
The Impact of Deep Learning on Learning Quality in Elementary Schools

Prof. Dr. Sudadio, M.Pd¹, Abdul Marta Nurdin S², Rizki Fatullah³, Henti Sulistiowati⁴, Handini⁵, Muldiyana Nugraha⁶, Iis Handoko⁷

ABSTRACT: This study aims to analyze the impact of Deep Learning implementation on student learning quality at the Elementary School level in Pandeglang Regency and Serang Regency, Banten Province. The study employs a mixed methods approach with a sequential explanatory design. The quantitative component uses Structural Equation Modeling based on Partial Least Square with 226 respondents from seven elementary schools, while the qualitative component uses semi-structured in-depth interviews. Of the three Deep Learning principles, only the Mindful (mindfulness) principle has a positive and significant effect on learning quality ($\beta=0.508$; $t=4.582$; $p=0.000$). The Meaningful ($p=0.053$) and Joyful ($p=0.090$) principles have not reached statistical significance. The model explains 50.5% of learning quality variation ($R^2=0.505$). The overall evaluation score is 73.1% (Good category). The Mindful principle is the most critical foundation in Deep Learning implementation for improving learning quality. The non-significance of Joyful and Meaningful reflects the early stage of implementation requiring systematic strengthening of teachers's pedagogical capacity.

KEYWORDS: deep learning, learning quality, elementary school

1. INTRODUCTION

Education is the primary foundation for building a smart, characterful, and globally competitive national civilization. However, the Indonesian education system still faces a fundamental challenge, namely the dominance of the *surface learning* approach that prioritizes memorization and procedural problem-solving over deep and applied understanding. Data from the *Programme for International Student Assessment* (PISA) 2022 shows that Indonesia ranks 68th out of 81 countries with mathematics score 379, science 398, and reading 371 (Widicahyani, 2023: 143).

This condition is exacerbated by findings from *The SMERU Research Institute* (2018) showing the phenomenon of *schooling without learning* in Indonesia. Of an average of 12.4 years of schooling, students only learn the equivalent of 7.8 years; and although 96% of learning time is spent in the classroom, students are truly engaged for only 48% of that time. Weak student engagement in the learning process and minimal critical thinking stimulation are the main factors behind poor learning quality (in Rahmawati et al., 2025: 2).

In the context of national education transformation, the Ministry of Primary and Secondary Education has established Deep Learning as the official approach through Ministerial Regulation No. 13 of 2025. Kemendikdasmen (2025) defines as an approach that honors the learning process through a *mindful* learning atmosphere, incorporating *meaningful*, and *joyful* dimensions, by holistically integrating intellectual, spiritual, emotional, and physical dimensions.

State of the art of Deep Learning -related research shows that Chotimah et al. (2025: 673-682) have examined Deep Learning implementation from a conceptual perspective, while Ratnasari et al. (2025: 43-50) found positive impacts of Deep Learning on mathematical critical thinking skills. However, Partial Least Square-Based Structural Equation Modeling -based empirical studies simultaneously measuring the influence of all three Deep Learning principles on learning quality in elementary schools remain scarce. This gap constitutes the originality of this study.

This study aims to: (1) analyze the influence of Deep Learning principles (*mindful*, *meaningful*, *joyful*) on student learning quality using Partial Least Square-Based Structural Equation Modeling analysis; (2) describe Deep Learning implementation from a multi-stakeholder perspective; and (3) identify supporting and inhibiting factors of Deep Learning implementation based on triangulation of quantitative and qualitative data.

The Impact of Deep Learning on Learning Quality in Elementary Schools

2. THEORETICAL FRAMEWORK

The concept of Deep Learning in the educational context was first systematically developed by Marton and Säljö (1976: 4-11) who distinguished it from the *surface learning*. Biggs and Moore (1993: 14) in the (*Presage-Process-Product*) framework explain that Deep Learning is characterized by students' intrinsic motivation to understand and engage critically. Fullan and Langworthy (2014: 15) formulated Deep Learning as a new pedagogical process developing six global competencies (6Cs): *Character, Citizenship, Collaboration, Communication, Creativity, and Critical Thinking*.

In Indonesia, the Deep Learning framework was developed by Kemendikdasmen (2025) through the Academic Paper on Deep Learning that forms the basis of Ministerial Regulation No. 13 of 2025. Rahmawati et al. (2025: 1) explain that Deep Learning in the Indonesian context is defined as an approach emphasizing the creation of a mindful, meaningful, and joyful learning atmosphere through the holistic integration of four dimensions.

a. Principles of Deep Learning

Mindful Learning. The mindfulness principle was introduced by Langer (2000: 220) as a state of mind that is open to various perspectives, questions information, and connects it to different situations. In the Deep Learning context, mindfulness means that students have intrinsic motivation to learn and are capable of developing learning strategies independently.

