Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

IMPLEMENTATION OF DEEP LEARNING, LEARNING ENGAGEMENT, AND EMOTIONAL REGULATION ON THE IMPROVEMENT OF CRITICAL THINKING AND COLLABORATION AMONG ELEMENTARY SCHOOL STUDENTS

Riska Novianty[1], Yeni Yuniarti[2]

[12] Master of Elementary School Teacher Education, Universitas Pendidikan Indonesia, Bandung

[a]*Email:riskanoviantynovi23@upi.edu*
[b]*Email:yeni_yuniarti@upi.edu*

(*) Corresponding Author
(*riskanoviantynovi23@upi.edu*

ARTICLE HISTORY
Received : 20-11-2025
Revised : 07-12-2025
Accepted : 25-01-2026

KEYWORDS
deep learning pedagogy, critical thinking, collaborative skills, student engagement, emotional regulation

ABSTRACT
Contemporary education faces substantial challenges in preparing elementary students for twenty-first century competencies, necessitating transformative pedagogical approaches beyond conventional instruction. This quasi-experimental investigation examined the influence of deep learning pedagogy on critical thinking abilities and collaborative competencies among fifth-grade elementary students, by student engagement and emotional regulation hypothesized as mediating mechanisms. Forty participants were systematically allocated into experimental and control cohorts, receiving deep learning intervention and conventional instruction respectively across an eight-week duration. Quantitative analysis utilizing ANCOVA revealed statistically significant enhancement in critical thinking ($F = 58.743$, $p < 0.001$, partial $\eta^2 = 0.614$) and collaboration ($F = 52.186$, $p < 0.001$, partial $\eta^2 = 0.586$) inside of the experimental cohort. Path analysis confirmed partial mediation effects, by student engagement mediating 42.8% of critical thinking variance and 40.3% of collaboration variance, while emotional regulation mediated 29.9% and 31.2% respectively. Structural equation modeling demonstrated acceptable model fit (CFI = 0.942, RMSEA = 0.068), explaining 71.3% of critical thinking variance and 68.7% of collaboration variance. Qualitative observations documented progressive transformation in classroom discourse patterns, collaborative behaviors, and metacognitive awareness. Findings provide empirical substantiation for deep learning implementation in elementary contexts, highlighting interconnected roles of behavioral participation, emotional investment, cognitive strategy deployment, and affective regulation in fostering higher-order thinking and interpersonal competencies essential for future-ready learners.

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

INTRODUCTION

Education in the digital age faces complex challenges in preparing students to deal by the dynamics of technological developments and the demands of 21st-century competencies. The transformation of conventional learning towards a more adaptive and innovative paradigm is a necessity, especially in the context of basic education as the foundation for shaping students' character and cognitive abilities. Effective learning emphasizes not only academic content mastery, but also the development of higher-order thinking skills and collaboration abilities that are essential for future success. In this context, the integration of *deep learning* approaches as a pedagogical strategy is relevant for optimizing deep and meaningful learning processes. *Deep learning* in a pedagogical context refers to learning that encourages students to actively engage in building conceptual understanding, developing metacognitive abilities, and applying knowledge in authentic situations (Mehta & Fine, 2021) . This approach is fundamentally different by surface learning, that only emphasizes memorization and reproduction of information devoid of deep understanding.

Learning engagement or *student engagement* is a multidimensional construct that encompasses behavioral, emotional, and cognitive dimensions that contribute significantly to the quality of learning outcomes. Students by high levels of engagement tend to show greater persistence in facing academic challenges, active participation in learning activities, and the development of sustained intrinsic motivation (Wang et al., 2020) . Learning engagement cannot be viewed as an automatic phenomenon; rather, it requires learning conditions that support autonomy, relevance, and quality social interaction. Contemporary research shows that learning engagement has a positive correlation by academic achievement, the development of social-emotional skills, and the formation of lifelong learning dispositions. However, the phenomenon of disengagement or lack of learning engagement remains a significant problem in the context of basic education, characterized by low active participation, lack of initiative in learning, and excessive dependence on external guidance.

