

GEOGRAPHY TEACHERS' UNDERSTANDING OF DEEP LEARNING PEDAGOGY IN THE MERDEKA BELAJAR CURRICULUM: A STUDY OF SENIOR HIGH SCHOOLS IN SURAKARTA

Gentur Adi Tjahjono*, Chatarina Muryani, Singgih Prihadi, Albertus Erico Jerry Krisna Nugroho,
Fitria Dewi Kartika
Geography Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret,
Surakarta, Indonesia
*E-mail: genturadi@staff.uns.ac.id

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ABSTRACT

There is still a gap between the implementation of deep learning pedagogy in the Independent Curriculum and the pedagogical readiness of geography teachers in Surakarta City. This study examines geography teachers' understanding of the deep learning approach within the implementation of the Merdeka Curriculum in Indonesian senior high schools. Deep learning is emphasised in the curriculum to promote meaningful, reflective, and critical learning; however, limited evidence exists regarding teachers' pedagogical readiness. Using a mixed-methods embedded design, data were collected from 25 geography teachers in Surakarta City through questionnaires and focus group discussions. The study focused on four indicators: knowledge of deep learning concepts, implementation in classroom practice, perceptions of effectiveness, and professional development needs. The results indicate that 64% of teachers demonstrated a moderate understanding of deep learning, 24% showed high understanding, and 12% had low levels. While most teachers acknowledged the importance of deep learning and displayed enthusiasm, they faced challenges related to conceptual clarity, consistency in instructional practice, and limited institutional support. These findings suggest a gap between theoretical knowledge and actual implementation in geography education. The study underscores the need for structured professional development, collaborative learning communities, and contextual instructional design to enhance teacher capacity. This research contributes to the international discourse on curriculum reform by mapping teacher readiness and highlighting practical challenges in applying deep learning pedagogy within the Indonesian context.

Keywords: *deep learning; geography education; merdeka belajar curriculum; senior high school; teacher understanding*

INTRODUCTION

21st-century skills are essential due to globalisation, the digital technology revolution, and multidimensional crises such as environmental, social,

humanitarian, and educational crises. This phenomenon poses a significant challenge for the world of education to prepare a generation that is not only



excellent but also able to adapt and contribute actively to a complex global society (Malik, 2018). Therefore, education is required not only to teach knowledge, but also to develop thinking and acting capacities that are relevant to morality in accordance with future needs. One global response to this challenge is to strengthen 21st-century skills among students. These skills include critical thinking, creativity, collaboration, and communication (4C) (Thornhill-Miller et al., 2023). According to Hastuti et al (2022), with the development of global dynamics, 21st-century skills have also developed and adapted, giving rise to aspects of character and citizenship in the face of the digital industrial revolution. This is in line with the opinion of Tohani & Aulia (2022), that 21st-century skills are seen as an important foundation in responding to the increasingly dynamic needs of the world of work and social life. Indonesia, which implements 4C-based learning, has also shown positive results in improving the quality of the learning process and outcomes of students.

Kim et al (2019) argue that various efforts to instil 21st-century skills in students also require a transformation in

pedagogical approaches and curriculum design that is more flexible, adaptive, and transformative. This is reinforced by González-pérez & Ramírez-montoya (2022), who state that the development of education 4.0 is directing education towards technology integration, personalised learning, and curriculum flexibility. This is also in line with the findings of Meyer & Norman (2020), that educational development requires teachers to not only act as conveyors of material, but also as facilitators in creating a collaborative, reflective, and contextual learning environment. This paradigm shift also reflects the importance of strengthening digital competencies and the use of educational technology by teachers to develop competitive and superior learners (Liesa-Orús et al., 2020). Therefore, teachers as educators in the 21st Century must have a deep understanding of new learning approaches that can comprehensively address the needs of students.

One example is geography, where 21st-century skills are highly relevant because the subject focuses on spatial understanding, interregional relationships, global environmental issues, and disasters. Geography has excellent potential in shaping critical



awareness of issues of sustainability, disasters, and social change (Biddulph et al., 2020). Through a good understanding of geography education, students can develop spatial thinking, literacy, environmental awareness, and responsible decision-making skills (Wilmot et al., 2025). In practice, a learning approach that emphasises the development of 21st-century skills in geography learning has been proven to improve student learning outcomes significantly (Miyatun et al., 2021). In addition, innovative learning models such as LIGEKA_21 also encourage student engagement in active and collaborative learning (Sugiyanto et al., 2023). A recent bibliometric study by Nugroho et al (2025) shows a global trend toward innovation in geography learning that emphasises contextual and reflective approaches in supporting 21st-century skills. Furthermore, this research highlights the importance of aligning the curriculum, learning methods, and teacher readiness in integrating higher-order thinking skills (HOTS) in geography learning in secondary schools. This shows that the transformation of geography learning needs to be directed towards strengthening learning approaches that

are in-depth, contextual, and relevant to the real world.