Meaningful Learning. Meaningful learning was first introduced by David Ausubel (1963: 37), who argued that learning is more effective when new information is connected to students' prior knowledge or experiences. Fullan et al. (2017: 45) emphasized the importance of learning experiences from diverse real-world contexts.

Joyful Learning. Joyful learning means that students are enthusiastic and enjoy every learning process. This principle aligns with the theory of neuroplasticity and the Self-Determination Theory of Deci et al. (2017: 78), which emphasizes fulfilling three basic psychological needs: autonomy, competence, and relatedness.

b. Learning Quality in the Deep Learning Perspective

Learning quality in the Deep Learning perspective cannot be measured solely by academic achievement scores. Rahmawati et al. (2025: 3) affirm that Deep Learning aims to foster the character of *lifelong learners* capable of facing the complexities of life adaptively and reflectively. In this study, learning quality encompasses cognitive dimensions (critical thinking, conceptual understanding), affective dimensions (motivation, self-confidence, independence), and social dimensions (collaboration, communication).

c. Previous Research

Several empirical studies have provided a foundation for this research. Ismayani and Wahyudin (2025: 93-108) examined school readiness in Deep Learning implementation at State Vocational High School 10 Cianjur and found that teachers' pedagogical readiness is a critical prerequisite for Deep Learning success. This finding is consistent with the results of this study, which show that the teacher instrument received the lowest score (69.3%).

Chotimah et al. (2025: 673-682) conceptually elaborated the three Deep Learning principles and showed that mindfulness is the most fundamental principle as it forms the foundation for meaningfulness and joyfulness. Without full mindfulness in learning, students will not be optimally able to benefit from meaningful experiences or joyful atmospheres. This conceptual finding receives empirical confirmation in this study through the dominant path coefficient of *Mindful* ($\beta=0.508$).

Quinn et al. (2020: 23) in *Dive into Deep Learning: Tools for Engagement* provide a practical Deep Learning implementation framework emphasizing the importance of *engagement* as a prerequisite condition. Biggs et al. (2022: 75) in *Teaching for Quality Learning at University* underline that quality learning requires constructive alignment between objectives, activities, and assessment — a principle relevant to all three Deep Learning dimensions. This theoretical foundation strengthens the argument that Partial Least Square-Based Structural Equation Modeling -based research in the Indonesian context is still greatly needed to produce empirical evidence that can guide Deep Learning implementation policy.

d. Hypotheses

Based on the theoretical review, this study formulates three hypotheses: (H1) *Mindful Learning* has a positive and significant effect on Learning Quality; (H2) *Meaningful Learning* has a positive and significant effect on Learning Quality; and (H3) *Joyful Learning* has a positive and significant effect on Learning Quality. The model is tested using Partial Least Square-Based Structural Equation Modeling and deepened through qualitative data.

The Impact of Deep Learning on Learning Quality in Elementary Schools

3. RESEARCH METHODS

A. Research Approach and Design

This study employs a *mixed methods* approach with a *sequential explanatory*, in which quantitative data analysis is conducted first, then deepened through qualitative data (Creswell & Creswell, 2014: 110). The quantitative component uses Partial Least Square-Based Structural Equation Modeling via SmartPLS v4.1.1.8; the qualitative component employs a descriptive-interpretive approach through semi-structured in-depth interviews analyzed in detail.

B. Research Location, Time, and Subjects

The study was conducted in seven Elementary Schools in Pandeglang Regency (Elementary Schools Citumenggung 1, Elementary Schools Bojong 4, Elementary Schools Manggungjaya 3) and Serang Regency (Elementary Schools Curug, Elementary Schools Sentul 2, Elementary Schools Jeruk Tipis 4, Elementary Schools Cilayangguha), Banten Province, in the 2025/2026 academic year. The total questionnaire respondents were 105 Students (n=105), with respondents for data triangulation comprising Mathematics Teachers (n=7), School Principals (n=7), Parents/Guardians (n=105), and School Supervisors (n=2).

C. Instruments and Analysis Techniques

The questionnaire instrument uses a 1–5 Likert Scale with a total of 24 final indicators for four latent variables: *Joyful* (JY1-JY6), *Meaningful* (MN1-MN6), *Mindful* (MF1-MF6), and Learning Quality (MT1-MT6). Quantitative analysis includes evaluation of the *outer model* (convergent validity, discriminant validity, reliability) and *inner model* (R^2 , f^2 , hypothesis testing through bootstrapping). The validity of qualitative data is ensured through source and technique triangulation.

D. General Overview of Research Location

The study was conducted in two regencies with contrasting characteristics. Pandeglang Regency, located at the western tip of Java Island, has schools with limited access to intensive training and uneven digital infrastructure. Elementary Schools Citumenggung 1, Elementary Schools Bojong 4, and Elementary Schools Manggungjaya 3 are located in semi-urban areas with limited technological facilities.