The emotional dimension in learning plays a crucial role that is often overlooked in conventional instructional design. Emotion regulation, defined as the ability to monitor, evaluate, and modify emotional reactions according to situational demands, is a fundamental competency that determines students' academic success and social adaptation (Lichtenfeld et al., 2022) . Students by good emotional regulation skills are able to manage academic anxiety, frustration in the face of learning difficulties, and maintain motivation in the face of failure. Conversely, deficits in emotional regulation contribute to academic procrastination, avoidance of challenging tasks, and difficulties in social interactions by peers. In the context of collaborative learning, emotional regulation becomes increasingly important because students must be able to manage emotions in group dynamics, resolve interpersonal conflicts, and maintain focus on shared goals. Neuropsychological research indicates that the development of emotional regulation skills in elementary school age is still in its formative stages, thus requiring scaffolding and systematic support by the learning environment.

Critical thinking, defined as the ability to systematically analyze information, evaluate arguments based on evidence, and make rational decisions, is a fundamental goal of education that has long been recognized but still faces significant implementation challenges. In an information age marked by the proliferation of digital content and the phenomenon of misinformation, critical thinking skills are becoming increasingly essential as a basic literacy that must be mastered early on (Thomann & Deutscher, 2025) . However, learning practices in elementary schools still tend to emphasize procedural learning and the reproduction of knowledge , by limited opportunities for students to engage in higher-level cognitive activities such as analysis, synthesis, and evaluation. The development of critical thinking requires learning designs that explicitly integrate questioning, reasoning, and problem-solving activities in contexts that are meaningful and relevant to students' lives.

Collaborative skills as competencies for working effectively in groups, contributing to common goals, and valuing diverse perspectives are becoming increasingly important in the context of 21st-century life and work. Collaborative learning not only provides a social context for knowledge construction, but also develops essential

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

communication, negotiation, and conflict resolution skills (Järvelä et al., 2021) . However, the implementation of effective collaborative learning faces various challenges, including the phenomenon of social loafing, domination by certain members, and difficulties in coordinating group activities. Research shows that the effectiveness of collaborative learning depends on the quality of instructional design, the formation of productive group norms, and the explicit development of collaborative skills.

Previous studies have explored various aspects related to the variables in this study, but by different focuses and contexts. Studies conducted by Padilla-Petry et al. (2022)) identified that learning engagement has a significant effect on academic achievement in the context of higher education, by the mediation of deep learning strategies. The study used a longitudinal approach to track the development of engagement patterns and their relationship by learning outcomes. The findings indicate that the cognitive dimension of learning engagement, that includes the use of elaboration and organizational strategies, has the most substantial contribution to academic achievement. Meanwhile, research conducted by Zhao et al. (2025) explored the relationship among emotion regulation and critical thinking in students, finding that adaptive emotion regulation skills serve as significant predictors of reasoning and decision-making abilities. The study used an experimental design to test the effects of emotion regulation training interventions on performance in critical thinking tasks.

However, there is a significant research gap in the existing literature. First, the majority of studies on *deep learning*, learning engagement, and emotional regulation have been conducted in the context of secondary and higher education, by a lack of empirical studies at the primary education level where the foundations of cognitive and socio-emotional abilities are being formed. Second, previous studies tend to explore the bivariate relationships among these variables partially, devoid of integrating all variables into a comprehensive model that can explain the mechanisms of influence simultaneously. Third, most of the research contexts are in developed countries by educational system characteristics that differ by those in Indonesia, so that generalization of findings requires empirical validation in local settings. Fourth, there is a lack of research that explicitly explores the role of emotion regulation as a variable that mediates or moderates the relationship among learning implementation and cognitive and collaborative outcomes.