The history of education in Indonesia shows that the curriculum has undergone dynamic developments since independence began, starting with the 1947 Curriculum to the Merdeka Belajar Curriculum, which has been implemented gradually since 2021 as a government effort to respond to global dynamics and address the needs of developing students' potential (Insani, 2019). The Merdeka Belajar Curriculum is a form of comprehensive reform after the COVID-19 pandemic that emphasises freedom of learning, differentiation, and character development through the Pancasila student profile project (Simarmata & Mayuni, 2023). The implementation of the Merdeka Curriculum in Indonesia has become one of the major agendas in post-pandemic education reform. This curriculum is designed to provide flexibility, differentiation, and emphasise meaningful learning oriented towards the development of the Pancasila student profile. In line with this, Nugroho et al (2025b) show that the implementation of the Merdeka Curriculum has had a positive impact on improving the quality of education at the senior high school



level, especially in terms of more contextual learning, strengthening 21st-century skills, and developing student character. However, the study also highlights implementation challenges, such as teacher readiness, availability of teaching tools, and the need for ongoing institutional support. These findings reinforce the urgency to further examine how teachers, especially geography teachers, understand the deep learning approach as one of the core elements of the Merdeka Belajar Curriculum. In the context of geography education, the implementation of the Merdeka Belajar Curriculum provides a great opportunity for the integration of local, national, and global issues that are contextual to the lives of students. A recent study by Desfandi et al (2025), in secondary schools in Banda Aceh showed that although teachers conceptually understand the importance of contextual and project-based learning, in practice many teachers are still not implementing geography learning in accordance with the Merdeka Curriculum. Therefore, strengthening teacher competencies through continuous training, learning community collaboration, and the development of teaching tools based on a deep learning approach is very

important. Successful implementation of the Merdeka Curriculum in geography requires teachers who not only understand the content but are also able to design learning experiences that encourage exploration, reflection, and active student engagement in understanding space and place.

Surakarta is one of the cities in Central Java that has implemented the Merdeka Belajar Curriculum in all senior high schools since 2021. The city has nine public senior high schools and 36 private senior high schools with relatively strong educational performance and an active professional teacher community. Most senior high schools in Surakarta have been categorised as pioneers in curriculum reform by local education authorities as driving schools and driving teachers. This situation makes Surakarta a relevant context for examining teacher readiness, particularly in implementing deep learning in geography teaching.

Deep learning approaches emerged as a response to the weaknesses of surface learning, which tends to be oriented towards memorisation and the fulfilment of low cognitive standards. Deep learning emphasises meaningful, reflective, and contextual learning processes, with the aim of developing



learners who are able to understand concepts deeply, connect knowledge across disciplines, and develop critical thinking and problem-solving skills (Fullan et al., 2017). In Indonesia, the values of deep learning are actually in line with Ki Hajar Dewantara's educational philosophy, which emphasises among, *asah*, *asih*, and *asuh*. In this view, learning not only sharpens the intellect but also shapes the personality and social wisdom of students (Dwipratama, 2023). Therefore, the application of a deep learning approach is not merely the adoption of external concepts, but rather the strengthening of the roots of national education that is humanistic and contextual.

Although the Merdeka Curriculum encourages the transformation of learning towards a more reflective and contextual approach, the reality in the field shows that the implementation of the deep learning approach has not been fully understood and applied by some teachers. A literature review shows that teachers still face challenges in understanding the pedagogical principles of deep learning, especially in distinguishing between deep learning and ordinary project-based approaches

or mere technology integration (Fitriani & Santiani, 2025). In this context, empirical problems that arise include teachers' limitations in designing learning processes that encourage the exploration of ideas, deep reflection, and the development of critical thinking and complex problem-solving skills (Hayati & Almuslim, 2025). Many teachers still focus on achieving conventional academic results, while deep learning emphasises reflective, meaningful, and future-oriented thinking processes (Cahyani, 2025). The gap in understanding is also evident in the tendency of some teachers to interpret deep learning as the use of artificial intelligence-based technology or digital applications alone.

In contrast, in the context of education, this approach emphasises holistic learning transformation (Hastuti et al., 2022). In fact, as a pedagogical approach, deep learning encompasses conceptual, affective, and social dimensions that are integrated in the learning process (Suwandi et al., 2024). The results of research by Hendrawan et al (2025) show that teachers at the elementary school level also face similar challenges, especially in adjusting learning strategies to the demands of the



Merdeka Curriculum, which emphasises flexibility, meaningfulness, and student independence in learning. If these challenges occur in primary education, then at the secondary level, such as high school, the complexity is expected to be higher due to more abstract material and a more complex learning context.

In addition, deep learning-based learning innovations have not been empirically studied in geography subjects. In fact, geography as an integrative science has great potential to be developed through a deep learning approach, especially in fostering spatial awareness, systemic thinking, and the ability to synthesise social and environmental phenomena (Nurhakim et al., 2025). Although previous studies have explored deep learning in various educational settings in Indonesia, they remain limited in several key aspects. Research by Rahayu et al. (2025) and Suwandi et al. (2024) mostly discusses deep learning at a conceptual level and focuses on general education, mathematics, or social studies rather than geography, leaving subject-specific pedagogical implications underexplored. Empirical studies conducted by Subiyantoro et al. (2024) and Fatmawati (2025) concentrate on primary and high schools, showing that

teachers still face conceptual confusion and a lack of institutional support, yet these findings do not reflect the pedagogical context of senior high school geography teachers operating under the Merdeka Belajar Curriculum. Moreover, existing research does not address urban educational ecosystems such as Surakarta, a city actively implementing curriculum reforms and possessing diverse school characteristics. These gaps indicate the absence of studies that specifically analyse geography teachers' understanding of deep learning in the context of the Merdeka Curriculum at the senior high school level, particularly in Surakarta, where curriculum innovation has progressed rapidly. This study aims to fill these gaps by providing an empirical analysis of teachers' conceptual, practical, and perceptual understanding of deep learning within geography education in Surakarta.