In contrast, Serang Regency, closer to the provincial government center of Banten, has relatively better infrastructure access. Elementary Schools Curug, Elementary Schools Sentul 2, Elementary Schools Jeruk Tipis 4, and Elementary Schools Cilayangguha show more adequate digital readiness, with most teachers having participated in the pioneer school program and more active learning communities (kombel). The contrasting conditions of these two regencies provide rich contextual variation that strengthens the external validity of the research findings.

The teachers at all seven schools generally hold S1/D4 qualifications with most already certified. However, most have not yet received formal and structured Deep Learning-specific training, but only through limited socialization via training representatives and learning communities. The training access gap between Pandeglang Regency and Serang Regency constitutes an important contextual finding in interpreting the results of this study.

4. RESEARCH RESULTS

Analysis was conducted using SmartPLS software version 4.1.1.8, which applies the *Partial Least Square* method between variables in a complex model. Meanwhile, SEM is used to test causal relationships between the involved variables (Hamid & Anwar, 2019: 97). Figure 1 shows the latent variable model to be analyzed in this study.

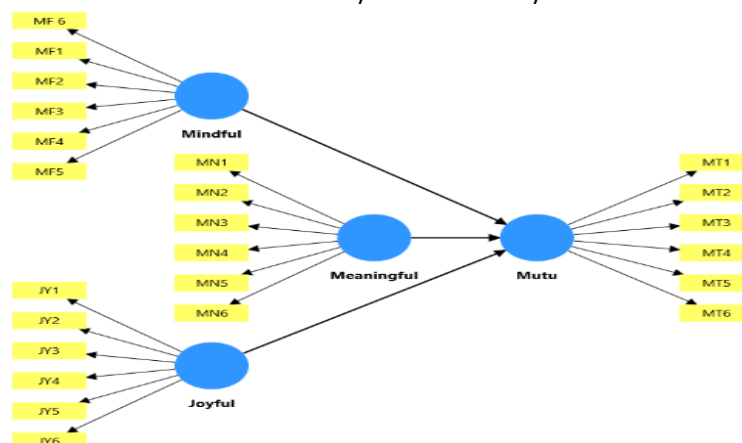


Figure 1. Latent Variable Model

The Impact of Deep Learning on Learning Quality in Elementary Schools

There are two stages conducted in testing the research model: the Outer Model and the Inner Model. The Outer Model focuses on the validity and reliability of indicators used to measure latent variables, with testing of Convergent Validity, Discriminant Validity, and Construct Reliability. The Inner Model focuses on relationships between latent variables and testing the strength and significance of those relationships through tests such as R^2 koefisien jalur and signifikansi jalur (Haryono, 2016: 401).

A. Outer Model

The Outer Model in Partial Least Square-based Structural Equation Modeling is a measurement model used to describe the relationship between latent variables and their constituent indicators. The Outer Model aims to evaluate whether the indicators used in the study are truly capable of measuring constructs validly and reliably. In SmartPLS, outer model testing is typically performed by examining loading factor values, Average Variance Extracted (AVE), cross loadings, and construct reliability. Wiyono adds that a good measurement model will produce research instruments that are valid, reliable, and capable of minimizing measurement error so that research results are more accurate and credible (Wiyono, 2020: 149).

Focusing on the Average Variance Extracted (AVE) value, this value indicates the extent of indicator variance that can be explained by the latent construct compared to variance due to measurement error. A good AVE value indicates that a construct has high capability in explaining its indicators. As Hamid and Anwar (2019: 104) suggest, a construct is declared to meet convergent validity when it has an AVE value greater than 0.50. This means the construct is capable of explaining more than 50% of the indicator variance used in the research model.

Table 1. AVE Values

Variable	Average variance extracted (AVE)	Note
Joyful	0.792	Valid
Meaningful	0.644	Valid
Mindful	0.676	Valid
Quality	0.683	Valid

Based on the convergent validity test using the AVE values in the table, all variables have AVE values above the minimum threshold of 0.500, so all are declared valid. The Joyful variable has the highest AVE value of 0.792, indicating that more than 79% of indicator variance can be explained by the construct. The Meaningful and Mindful variables have AVE values of 0.644 and 0.676 respectively, both exceeding the threshold. The Quality variable also exceeds the threshold at 0.683. Thus, all constructs in the model have met the convergent validity criteria, as each is capable of explaining more than 50% of its indicator variance.

Focusing next on the Fornell-Larcker Criterion approach, this is performed by comparing the square root of a construct's Average Variance Extracted (AVE) with the correlations between other constructs. According to Hamid and Anwar (2019: 115), discriminant validity is considered good when the square root of a construct's AVE is greater than its correlations with other constructs. This criterion indicates that a construct is better able to explain its own indicators than to explain other constructs in the research model. In SmartPLS output, Fornell-Larcker results are typically presented as a correlation matrix with diagonal values representing the square root of AVE, which must be higher than values below or beside them.