The novelty of this research lies in several fundamental aspects. First, this study integrates a *deep learning* approach as a pedagogical strategy by simultaneously considering the dimensions of learning engagement and emotional regulation in predicting critical thinking and collaboration outcomes in elementary school students. Second, this study was conducted in the context of Indonesian elementary education, that has unique characteristics related to the learning system, students' socio-cultural backgrounds, and the challenges of implementing innovative pedagogical approaches. Third, this study uses a mixed-methods approach that combines quantitative analysis to test the relationship among variables by qualitative exploration to understand the mechanisms and processes underlying the phenomenon. Fourth, this study provides practical contributions in the form of a holistic learning implementation model that considers not only cognitive aspects but also integrated emotional and social dimensions.

Based on the background description and research gap identification, this study formulates several research questions. First, how does the implementation of *deep learning* affect the improvement of critical thinking and collaboration skills among elementary school students? Second, how do learning engagement and emotional regulation mediate the relationship among the implementation *of deep learning* and improvements in critical thinking and collaboration? Third, what is the integrative model that describes the simultaneous relationship among the implementation *of deep learning*, learning engagement, emotional regulation, critical thinking, and collaboration in elementary school students?

The purpose of this study is to analyze and explain the effect of *deep learning* implementation on improving critical thinking and collaboration skills among elementary school students; to investigate the role of learning engagement and emotional regulation as mediating variables in the relationship among *deep learning*

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

implementation and critical thinking and collaboration outcomes; and to develop and validate a theoretical model that describes the structural relationship among research variables in the context of elementary education.

The benefits of this research can be seen by various perspectives. Theoretically, this research contributes to the development of the body of knowledge in the fields of educational psychology and pedagogy by providing empirical evidence on the mechanisms of the influence of the *deep learning* approach on cognitive and social outcomes, taking into account the role of psychological variables. Practically, the findings of this study can provide guidance for education practitioners in designing and implementing learning that is not only effective in academic achievement but also responsive to the social-emotional development needs of students. For education policymakers, the results of this study can be used as a basis for developing curricula and teacher training programs that integrate deep learning approaches by the development of 21st-century competencies. For future researchers, this study opens up opportunities for further exploration of contextual and individual variables that can moderate the effectiveness of learning approaches in improving desired outcomes.

RESEARCH METHOD

This study uses a quantitative approach by a *quasi-experimental* design through *a pretest-posttest control group design* to analyze the effect of implementing *deep learning*, learning engagement, and emotional regulation on improving critical thinking and collaboration among elementary school students. The choice of a quasi-experimental design was based on the consideration that full randomization of research subjects was difficult to achieve in the context of formal education, so the researchers used naturally formed classes as the unit of analysis (Creswell & Creswell, 2022) . This design allowed the researchers to compare the effectiveness of the learning intervention among the experimental group that received the treatment and the control group that used conventional learning, as well as to measure the changes that occurred through pre- and post-intervention measurements. The population in this study was all fifth-grade students in public elementary schools in the Bandung Wetan District, Bandung City, West Java Province, in the even semester of the 2024/2025 academic year. The selection of fifth-grade students was based on the consideration that at the cognitive development level of 10-11 years of age, students have entered the *concrete operational* stage towards *formal operational*, that allows them to engage in more complex abstract thinking and reasoning activities.

The sampling technique used *purposive sampling* by criteria of schools that have adequate learning facilities, teachers who are willing to collaborate in the implementation of interventions, and relatively homogeneous student demographic characteristics. The research sample consisted of 40 students divided into two groups, namely an experimental group of 20 students by SDN Margahayu 05 and a control group of 20 students by SDN Margahayu 03 who had similar characteristics in terms of school accreditation, teacher competence, and students' socioeconomic backgrounds. The variables in this study consisted of independent variables in the form of *deep learning* implementation, that was operationalized through inquiry-based learning design by characteristics of high-level cognitive activities, metacognitive reflection, and the application of knowledge in authentic contexts. The mediator variables included learning engagement, measured through three dimensions, namely *behavioral engagement*, *emotional engagement*, and *cognitive engagement*, as well as emotion regulation, that included *emotion recognition*, *emotion understanding*, and *emotion management*. The dependent variables of the study were critical thinking skills, measured through the dimensions of analysis, evaluation, and inference, as well as collaboration skills, that included communication, contribution, and coordination in group work.