Studies that specifically analyse geography teachers' understanding of this approach in the context of the Merdeka Curriculum are still minimal. These issues indicate a knowledge gap, both theoretically and practically, regarding how teachers understand and implement deep learning in the learning



process, especially in geography subjects at the high school level. Therefore, this research is important to critically analyse how geography teachers understand, interpret, and try to implement deep learning approaches in the context of the Merdeka Curriculum. This study also aims to analyse the extent of geography teachers' understanding in applying deep learning in geography learning in Surakarta City, as a representative region that has actively implemented the Merdeka Curriculum. The results of this study are expected not only to fill the gap in the literature on curriculum implementation in the context of deep learning approaches, but also to provide practical contributions for further research related to improving the quality of teacher training, developing teaching tools, and developing education policies based on reflective and deep approaches, as well as research on the evaluation of deep learning approaches in geography learning and their implementation strategies.

MATERIALS AND METHODS

This study uses a mixed-method embedded model approach, through which the researcher combines quantitative and qualitative data

simultaneously but with a dominance of the qualitative approach (Creswell, 2017). This research design was used to obtain a comprehensive understanding of the extent to which geography teachers understand the deep learning approach in the implementation of the Merdeka Belajar Curriculum in accordance with the objectives of this study. The mixed method approach is considered adequate in the context of exploring information in the form of measurements because it can capture both the numerical aspects and the meaning behind the available data (Adnan & Latief, 2020). In addition, this research is descriptive in nature, focusing on interpreting and exploring geography teachers' understanding of the concept of deep learning approaches and their application in the Merdeka Belajar Curriculum.

The population in this study was all high school geography teachers in Surakarta City who had implemented the Merdeka Belajar Curriculum. The sampling technique used was purposive sampling, which is the selection of informants based on specific criteria in order to obtain information that is relevant and in-depth to the research needs (Etikan et al., 2016). The inclusion criteria were as follows: 1) being a geography teacher



actively teaching in Phase E and/or Phase F; 2) having at least 3 years of teaching experience; 3) the school having implemented the Merdeka Belajar Curriculum for at least 3 years; 4) being willing to be a respondent and willing to participate in discussions. Based on these criteria, 25 high school geography teachers in Surakarta City became research respondents. Purposive sampling was applied not only to select participants who met the inclusion criteria, but also to ensure that the characteristics of the teachers were in line with the objectives of this study. Teachers in Phases E and F were selected because these phases emphasise high-level cognitive competencies relevant to the deep learning approach. A minimum of three years of teaching experience was required to ensure sufficient pedagogical maturity, while schools that had implemented the Merdeka Belajar Curriculum for at least three years were selected to ensure institutional readiness. These considerations strengthened the relevance of the sample in analysing teachers' understanding of deep learning. The questionnaire was used to measure geography teachers' understanding of the

deep learning approach. **Table 1** presents the research questionnaire indicators to provide results on the extent of geography teachers' understanding of the in-depth learning approach in the implementation of the Merdeka Belajar Curriculum. **Table 2** presents the 4-point Likert scale options used in this study, which are adapted to the context of the implementation of the Merdeka Belajar Curriculum in geography learning in senior high schools.

Focus Group Discussion (FGD) is used to explore in depth the meaning, perceptions, understanding, and experiences of teachers related to geography learning and the implementation plan for the deep learning approach. Focus Group Discussions are guided by semi-structured guidelines based on questionnaire themes and the principles of in-depth learning approaches in the context of the Merdeka curriculum. Focus Group Discussions are important because they enable the collection of comprehensive data from informants in a short period of time and focus on problems and their solutions in an open manner (Sim & Waterfield, 2019).



Table 1. Research Instrument Indicators

Indicator	Focus	Number of Items
Knowledge of Deep Learning Concepts in Education	Exploring the theory and principles of deep learning	8
Implementation in Geography Learning	Exploring concrete plans for implementing deep learning approaches in the planning, implementation, and evaluation of geography learning	8
Perceptions of the Effectiveness of Deep Learning Approaches	Assessing teachers' views on the benefits, effectiveness, and positive impact of deep learning on students and the learning process	10
The Need for Teacher Professional Development	Exploring teachers' needs to support the successful implementation of deep learning through training, system support, and learning resources	7
Total items		33

Source: (Fullan et al., 2017), with modification

Table 2. Likert Scale Points

Scale	Categories
1	Strongly disagree
2	Disagree
3	Agree
4	Strongly Agree

Source: (South et al., 2022), with modification

Quantitative data from the questionnaire were analysed descriptively statistically by calculating each aspect of the indicators, including scores, averages, and categorisations, to draw comprehensive conclusions about the categorisation of understanding results.