Table 2. VAVE

Variable	Joyful	Meaningful	Mindful	Quality	VAVE	Note
Joyful	1	0.541	0.735	0.590	0.902	Valid
Meaningful	0.541	1	0.573	0.505	0.878	Valid
Mindful	0.735	0.573	1	0.692	0.826	Valid
Quality	0.590	0.505	0.692	1	0.910	Valid

Based on the test results, it can be shown that:

- The Joyful variable has a square root AVE (VAVE) of 0.902. This value is higher than all its correlations with other variables, namely with Meaningful (0.541), Mindful (0.735), and Quality (0.590). Since VAVE is greater than all inter-construct correlations, this variable is declared to meet discriminant validity requirements.
- The Meaningful variable has a square root AVE (VAVE) of 0.878. This value is higher than all its correlations with other variables, namely with Joyful (0.541), Mindful (0.573), and Quality (0.505). Since VAVE is greater than all inter-construct correlations, this variable is declared to meet discriminant validity requirements.

The Impact of Deep Learning on Learning Quality in Elementary Schools

- The Mindful variable has a square root AVE (VAVE) of 0.826. This value is higher than all its correlations with other variables, namely with Joyful (0.735), Meaningful (0.573), and Quality (0.692). Since VAVE is greater than all inter-construct correlations, this variable is declared to meet discriminant validity requirements.
- The Quality variable has a square root AVE (VAVE) of 0.910. This value is higher than all its correlations with other variables, namely with Joyful (0.590), Meaningful (0.505), and Mindful (0.692). Since VAVE is greater than all inter-construct correlations, this variable is declared to meet discriminant validity requirements.

In the Partial Least Square-Based Structural Equation Modeling approach using SmartPLS, reliability testing is generally conducted through two main indicators, namely Cronbach's Alpha and Composite Reliability. Both measures are used to assess the internal consistency of indicators within a latent construct. Hamid and Anwar explain that internal reliability is needed to ensure that all indicators used in the study have consistent capability in measuring the same construct (Hamid & Anwar, 2019: 82). Therefore, reliability testing is an important step before researchers conduct structural model analysis or hypothesis testing.

Table 3. Cronbach's alpha

Variable	Cronbach's alpha	Note.
Joyful	0.886	Reliable
Meaningful	0.901	Reliable
Mindful	0.883	Reliable
Quality	0.931	Reliable

Based on Table X, all variables in the model have Cronbach's Alpha values above the minimum threshold of 0.70, which means that the instruments used are reliable. The Quality variable has the highest value at 0.931, followed by Meaningful (0.901), Joyful (0.886), and Mindful (0.883).

Although Cronbach's Alpha is widely used, this approach has a weakness as it assumes all indicators have equal weight. Therefore, in Partial Least Square-Based Structural Equation Modeling analysis, the use of Composite Reliability is considered more appropriate. According to Wiyono, Composite Reliability is a more accurate reliability measure than Cronbach's Alpha because it considers the outer loading value of each indicator in the latent construct (Wiyono, 2020: 156). Thus, Composite Reliability provides a more realistic reliability estimate of the research construct quality.

Table 4. Composite Reliability

Variable	Composite Reliability	Note.
Joyful	0.929	Reliable
Meaningful	0.931	Reliable
Mindful	0.915	Reliable
Quality	0.951	Reliable

Based on Table 4, all variables in the model have Composite Reliability values above the minimum threshold of 0.70, thus declared reliable. These values indicate that the indicators for each construct/variable have very good consistency in measuring the variables. The Quality variable has the highest composite reliability value of 0.951, followed by the Joyful variable (0.929), the Meaningful variable (0.931), and the Mindful variable (0.915). Therefore, all constructs in the model have met the composite reliability criteria and are appropriate for further analysis.

B. Inner Model

The Inner Model in Partial Least Square-based Structural Equation Modeling is a structural model used to describe causal relationships between latent variables in the study. The Inner Model functions to test research hypotheses and determine the strength of influence between exogenous and endogenous constructs. According to Hamid and Anwar, the inner model is used to evaluate structural relationships between latent variables through path coefficient values, coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and significance testing through bootstrapping (Hamid & Anwar, 2019:88). Thus, the inner model is an important stage in determining whether research hypotheses are accepted or rejected.

First, we focus on the Coefficient of Determination (R^2), which is one of the important measures in evaluating the inner model in Partial Least Square-Based Structural Equation Modeling analysis. The R^2 value is used to indicate the ability of exogenous variables to explain the endogenous variable in a research model. The higher the R^2 value, the greater the model's predictive capability in explaining the variation of the dependent variable. According to Hamid and Anwar, the coefficient of determination

The Impact of Deep Learning on Learning Quality in Elementary Schools

is used to measure the proportion of endogenous variable variance that can be explained by exogenous variables in the structural model (Hamid & Anwar, 2019: 89).