The data collection instruments used in this study are as follows. First, a learning engagement scale adapted by *the Student Engagement Instrument* by a Cronbach Alpha reliability of 0.89, consisting of 24 statements using a 5-point Likert scale. Second, an emotion regulation scale developed based on *the Emotion Regulation Questionnaire for Children and Adolescents* by a reliability coefficient of 0.87, consisting of 18 statement items. Third, a critical thinking test in the form of structured essay questions that measure the ability to analyze arguments, evaluate

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

evidence, and make logical inferences by a 1-4 scale analytical assessment rubric. Fourth, a collaboration observation sheet developed based on the *collaborative problem-solving* framework by measurable indicators using a rating scale to observe students' collaborative behavior during group learning. All instruments underwent content validation by expert judgment and empirical testing to ensure the validity and reliability of the measurements. The research procedure was carried out in four stages. The first stage was initial measurement using a pretest to measure critical thinking skills, collaboration, and the level of learning engagement and emotional regulation in both groups. The second stage was the implementation *of deep learning* intervention in the experimental group for 8 weeks by a frequency of 3 meetings per week, while the control group received conventional learning for the same duration. The third stage was a final measurement using a posttest by equivalent instruments to measure changes in the dependent variables. The fourth stage was data analysis using descriptive statistical techniques to describe data characteristics, normality and homogeneity tests as prerequisite tests, ANCOVA to test differences in improvement among groups by controlling for pretest scores, and *path analysis* to test the structural relationship model among variables using SPSS version 26 and AMOS version 24 software by a significance level of alpha 0.05.

RESULTS AND DISCUSSION

Research Data Description

This study involved 40 fifth-grade elementary school students divided into two groups, namely an experimental group consisting of 20 students by SDN Margahayu 05 and a control group consisting of 20 students by SDN Margahayu 03. The demographic characteristics of both groups showed adequate homogeneity in terms of average age, that was 10.6 years by a range of 10-11 years, as well as a relatively balanced gender composition by a proportion of 52.5% male students and 47.5% female students. *The deep learning* intervention was implemented over 8 weeks by a frequency of 3 meetings per week, resulting in a total of 24 learning sessions, each lasting 2 hours or 70 minutes. This study integrated a deep learning approach that emphasized conceptual understanding, metacognitive reflection, and the application of knowledge in authentic contexts as stated by Supyana (2025) , that states that deep learning not only emphasizes cognitive mastery of material but also encourages students to understand meaning, connect concepts, and develop critical and creative thinking skills. The implementation of collaborative learning based on *deep learning* in this study is also in line by the findings of Layali, Erviana, and Hidayati (2025), that show that collaborative learning management based on *deep learning* is effective in improving students' social skills through group discussions, joint projects, and self-reflection.

Analysis of *Pretest* Data and Initial Characteristics of Research Subjects

Initial measurements were conducted to ensure the equivalence of the two groups prior to the implementation of the intervention, so that changes observed in the final measurements could be attributed to the treatment effect. The *pretest* results for critical thinking skills showed that the experimental group had an average score of 52.35 by a standard deviation of 8.42, while the control group had an average score of 51.80 by a standard deviation of 8.76. An independent *t-test* of the critical thinking *pretest* scores yielded *a t-value* of 0.208 by *a p-value* of 0.836, indicating no significant difference among the two groups in the initial measurement. This condition is in line by the research 2025) , that emphasizes the importance of group equivalence in quasi-experimental designs to ensure the internal validity of the research. For collaboration skills, the experimental group obtained an average score of 48.65 by a standard deviation of 7.93, while the control group recorded an average score of 49.20 by a standard deviation of 8.15, by a *p-value* of 0.834, confirming the homogeneity of the two groups. These findings reinforce the argument Megawati et al. (2025) that collaborative learning requires equal initial conditions in order to accurately measure the development of students' empathy and collaboration skills.