Equation 1 shows how the researcher calculated the categorisation of the indicators used to provide measurable and accurate results. This makes it possible to determine the class interval formula for the categorisation of each indicator to the categorisation of conclusions based on the instrument developed (see **Table 3**).

$$S = \frac{\sqrt{\sum_{i=1}^n (Xi - \bar{x})^2}}{n - 1} \quad (1)$$

Source: (Lee et al., 2015)

Description:

S = standard deviation

Xi = median

\bar{x} = average value

n = amount of data

Qualitative data from the FGD were analysed using a thematic analysis approach in line with the main themes of deep learning and teacher competence in the Merdeka Belajar Curriculum. Before these themes were grouped, the data were first reduced, presented, and conclusions were drawn to classify and



group the data appropriately (Miles et al., 2014).

This study maintains data validity through method triangulation, namely comparing questionnaire and FGD results to strengthen findings (Achjar et al., 2023). In addition, the validation process was carried out through expert judgment on the questionnaire

instrument and member checking on the FGD data to ensure the accuracy of the researcher's interpretation of the informants' statements (Ingram et al., 2023). All participants were informed of the research objectives, and their privacy and confidentiality were guaranteed to maintain the integrity of the research ethics.

Table 3. Interval Class

Score	Categories
$X < M - 1SD$	Low
$M - 1SD \leq X < M + 1SD$	Medium
$X > M + 1SD$	High

Source: (Lee et al., 2015), with modification

RESULTS AND DISCUSSION

This study has found the results of geography teachers' understanding of applying deep learning in geography education in Surakarta City through each indicator on knowledge of the concept of deep learning in education, implementation in geography education, perceptions of the effectiveness of deep learning, and the need for professional development. Data analysis was conducted based on the results of questionnaires completed by 25 geography teachers who were selected based on inclusion criteria set by the researcher. In addition, the quantitative results were enriched with qualitative

analysis from Focus Group Discussions (FGD), which provided a deeper understanding of teachers' experiences and perceptions in learning practices.

1. Knowledge of the Concept of Deep Learning Approach in Education

Based on **Table 4**, which presents the criteria for category one indicators, namely, knowledge of the concept of deep learning approaches in education. Based on this table, the researcher was able to identify the frequency of respondents at the low level as four respondents, the medium category as 19 respondents, and the high category as two respondents.



Table 4. Class Interval Indicator 1

Score	Categories	Frequency
$X < 23.4$	Low	4
$23.4 \leq X < 29$	Medium	19
$X > 29$	High	2

Source: Research, 2025

Based on the calculations and classifications presented in **Table 4**, the frequency can be illustrated. **Figure 1** presents the results of the frequency distribution percentage of categories in indicator 1, namely knowledge of the concept of deep learning in education. A total of 16% of respondents were in the low category, indicating that some geography teachers still do not fully understand the concept of deep learning approaches in education, especially in the question item on teachers' ability to identify holistic learning (thinking, feeling, heart, and physical activity). Teachers tend not to fully understand how they can identify this in geography learning. The moderate category results were 76%, which was the highest in indicator 1. This indicates that the majority of geography teachers in Surakarta City high schools have understood indicator 1, namely, knowledge of the concept of deep learning approaches in education. In general, geography teachers at senior high schools in Surakarta City can identify and explain the concepts of

mindful, joyful, and meaningful learning in the deep learning approach, so teachers have no difficulty implementing it in their teaching. There are geography teachers who have a high understanding of indicator 1, knowledge of the concept of deep learning approaches in education, amounting to 8% of respondents. This is because some teachers have attended seminars, training sessions, and workshops related to the Merdeka Belajar Curriculum and deep learning approaches. Therefore, teachers are already familiar with the concept of deep learning approaches to be implemented in geography learning. The results of the analysis of the first indicator in **Table 4** and **Figure 1** show that most teachers, namely 19 out of 30 respondents (76%), are in the moderate category in terms of their understanding of deep learning concepts. This percentage indicates that although the majority of teachers are familiar with the term deep learning in the context of the Merdeka Curriculum, their understanding of the core principles of this approach is not yet fully deep or



systematic. This finding indicates that teachers tend to understand deep learning as an approach that supports the reinforcement of material or learning outcomes, but do not yet fully see it as a transformative educational process that emphasises active student involvement, learning principles (joyful, meaningful, and mindful), critical reflection, and knowledge transfer in real-life contexts. This is in line with the findings of (Prasetyo & Santos, 2025), which explain that teachers' perceptions of deep learning are still dominated by technical interpretations rather than philosophical

understanding, so they have not yet connected the concepts as a whole. Furthermore, the concept of deep learning is also closely related to Ki Hajar Dewantara's educational philosophy and the principles of Understanding by Design, where teachers act as facilitators in building concepts and students' understanding in a holistic, progressive, and comprehensive manner (Namus et al., 2024). However, in reality, this approach still requires adjustments from teachers and reflective biases that must be developed.