Table 5. R²

Variable Dependen	R-square	R-square Adjusted
Quality	0.505	0.490

The R Square (R²) test results show the proportion of variance in the dependent variable that can be explained by the independent variables in the model. The R² value of 0.505 for the Quality variable indicates that 50.5% of the variation in quality can be explained through the independent constructs that influence it in the model. The remaining 49.5% is explained by other factors outside the model. This value falls into the moderate category since R² > 0.50.

Second, we focus on the effect size (f²), which in Partial Least Squares Structural Equation Modeling analysis is used to indicate the magnitude of the contribution of an independent variable in increasing the coefficient of determination (R²) of the dependent variable. According to Hamid and Anwar, effect size testing is conducted to determine the strength of the effect of each exogenous construct on the endogenous construct after a particular variable has been included in or excluded from the research model (Hamid & Anwar, 2019: 90).

Table 6. effect size (f²)

Variable	Quality
Joyful	0.018
Meaningful	0.024
Mindful	0.217

Based on the results in table 6, the following can be explained:

- Prinsip Joyful (menggembirakan) terhadap Quality Hasil Belajar
An f² value of 0.018 indicates that the effect of the Joyful principle on Learning Quality is very small. This indicates that the Joyful principle does contribute to learning quality but its influence is limited.
- Prinsip Meaningful (bermakna) terhadap Quality Hasil Belajar
An f² value of 0.024 indicates that the effect of the Meaningful principle on Learning Quality is small, meaning that the Meaningful principle also has limited influence.
- Prinsip Mindful (berkesadaran) terhadap Quality Hasil Belajar
An f² value of 0.217 indicates that the effect of the Mindful (mindfulness) principle on Learning Quality has a medium effect, Showing that the Mindful principle is currently the most influential compared to other principles on learning quality.

Finally, significance testing (hypothesis testing) in Partial Least Squares Structural Equation Modeling is used to determine whether the relationships among latent variables in a research model are statistically significant. This testing is conducted through a bootstrapping procedure by examining the t-statistics and p-values for each path relationship among constructs. According to Hamid and Anwar, significance testing aims to verify whether research hypotheses are accepted or rejected based on the probability level and the strength of the relationships among latent variables (Hamid & Anwar, 2019: 94). Therefore, significance testing constitutes a key stage in the evaluation of the inner model in Partial Least Square-Based Structural Equation Modeling. Haryono further explains that a relationship between variables is considered significant when the t-statistic value exceeds 1.96 at a 5% significance level, or when the p-value is less than 0.05 (Haryono, 2016: 387). These values indicate that the relationship among constructs is unlikely to have occurred by chance. Wiyono adds that significance testing in SmartPLS helps researchers understand the direction and strength of the effects among variables, enabling research findings to serve as a basis for scientific decision-making (Wiyono, 2020: 160). Consequently, significance testing serves as the primary foundation for interpreting research hypotheses in Partial Least Square-Based Structural Equation Modeling -based studies.

The Impact of Deep Learning on Learning Quality in Elementary Schools

Table 7. Significance Test Results

Path Coefficient	Original Sample	T Statistics	P Values	Note
(H1) Joyful -> Quality	0.143	1.341	0.090	Rejected
(H2) Meaningful -> Quality	0.136	1.617	0.053	Rejected
(H3) Mindful -> Quality	0.508	4.582	0.000	Accepted

Based on the results presented in Table 7, the following explanations can be provided:

1) The Effect of Joyful Learning on Learning Outcome Quality

Based on the path coefficient table from the hypothesis testing results, the Joyful Learning variable has an original sample value of 0.143, with a T-statistic of 1.341 and a P-value of 0.090. Since the P-value is greater than 0.05 and the T-statistic is less than 1.96, Hypothesis H1 is rejected. This finding indicates that Joyful Learning does not have a significant effect on Learning Outcome Quality.

2) The Effect of Meaningful Learning on Learning Outcome Quality

Furthermore, the Meaningful Learning variable has an original sample value of 0.136, with a T-statistic of 1.617 and a P-value of 0.053. The P-value remains higher than 0.05, and the T-statistic does not reach the threshold of 1.96, indicating that Hypothesis H2 is also rejected. Therefore, Meaningful Learning does not have a significant effect on Learning Outcome Quality.

3) The Effect of Mindful Learning on Learning Outcome Quality

Meanwhile, the Mindful Learning variable has an original sample value of 0.508, with a T-statistic of 4.582 and a P-value of 0.000. Since the P-value is less than 0.05 and the T-statistic exceeds 1.96, Hypothesis H3 is accepted. This result indicates that Mindful Learning has a positive and significant effect on Learning Outcome Quality. The path coefficient value of 0.508 suggests that a higher level of Mindful Learning implementation is associated with a corresponding increase in Learning Outcome Quality.

