000	Signifikan
Integrative Learning	0,287	0,011	Signifikan
$R^2 = 0.62$			Powerful models

The value of the determination coefficient ($R^2 = 0.62$) showed that 62% of the variation in metacognitive competence could be explained by the deep learning-based instruction variable, while the rest were influenced by other factors. The reflective learning dimension has the most dominant influence on students' metacognitive competence. This is supported by the student's statement (S-03, interview March 12, 2025), "I have a better understanding of my own way of thinking after being asked to explain the results of the discussion."

Qualitative Findings: Patterns of Student Metacognition Development

The results of the interviews show that there are several patterns in the development of students' metacognition. Students begin to be able to plan learning strategies, such as setting learning goals before the activity begins. One of the students (S-07, interview March 14, 2025) stated, "Before studying, I usually determine what I want to understand in order to be more focused."

In addition, some students also show the ability to self-reflect after learning, especially through discussion activities and project-based assignments. However, many students still have difficulty monitoring the learning process in real-time, especially when dealing with complex material. From the teacher's side, it was found that the application of deep learning is more focused on discussion activities and projects, but has not explicitly taught metacognitive strategies to students, as expressed by the teacher (G-01, interview March 11, 2025), "We focus more on learning activities, not specifically teaching how students control their way of thinking."

Integration of Technology in Supporting Metacognition

The results of documentation and interviews show that technology has been used in learning, especially through digital platforms and interactive media. The use of this technology has been proven to be able to increase access to information and student involvement in learning. However, its use is still limited to the delivery of material and is not optimal in supporting metacognitive processes such as self-monitoring and self-evaluation.

One student (S-05, interview March 18, 2025) said, "Technology is usually just for finding material or doing assignments, it hasn't helped me evaluate how to learn." In addition, there is no special feature available that can provide metacognitive feedback to students, so the potential of technology in supporting learning reflection has not been utilized to the fullest.

Comparison with Previous Research (Indication of Difference)

The results of this study show that there are several differences compared to previous research. The level of influence *of deep learning* on metacognitive competence in this study was relatively high with an R^2 value of 0.62, which is greater than some previous studies that generally showed a moderate effect. In addition, the reflective *learning* dimension was found to be the most dominant factor, while previous research placed more emphasis on cognitive aspects or general learning strategies. The study also shows that the implementation of *deep learning* has not been fully integrated with metacognitive strategies explicitly, in contrast to the assumptions in some previous studies that assumed that *deep learning* automatically enhances metacognition.

Key Research Findings

Overall, the results of this study show that *deep learning-based instruction* has been implemented at a high level, although there are still weaknesses in the reflective aspect. Students' metacognitive competencies are in the medium to high category, with the main weakness in *the monitoring* aspect. There was a significant and strong influence between *deep learning* and students' metacognitive competence with an R^2 value of 0.62, where *reflective learning* was the most influential factor. In addition, the integration of technology in learning has not fully supported students' metacognitive development. Other findings show that there is a gap between *deep learning* practices and the explicit development of metacognition in learning.

DISCUSSION

The results showed that the implementation of deep learning-based instruction was in the high category and had a significant influence on students' metacognitive competence ($R^2 = 0.62$). These findings reinforce the view of constructivism that places students as active subjects in building knowledge through meaningful learning experiences. Within this framework, deep learning not only encourages conceptual understanding, but also activates the reflective processes that are at the core of metacognition. In line with that, Chen et al. (2025) stated that deep learning contributes significantly to the development of students' thinking awareness and self-regulation because it involves the process of elaboration, concept connection, and continuous reflection.

The dominance of the reflective learning dimension as the most influential factor on metacognitive competence shows that reflection is a key component in the development of metacognition. These findings are in line with the metacognition theory put forward by Flavell and are reinforced by recent research that confirms that self-reflection allows students to evaluate learning strategies and increase their effectiveness (Zhang, 2025). Thus, learning that provides space for reflection, such as critical discussion and project-based learning, has great potential in improving students' metacognitive quality. However, the low score on the monitoring indicator shows that the ability to control the thought process in real-time is still a challenge, which was also found in the study by An et al. (2024) that monitoring is the most difficult aspect of metacognition to develop in the context of formal learning.

Although the implementation of deep learning is relatively high, the results of the study reveal a gap between learning practices and explicit metacognition development. This shows that deep learning has not been fully oriented as a strategy to build students' thinking awareness. These findings differ from assumptions in some previous studies that stated that deep learning automatically improves metacognition. Pacheco et al. (2025) assert that without structured pedagogical interventions, modern learning technologies and approaches do not necessarily have a significant impact on metacognition. Thus, a reorientation of learning is needed that explicitly integrates metacognitive strategies such as.

Another factor that affects the results of the research is the integration of technology in learning. Although technology has been proven to increase student engagement, the results of the study show that its use is still limited to the delivery of material and is not optimal in supporting metacognitive processes. This is in line with the findings of Romdhoni et al. (2025) who stated that most educational technology implementations still focus on cognitive aspects and have not touched the reflective dimension in depth. On the other hand, if used appropriately, technologies such as learning analytics and AI can act as a reflection tool that helps students understand the learning process more deeply.

From the perspective of scientific contribution, this research strengthens the integration of deep learning concepts and metacognition in a more comprehensive learning framework. This study also expands on previous studies by showing that the reflective dimension has a more dominant role than other dimensions in improving metacognition. Practically, these findings imply that teachers need to design learning that is not only oriented to material comprehension, but also to the development of students' learning awareness through reflective and regulative activities.

However, this study has some limitations. First, the relatively limited number of samples and the use of purposive sampling techniques can limit the generalization of research results. Second, the use of questionnaire instruments has the potential to cause subjective bias because it depends on students' perceptions. Third, this study has not fully explored other variables that can affect metacognition, such as learning motivation and self-efficacy. This limitation was also found in the study of Prihandoko et al. (2024) which showed that affective factors have an important role in mediating metacognition.

Based on these limitations, further research is recommended to use longitudinal design to look more deeply at the development of students' metacognition over time. In addition, the integration of experimental methods can be used to test the effectiveness of deep learning-based learning models in a more controlled manner. Further research also needs to develop more comprehensive instruments, including the use of learning analytics to objectively measure metacognition. Thus, future research development is expected to be able to make a broader contribution to improving the quality of learning in the digital era.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that deep learning-based instruction applied through a mixed method (sequential explanatory) approach is proven to have a significant influence on improving students' metacognitive competence, as shown by the results of quantitative analysis ($R^2 = 0.62$) which is strengthened by qualitative findings that the reflective learning dimension is the dominant factor in encouraging learning planning, monitoring, and evaluation skills. However, there is still a gap between the implementation of deep learning and the development of metacognitive strategies explicitly, especially in the aspect of monitoring and the use of technology that is not optimal as a means of reflection. Therefore, it is recommended that educators explicitly integrate metacognitive strategies, such as structured reflection and self-monitoring, as well as optimize technology as a tool to support reflective processes. In addition, further research needs to use longitudinal or experimental designs with a wider sample coverage and consider other variables such as motivation and self-efficacy to gain a more comprehensive understanding.

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