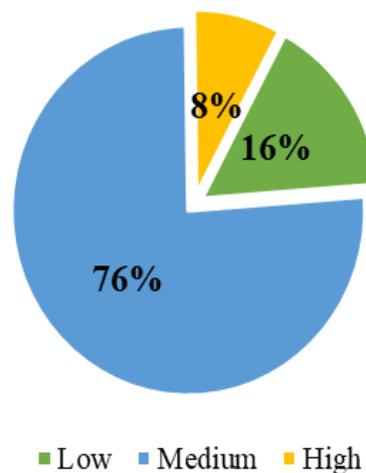


Figure 1. Percentage of Indicator 1

Source: Research, 2025

Although the deep learning approach has only recently been launched by the Ministry of Primary and Secondary Education of the Republic of Indonesia, it is designed as an adaptive,

differentiated learning transformation with a dimension of globally competitive and responsible graduate profiles (Mu'ti et al., 2025). In some regions, teachers enthusiastically welcomed the deep

learning approach with activities that supported their understanding. As shown in studies by Setiawati et al (2025) and Jafar et al (2025), teaching module workshops showed that teachers' understanding could increase significantly after being facilitated with concrete examples, training, technical guidance, and the use of technology. This shows the importance of structured professional development support. Recent studies by Nuriah et al (2025) and Andrisyah et al (2025) add that a deep understanding of the concept of deep learning will be maximised if teachers are involved in a community of practice or long-term training that is measurable and supervised by the relevant agency. This will maximise teachers' contribution to shaping the graduate profile in line with the deep learning approach. Thus, the moderate category for this indicator confirms that

there is still a gap between conceptual knowledge and actual pedagogical mastery of deep learning. Therefore, intervention strategies such as pedagogical mentoring, learning design training, and strengthening curriculum literacy are needed so that geography teachers are able to implement this approach comprehensively and contextually.

2. Implementation in Geography Learning

Based on **Table 5**, which presents the criteria for category two indicators, namely Implementation in Geography Learning. Based on this table, the researcher was able to identify the frequency of respondents at the low level as five respondents, the medium category as 15 respondents, and the high category as five respondents.

Table 5. Class Interval Indicator 3

Score	Categories	Frequency
$X < 21.7$	Low	5
$21.7 \leq X < 26.5$	Medium	15
$X > 26.5$	High	5

Source: Research, 2025

Based on **Table 5**, we can see the frequency of implementation indicators in geography learning, which provides an overview of schools that implement according to their frequency categories.

Figure 2 presents the percentage distribution of categories in indicator 2, namely Implementation in Geography Learning. A total of 20% of respondents were in the low category, indicating that



some geography teachers still do not fully understand Implementation in Geography Learning, especially in the item where teachers evaluate students' understanding based on their ability to analyse and synthesise information. Teachers tend not to fully understand how they can identify this in geography learning. The moderate category results amounted to 60%, which was the highest for indicator 2. This indicates that the majority of geography teachers in Surakarta City high schools have understood indicator 2, namely Implementation in Geography Learning.

In general, geography teachers in Surakarta City high schools can frequently use learning methods that encourage students to think critically and reflectively, so that teachers do not have difficulty implementing them in learning. There are geography teachers who have a high understanding of indicator 2, Implementation in Geography Learning, amounting to 20% of respondents. This is because some of them have often carried out reflective, project-based, and differentiated learning, so they are quite familiar with its application in geography learning.

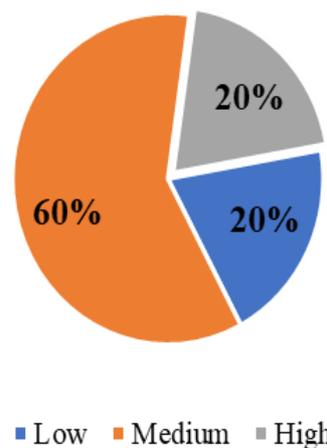


Figure 2. Percentage of Indicator 2

Source: Research, 2025

The results of the analysis of the second indicator show that 15 of the 25 respondents were in the moderate category, or 60%, in terms of implementing the deep learning

approach in geography learning. With an average percentage of 60%, this finding illustrates that most teachers have not fully integrated deep learning principles into their daily teaching practices,

especially in the context of the Merdeka Belajar Curriculum. This moderate category indicates that the application of deep learning principles, such as reflective, collaborative, and contextual learning, has not been carried out consistently and comprehensively. Teachers still predominantly use conventional methods, focusing on achieving material targets and cognitive-based assessment, rather than on the process of forming deep understanding and 21st-century skills. This is in line with the findings of Bawamenewi & Yenny (2025), who stated that not many geography teachers in Medan City have designed problem-based and spatially contextualised learning as mandated in the Merdeka Belajar Curriculum.

Meanwhile, a study by Desfandi et al (2025) in Banda Aceh shows that the implementation of deep learning in the Merdeka Curriculum still faces challenges in the form of limited learning resources, a lack of practical training, and the absence of a reflective culture in teaching. Teachers tend to understand the concept of the Merdeka Curriculum normatively, but have not been able to transform this approach into active and collaborative Geography teaching strategies. In a bibliometric

review by Nugroho et al (2025a), it is mentioned that although there is a positive trend in the literature on the integration of deep learning in geography education, practice in the field is still lagging. This is due to the lack of geography learning models that are explicitly designed with a deep approach based on local contexts and global issues, such as the environment, disasters, or spatial changes. One of the keys to the successful implementation of the Merdeka Curriculum in Geography is through flexible yet competency-based learning planning design. However, in reality, many teachers are not yet accustomed to formulating operational learning objectives that lead to higher-order thinking and personal reflection among students (Soekamto & Handoyo, 2022).