C. Qualitative Findings: Deep Learning Implementation in the Field

Several dynamics observed in the field, which may serve to reinforce and complement the quantitative findings presented, include the following:

Implementation Dynamics of the *Mindful* Principle. The dominant influence of the *Mindful* principle received strong confirmation from interview data. Teachers who consistently implemented Deep Learning reported fundamental changes in the way they facilitate learning:

"After learning about Deep Learning, I now know that in Deep Learning, students must be honored. The most influential moment was during the Deep Learning training." (Teacher, Elementary Schools Bojong 4)

"The most memorable learning experience was when doing direct practice in front of the class. Teachers no longer merely stand in front of the class, but take on more of a companion or mentor role." (Student, Elementary Schools Cilayanguha)

Implementation Dynamics of the *Meaningful*. Although not statistically significant ($p=0.053$), interview data shows that the *Meaningful* principle has begun to be implemented:

"The most effective strategy I apply is problem-based learning, because students are invited to solve concrete problems related to their lives." (Teacher, Elementary Schools Manggungjaya 3)

Implementation Dynamics of the *Joyful*. Supervisors identified *Joyful* as the most difficult dimension to implement due to teachers' limited digital competency:

"At present, many teachers still perceive Deep Learning as merely an administrative requirement and have not yet fully implemented it in practice. The utilization of digital technology remains the most challenging dimension." (School Supervisor, Pandeglang Regency).

D. The Impact of Deep Learning on Learning Outcome Quality: A Multi-Stakeholder Perspective

The overall average score of 73.1% (Good category) indicates that Deep Learning has generated a tangible positive impact. The Mathematics Teacher Instrument (69.3% – Fair category) was the only instrument that fell below the Good category, suggesting the need to strengthen teachers' pedagogical capacity in the implementation of Deep Learning.

The cognitive impact is reflected in the Deep Learning Experience dimension, which achieved the highest score (74.7%). The affective impact was measured through the parent questionnaire, particularly on items related to students' motivation, independence, and self-confidence (76.2%). Meanwhile, the social impact is evident in the Graduate Profile dimension, although the collaboration indicator (72.4%) emerged as the aspect most in need of further improvement.

The Impact of Deep Learning on Learning Quality in Elementary Schools

E. Supporting and Inhibiting Factors

Supporting Factors: (a) Visionary school leadership, demonstrated through the allocation of budget for *Deep Learning* training programs (77.1%); (b) A systematic monitoring mechanism supported by written reporting procedures, which received the highest score (82.9%); (c) The mentoring competence of school supervisors, which was rated Very Good (90.0%).

Inhibiting Factors (a) Teachers' pedagogical readiness, which remains at a Fair level (69.3%), particularly regarding difficulties in integrating the four developmental dimensions into a single learning session (42.9% – Poor); (b) Supervision practices that remain largely administrative in nature (45.7% – Poor); (c) Limited digital infrastructure, especially in Pandeglang Regency; (d) Professional learning communities that have not yet been optimized, as reflected by their Fair rating (68.6%).

5. CONCLUSION

The most significant finding is the dominance of the Mindful dimension ($\beta = 0.508$; $p = 0.000$) in influencing learning quality. From a theoretical perspective, this result is consistent with the findings of Langer (2000: 220–223), who argued that mindful learning is the foundation of all effective learning. Without learning awareness, students are unable to fully benefit from either meaningful or joyful learning experiences. Likewise, Biggs and Moore (1993: 14), through the 3P Model (Presage–Process–Product), explained that intrinsic motivation, the core element of mindfulness, is the most fundamental factor in the learning process.

The non-significant effects of Joyful Learning ($p = 0.090$) and Meaningful Learning ($p = 0.053$) should be understood within the context of the early stage of implementation. Paramita et al. (2025: 757–769) found that Deep Learning implementation in Indonesia still faces substantial challenges related to teacher readiness. The p -value of 0.053 for Meaningful Learning, which is very close to the significance threshold, supports the threshold effect argument, suggesting that a higher level of implementation may be required before its impact becomes statistically significant. Similarly, Chotimah et al. (2025: 673–682) reported that the effect of the Joyful principle became significant only after Deep Learning had been implemented consistently for at least one semester.

By integrating the quantitative and qualitative findings, this study recommends a priority-based implementation model of Deep Learning. Stage 1 (Foundation) focuses on strengthening the Mindful principle through the development of intrinsic motivation and metacognitive awareness. Stage 2 (Reinforcement) emphasizes the implementation of the Meaningful principle through contextual learning experiences. Stage 3 (Maturation) involves enhancing the Joyful principle through the diversification of instructional strategies and learning activities.