The study by Arinto et al (2025) emphasises the importance of diagnostic assessment in supporting deep learning, so that teachers can understand students' initial readiness and learning styles before determining differentiation strategies. Unfortunately, the FGD results also show that formative and reflective assessments have not been fully integrated into teachers' practices in the process of evaluating students'



understanding based on their abilities. In the context of innovation, Putra et al (2024) and Putra et al (2023) provide examples of digital-based instructional design, microlearning, and virtual reality being utilised to increase student engagement and learning experiences in geography. However, not all teachers have the technological competence or adequate infrastructure access to implement similar approaches.

Another study by Mahaswa et al (2024) proposes the importance of a geophilosophical approach in the Merdeka Curriculum to shape students' ecological awareness. However, without in-depth understanding and training, this kind of pedagogical transformation will be difficult for teachers to carry out independently. Thus, the moderate score for this indicator reinforces that although

the spirit of curriculum reform has reached the educational unit level, its implementation in Geography learning still requires strengthening teacher capacity, revising learning designs, and accessing contextual, practical, and technology-based learning practices.

3. Perceptions of the Effectiveness of Deep Learning Approaches

Based on **Table 6**, which presents the criteria for category three indicators, namely knowledge of the concept of Perceptions of the Effectiveness of Deep Learning Approaches. Based on this table, the researcher was able to identify the frequency of respondents at the low level as four respondents, the medium category as 15 respondents, and the high category as six respondents.

Table 6. Class Interval Indicator 3

Score	Categories	Frequency
$X < 31.6$	Low	4
$31.6 \leq X < 38.5$	Medium	15
$X > 38.5$	High	6

Source: Research, 2025

Figure 3 presents the results of the frequency distribution percentage of categories in indicator 3, namely, knowledge of the concept of Perception of the Effectiveness of Deep Learning Approaches. A total of 16% of respondents were in the low category,

indicating that some geography teachers still did not fully understand the concept of Perception of the Effectiveness of Deep Learning Approaches, especially as teachers tended to equate deep learning with machine learning. The contexts of deep learning and machine



learning are very different, so teachers assumed that deep learning was related to coding and artificial intelligence. The moderate category resulted in 60%, which was the highest in indicator 3, indicating that the majority of geography teachers in Surakarta City high schools have understood indicator 3, namely knowledge of the concept of Perception of the Effectiveness of Deep Learning Approaches. In general, geography teachers in Surakarta City high schools can use the concept of deep learning

approaches, but only understand it after the academic paper on deep learning was launched. There are geography teachers who have a high understanding of indicator 3, knowledge of the concept of Perception of the Effectiveness of Deep Learning Approaches, amounting to 24% of respondents. This is because some of them have often applied comprehensive, broad, and global learning, differentiated, contextual learning, but only understood the term that it was deep learning.

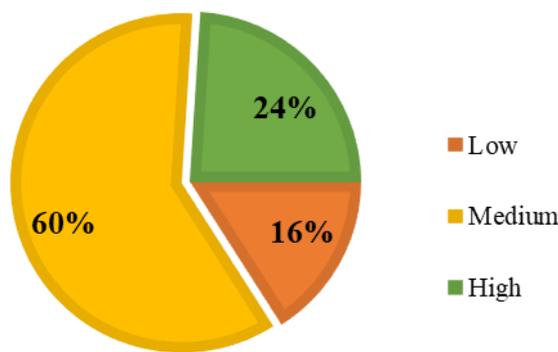


Figure 3. Percentage of Indicator 3

Source: Research, 2025

There is not much literature that discusses explicitly the effectiveness of the deep learning approach in the context of learning in Indonesia, especially in Geography subjects at the high school level. Therefore, the results of this study provide an important initial contribution in describing how teachers view the effectiveness of this approach in

promoting profound and transformative student competency achievement. Based on the questionnaire results, 15 of the 25 respondents (60%) showed a moderate perception of the effectiveness of deep learning. This shows that although some teachers are beginning to recognise the potential of deep learning in improving the quality of the learning process and



outcomes, they are not yet fully convinced that this approach can work optimally in their classrooms. This doubt may arise due to technical challenges, resource limitations, and limited direct implementation experience.

The results of a study by Mea et al (2024) state that teachers' perceptions of learning effectiveness are primarily determined by their ability to create dynamic, innovative, and conducive classrooms for student engagement. Teacher readiness greatly determines the learning process. If teachers are not yet fully capable of developing pedagogical creativity and strategic flexibility, the effectiveness of the deep learning approach tends to be low even if the concept is understood in theory. In addition, a study by Katrina et al (2025) shows that the use of a deep learning approach with the help of Desmos-based interactive e-modules can significantly improve students' understanding of mathematical concepts. This reinforces the view that the effectiveness of deep learning is highly dependent on the integration of media, digital tools, and participatory strategies designed according to the learning context.

In the context of differentiated curricula, Tulak et al (2024) emphasise that

teachers' perceptions of the effectiveness of new approaches will increase as their pedagogical competencies improve, especially in responding to the diverse learning needs of students. Therefore, if teachers are not yet trained to manage differentiated classrooms effectively, the deep learning approach will be considered impractical or inefficient. Furthermore, Mustaghfirin & Zaman (2025) underline that deep learning is actually an approach that is in line with Islamic educational values that emphasise character building, self-reflection, and deep understanding of knowledge. However, to make this approach effective, there needs to be continuity between the curriculum vision, learning strategies, and school culture that supports the exploration of ideas and open dialogue in the classroom. These findings indicate that although teachers are beginning to accept the idea that deep learning has the potential to improve overall learning outcomes, both in terms of cognitive and affective aspects as well as higher-order thinking skills, its implementation is not yet convincing from a practical and managerial point of view. Training, examples of good practice, and a school support system are needed for this



positive perception to develop into internalized pedagogical beliefs and skills in learning practices.

4. The Need for Teacher Professional Development

Based on **Table 7**, which presents the criteria for category four indicators,

Table 7. Class Interval Indicator 4

Score	Categories	Frequency
$X < 23.1$	Low	7
$23.1 \leq X < 38.0$	Medium	18
$X > 38.0$	High	0

Source: Research, 2025

Figure 4 presents the results of the frequency distribution percentage for indicator 4, namely Teacher Professional Development Needs. A total of 28% of respondents were in the low category, indicating that some geography teachers still do not fully understand Teacher Professional Development Needs, especially in terms of being creative and innovative in developing in-depth learning in geography lessons. This condition is due to limited learning resources, school infrastructure, mastery of technology, and budget constraints. The moderate category results amounted to 72%, which was the highest in indicator 4. This indicates that the majority of geography teachers in Surakarta City high schools have

namely Teacher Professional Development Needs. Based on this table, the researcher was able to identify the frequency of respondents at the low level as seven respondents, the medium category as 18 respondents, and no respondents in the high category.

understood indicator 4, namely, knowledge about the concept of Teacher Professional Development Needs. In general, geography teachers in Surakarta City high schools strive to provide creative, innovative, and differentiated learning in accordance with the in-depth learning approach. Although the implementation is not 100% successful, the teachers are committed to providing adaptive learning to support the graduate profile dimensions. There were no respondents in the high category for this indicator, as the majority of teachers still experience confusion and have needs related to professional development, especially in the context of deep learning.



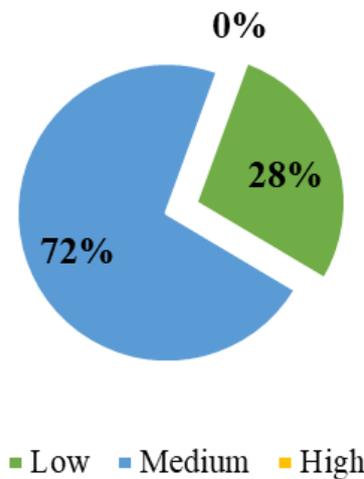


Figure 4. Percentage of Indicator 4

Source: Research, 2025

Based on **Figure 4**, the results show that 18 out of 25 respondents (72%) rated the need for teacher professional development as moderate, indicating that most teachers recognise the importance of improving their professional and pedagogical competencies, particularly in implementing deep learning in the Merdeka Curriculum. However, this need has not been fully addressed through systematic and sustainable training programs or institutional support. These findings emphasise the importance of continuous professional development. Research by Kusumawati & Umam (2025) states that the successful implementation of the Merdeka Curriculum is primarily determined by teachers' competence in leading transformative learning that is

oriented towards the needs of students. Without specific competency strengthening, teachers tend to revert to traditional approaches even though the curriculum has changed.

This perspective is also in line with the study by Kumayas et al (2025), which found a gap between curriculum policy and classroom reality, where teachers often feel inadequately prepared to adopt new approaches such as deep learning due to limited training, learning resources, and reflective space. Teachers feel burdened by curriculum demands but are not always equipped with practical strategies to implement them. Another opinion by Umar et al (2023) reveals that strengthening pedagogical and professional competencies has a significant correlation with the

successful implementation of the Merdeka Curriculum. In this case, professional development needs to not only cover methodological aspects but also an understanding of curriculum philosophy, authentic assessment planning, and the ability to reflect on learning practices. Teaching tool development assistance programs, such as those developed by Nadya et al (2023), have been proven to improve teachers' readiness in developing teaching modules based on the principles of deep learning and differentiation. Unfortunately, however, this type of training has not reached all teachers equally, including high school geography teachers.

The study by Purwati & Sukirman (2024) also emphasises that the development of teacher competencies in the context of the Merdeka Curriculum needs to refer to a training model that is needs-based, collaborative, and encourages reflective learning. This includes training in integrating the deep learning approach with local wisdom, the use of technology, and contemporary spatial issues in geography learning. Thus, the high percentage of respondents

in the moderate category for this indicator reflects teachers' collective awareness of the need for professional development, but also indicates a lack of access to competency improvement programs that meet the demands of the Merdeka Curriculum and deep learning approaches. Therefore, collaborative strategies between schools, adaptive policy support, and learning community facilitation need to be strengthened to bridge the gap between teachers' needs and available professional development resources.

5. Geography Teachers' Understanding of Applying Deep Learning in Geography Education in Surakarta City

Based on **Table 8**, which presents the criteria for the category intervals of Geography Teachers' Understanding in Implementing Deep Learning in Geography Education in Surakarta City. Based on this table, the researcher was able to identify the frequency of respondents at the low level, which was three respondents, the medium category, which was 16 respondents, and the high category, which was six respondents.