These findings are also relevant from the perspective of national education policy. The R^2 value of 0.505 indicates that the model possesses adequate predictive power; however, approximately 49.5% of the variation in learning quality is explained by factors beyond the three Deep Learning principles. Moderating variables such as school leadership quality, digital infrastructure readiness, and family support may strengthen the effects of the three Deep Learning principles. This issue represents an important agenda for future research.

Data obtained from school principals confirm that Deep Learning has contributed to strengthening partnerships among schools, parents, and communities. Within the Graduate Profile dimension, the indicator of faith and piety received the highest score (75.8%), whereas the indicator of collaboration across diversity obtained the lowest score (72.4%). This suggests that collaborative competencies require more complex and systematically designed learning experiences.

Comparison with previous studies further reinforces the significance of these findings. Ratnasari et al. (2025, pp. 43–50), who examined the impact of Deep Learning on mathematical critical thinking skills, reported significantly positive effects, which is consistent with the dominance of the Mindful dimension as a predictor of cognitive learning quality. Likewise, Paramita et al. (2025, pp. 757–769), who identified challenges in implementing Deep Learning within the current curriculum, confirmed that teacher readiness remains the primary limiting factor. This finding is consistent with the teacher instrument score obtained in the present study (69.3% – Fair/Sufficient).

Several key conclusions can be drawn from these findings, including the following:

First, among the three Deep Learning principles, only the Mindful principle has a positive and statistically significant effect on learning quality ($\beta = 0.508$; $t = 4.582$; $p = 0.000$). The Meaningful ($\beta = 0.136$; $p = 0.053$) and Joyful ($\beta = 0.143$; $p = 0.090$) principles have not yet reached statistical significance, although both exhibit positive effect directions. The model is able to explain 50.5% of the variance in learning quality ($R^2 = 0.505$).

Second, the implementation of Deep Learning across seven elementary schools falls within the Good category, with an overall average score of 73.1%. School principals, parents, supervisors, and students assessed the impact of Deep Learning positively, whereas mathematics teachers rated it within the Fair category (69.3%). The Deep Learning Experience dimension achieved the highest score (74.7%).

The Impact of Deep Learning on Learning Quality in Elementary Schools

Third, the supporting factors for Deep Learning implementation include visionary school leadership, systematic monitoring mechanisms, and the mentoring competence of supervisors (90.0% – Very Good). Meanwhile, inhibiting factors include teachers' pedagogical readiness (69.3%), administrative-oriented supervision (45.7%), limited digital infrastructure, and professional learning communities that have not yet been fully optimized (68.6%).

This study contributes empirically to Deep Learning theory by demonstrating that, within the context of the initial implementation of Deep Learning in Indonesia, the Mindful principle is the strongest predictor of learning quality. This finding reinforces Langer's (2000: 220–223) theory of mindful learning as the foundation of effective learning, confirms the 3P Model of Biggs and Moore (1993), which positions intrinsic motivation as a prerequisite for Deep Learning, and extends the analytical framework of Fullan et al. (2017) within the context of Deep Learning implementation in developing countries.

As a practical implication for teachers, these findings provide an empirical basis for prioritizing the strengthening of the Mindful principle through strategies that cultivate students' intrinsic motivation and metacognitive awareness before implementing the other principles. For school principals, the results indicate the need to reform supervision practices from an administrative model (score 45.7%, Poor) to a more substantive instructional coaching model focused on improving the quality of Deep Learning implementation in classrooms. For local Education Offices, the findings highlight the necessity of equalizing digital infrastructure and access to Deep Learning training across districts, considering the disparities identified between Pandeglang Regency and Serang Regency.

Recommendations for teachers include: (a) Strengthening strategies that foster learning awareness through guiding questions, reflective activities, and explicit learning-goal setting at the beginning of each lesson; (b) Actively participating in professional learning communities (*Komunitas Belajar/Kombel*) as a platform for sharing Deep Learning best practices; (c) Gradually expanding the repertoire of Joyful learning strategies, beginning with those that are easiest to implement; (d) Building active partnerships with parents as Deep Learning partners within the family environment.

Recommendations for school principals and local Education Offices include: (a) Reforming learning supervision from an administrative approach to an instructional coaching model; (b) Optimizing professional learning communities by establishing concrete output targets for each meeting; (c) Designing phased Deep Learning training programs—beginning with strengthening the Mindful principle, followed by Meaningful, and concluding with Joyful; (d) Ensuring equitable digital infrastructure development across districts with limited access.

Final recommendations for the Ministry of Primary and Secondary Education (*Kemendikdasmen*) include: (a) Developing Deep Learning implementation monitoring instruments based on measurable indicators derived from the three Deep Learning principles; (b) Allocating practice-based Deep Learning training programs rather than relying solely on conceptual socialization activities; (c) Considering the findings of this study as evaluation material for Deep Learning policy implementation during the first year of Ministerial Regulation No. 13/2025.

Finally, recommendations for future research include: (a) Employing longitudinal research designs to measure changes in the significance of the Joyful and Meaningful principles as DEEP LEARNING implementation matures over time; (b) Incorporating moderating variables such as leadership quality and digital readiness as contextual factors; (c) Expanding the sample of supervisors ($n > 2$) to improve representativeness; (d) Developing specialized instruments capable of measuring the Joyful and Mindful dimensions more comprehensively and with greater nuance across different educational levels.

REFERENCES

- 1) Ausubel, D. P. 1963. The psychology of meaningful verbal learning. Grune & Stratton.
- 2) Biggs, J., & Moore, P. 1993. The process of learning (3rd ed.). Prentice Hall.
- 3) Biggs, J., Tang, C., & Kennedy, G. 2022. Teaching for quality learning at university (5th ed.). McGraw-Hill Education.
- 4) Chotimah, S. C., Suhartono, & Fantofik, D. 2025. Implementasi pembelajaran mendalam: Berkesadaran (mindful) learning atmosphere, incorporating meaningful, and joyful). *An-Nuha: Jurnal Pendidikan Islam*, 5(4), 673–682.
- 5) Creswell, H. W., & Creswell, J. D. 2014. Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). SAGE Publications.
- 6) Deci, E. L., Olafsen, A. H., & Ryan, R. M. 2017. Self-determination theory in work organizations: The state of a science. *Annual Review of Organizational Psychology and Organizational Behavior*, 4, 19–43.
- 7) Fullan, M., & Langworthy, M. 2014. A rich seam: How new pedagogies find Deep Learning. Pearson.
- 8) Fullan, M., Quinn, J., & McEachen, J. 2017. Deep Learning: Engage the world change the world. Corwin Press.
- 9) Hamid, M. A., & Anwar, S. 2019. Structural Equation Modeling (SEM) berbasis varian: Konsep dasar and aplikasi dengan program SmartPLS. STIE Bank BPD Jateng.
- 10) Haryono, S. 2016. SEM Method for Management Research with AMOS LISREL PLS. Luxima Metro Media.

The Impact of Deep Learning on Learning Quality in Elementary Schools

- 11) Ismayani, A., & Wahyudin, D. 2025. Reviewing school readiness in Deep Learning implementation at SMKN 10 Cianjur. *Jurnal Penelitian Kebijakan Pendidikan*, 18(2), 93–108.
- 12) Kementerian Pendidikan Dasar and Menengah. 2025. Naskah akademik pembelajaran mendalam: Menuju pendidikan bermutu untuk semua. Pusat Kurikulum and Pembelajaran, BSKAP, Kemendikdasmen.
- 13) Langer, E. J. 2000. Mindful learning. *Current Directions in Psychological Science*, 9(6), 220–223.
- 14) Marton, F., & Säljö, R. 1976. On qualitative differences in learning: I—Outcome and process. *British Journal of Educational Psychology*, 46(1), 4–11.
- 15) OECD. 2023. PISA 2022 results (Volume I): The state of learning and equity in education. OECD Publishing.
- 16) Paramita, A. A. J., Ariani, K. B., Mahadewi, N. P. D., & Werang, B. R. 2025. Tantangan implementasi pembelajaran mendalam sebagai pendekatan dalam Kurikulum Merdeka. *DIKSI: Jurnal Kajian Pendidikan and Sosial*, 6(4), 757–769.
- 17) Quinn, J., McEachen, J., Fullan, M., Gardner, M., & Drummy, M. 2020. *Dive into Deep Learning: Tools for engagement*. SAGE Publications.
- 18) Rahmawati, Y., Mu'ti, A., Suyanto, & Herianingtyas, N. L. R. 2025. Pembelajaran mendalam: Transformasi pembelajaran menuju pendidikan bermutu. *Jurnal Penelitian Kebijakan Pendidikan*, 18(1), 1–16.
- 19) Ratnasari, R., Nurvicalesi, N., & Wati, A. S. 2025. Implementasi pembelajaran mendalam terhadap kemampuan berpikir kritis matematis siswa. *Algoritma: Jurnal Matematika, Ilmu Pengetahuan Alam, Kebumian and Angkasa*, 3(4), 43–50.
- 20) Widicahyani I.A.G, Suweken, G and Ariawan, I.P.W. 2025. *Wahana Matematika and Sains: Jurnal Matematika, Sains, and Pembelajarannya*, Vol.19 No 3, 142-152
- 21) Wiyono, B. B. (2020). *Metodologi penelitian (pendekatan kuantitatif, kualitatif, and action research)*. Malang: Fakultas Ilmu Pendidikan Universitas Negeri Malang



There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0) (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.