Table 8. Class Interval all Indicators

Score	Categories	Frequency
$X < 69.9$	Low	3
$61.9 \leq X < 81.8$	Medium	16
$X > 81.8$	High	6

Source: Research, 2025

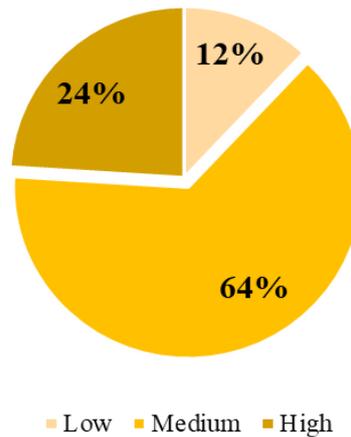


Figure 5. Percentage of Geography Teachers' Understanding of Implementing Deep Learning in Surakarta City

Source: Research, 2025

Figure 5 presents the results of the frequency distribution of Geography Teachers' Understanding in Applying Deep Learning in Geography Education in Surakarta City. A total of 12% of respondents were in the low category, indicating that some geography teachers still do not understand the concept of deep learning. The moderate category results of 64% indicate that the majority of geography teachers in Surakarta City high schools understand deep learning. A total of 24% of respondents were in the high category. This certainly gives hope that geography teachers in

Surakarta City will strive to support all educational programs to continue to advance the intelligence of the nation's children through knowledge, skills, and noble cultural values.

In the context of geography learning, teachers' understanding of the deep learning approach is a strategic element in shaping students who not only master factual knowledge but are also able to think critically, contextually, and reflectively about the space and environment in which they live. Geography, as an integrative and spatial discipline, requires teachers to provide



meaningful learning and be able to connect concepts with local and global realities. As emphasised by Sugandi (2015), Geography learning is not only oriented towards mastering spatial concepts but also has an important role in shaping the nation's character through an understanding of regional diversity, resource potential, and environmental challenges. In this framework, the deep learning approach is relevant because it encourages students to actively engage in the learning process through real case analysis, reflective discussion, and exploration of social values and spatial ethics. Furthermore, Nurlaela (2016) emphasises that the surrounding environment is the primary source of learning in effective geography learning. Teachers who understand the principles of deep learning will utilise the environment as an open laboratory that allows students to observe, measure, map, and solve problems directly. Through this experience, students can develop a critical attitude towards spatial issues such as regional inequality, environmental degradation, and natural disasters.

Another opinion, Rombe (2024), through a systematic review, states that the design of Geography learning in the

digital era must be directed at creating a collaborative, technology-based learning space that is oriented towards higher-order thinking skills. Teachers who master the in-depth approach are not only facilitators but also learning designers who are able to develop a logical learning flow based on student needs and supported by interactive digital media that enable independent exploration. In the aspect of disaster education, Fitriana (2021) emphasises that Geography has a strategic position in instilling disaster preparedness through experience-based learning and local case studies. The deep learning approach in this context allows students to not only understand natural phenomena theoretically but also to build risk awareness and social responsibility through simulations, action projects, and community-based assignments. Thus, Geography teachers' understanding of the deep learning approach reflects a pedagogical awareness that focuses not only on academic achievement but also on strengthening spatial literacy, environmental sensitivity, and the formation of students' geographical character. The application of this approach requires teachers to develop



their professional competencies continuously, understand the local context, and integrate technology and human values into their teaching practice.

CONCLUSIONS

This study shows that the understanding of geography teachers in Surakarta City regarding the deep learning approach in the implementation of the Merdeka Curriculum is mostly in the moderate category. A total of 64 percent of teachers demonstrated a moderate understanding of the deep learning concept, 24 percent showed a high level of understanding, and 12 percent still exhibited a low level of comprehension. These findings indicate that although teachers have shown awareness and interest in adopting deep learning as part of curriculum transformation, its implementation still faces conceptual, technical, and institutional challenges. Therefore, strengthening teachers' competencies through structured training, enhanced curriculum literacy, and the development of contextual learning models that reflect deep learning principles is essential to improve the quality of geography learning.

The novelty of this study lies in its comprehensive analysis of geography teachers' conceptual, practical, and perceptual understanding of the deep learning approach within the context of the Merdeka Curriculum, an area that has been scarcely explored in previous research. By integrating questionnaire data with focus group discussions, this study provides empirical insights that can inform teacher training policies, the development of reflective learning strategies, and the design of models that support deep and meaningful learning in geography classrooms. Future research is recommended to evaluate the implementation of deep learning in actual classroom practices and to examine its impact on students' critical and reflective thinking skills. Strengthening collaboration with teacher development programs and professional learning communities may further enhance teachers' capacity in responding to the transformative demands of the Merdeka Belajar Curriculum.

This study has several limitations that need to be acknowledged. First, the sample size was limited to 25 senior high school geography teachers in Surakarta, which may not fully represent the diversity of teacher competencies and



school characteristics in other regions of Indonesia. Second, the data mainly relied on self-reported questionnaires and focus group discussions, which may contain subjective biases and do not fully capture teachers' actual classroom practices. Third, the study did not include classroom observations or document analysis, limiting the ability to validate whether teachers' stated understanding of deep learning was consistently implemented in instructional activities. Fourth, this study focused exclusively on teachers who met specific inclusion criteria, such as minimum teaching experience and curriculum implementation duration, which may exclude variations among novice teachers or schools newly adopting the Merdeka Belajar Curriculum. Future research should expand the sample to multiple cities, incorporate classroom observations, and employ longitudinal or experimental designs to examine changes in teacher understanding and implementation over time.

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