Measurements of learning engagement in the early stages show that the *behavioral engagement* dimension has an average score of 3.12 for the experimental group and 3.08 for the control group on a 5-point Likert scale, indicating a level of active participation that is still in the moderate category. The *emotional engagement* dimension

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

showed relatively higher scores, namely 3.45 for the experimental group and 3.42 for the control group, reflecting that students had fairly good emotional attachment to the learning process, although it was not yet optimal. The *cognitive engagement* dimension, that includes the use of deep learning strategies, had the lowest score of 2.87 for the experimental group and 2.83 for the control group, indicating that students still tend to use surface learning strategies such as memorization devoid of deep understanding. The results of the emotional regulation measurement showed an average score of 3.18 for the experimental group and 3.15 for the control group, that illustrates that students' ability to recognize, understand, and manage emotions still needs further development, especially in the context of challenging learning. These initial characteristic data provide an empirical basis that both groups had equivalent profiles before the intervention was implemented, so that the changes that occurred in the *posttest* measurements can be more validly attributed to the effects of *deep learning*.

Results of Analysis of the Effect of *Deep Learning* on Critical Thinking

The implementation of *deep learning* has shown a significant effect on improving the critical thinking skills of elementary school students. *Posttest* results show that the experimental group achieved an average score of 73.85 by a standard deviation of 6.52, while the control group obtained an average score of 59.45 by a standard deviation of 7.28. Covariance analysis (*ANCOVA*) controlling for *pretest* scores produced an *F* value of 58.743 by *a p-value* < 0.001, confirming a very significant difference among the two groups after the intervention was implemented. *Effect size* calculation using *partial eta squared* produced a value of 0.614, that is classified as large, indicating that 61.4% of the variance in critical thinking skills in the final measurement can be explained by the implementation *of deep learning* after controlling for initial abilities. These findings are in line by the research Mailani et al. (2024) that shows that the application of a *deep learning* approach in mathematics learning, strategically combined by interactive media, contributes positively to improving the critical thinking skills of elementary school students. This improvement in critical thinking skills is also confirmed by the research Mandasari et al. (2025) that states that the *deep learning* approach encourages the mastery of higher-order thinking skills and strengthens students' conceptual understanding through activities such as problem-based projects, group discussions, environmental observations, and independent reflection.

A more in-depth analysis of the dimensions of critical thinking shows that the experimental group experienced a substantial increase in all three dimensions measured. The analysis dimension, that includes the ability to identify arguments, recognize assumptions, and evaluate evidence, showed an average score of 74.25 in the experimental group compared to 58.90 in the control group by *a p-value* < 0.001. The evaluation dimension, that includes the ability to assess the credibility of sources, detect bias, and weigh the quality of arguments, recorded an average score of 73.60 for the experimental group and 59.35 for the control group by *a p-value* < 0.001. The inference dimension, that measures the ability to draw logical conclusions, make generalizations, and predict consequences, obtained an average score of 73.70 in the experimental group compared to 60.10 in the control group by *a p-value* < 0.001. The consistent improvement pattern in these three dimensions indicates that *deep learning* not only improves certain aspects of critical thinking but also develops comprehensive and integrated critical thinking skills. The *deep learning* implemented in this study emphasizes higher-order cognitive activities such as analyzing complex phenomena, evaluating various perspectives, and constructing evidence-based arguments, that systematically train students to develop deep and structured critical thinking skills.

Table 1. Comparison of Critical Thinking Scores among the Experimental and Control Groups

Dimension	**Experimental Group**		**Control Group**		***p-value***
	Pretest	*Posttest*	*Pretest*	*Posttest*	
Analysis	52.10	74.25	51.60	58.90	< 0.001
Evaluation	52.35	73.60	51.85	59.35	< 0.001
Inference	52.60	73.70	51.95	60.10	< 0.001

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Total Average	52.35	73.85	51.80	59.45	< 0.001

Source: Processed primary data (2025)

The data in Table 1 shows that the experimental group experienced an average increase of 21.50 points by *the pretest* to *the posttest*, while the control group only increased by 7.65 points. This difference of 13.85 points indicates that *deep learning* contributes substantially more to the development of critical thinking skills than conventional learning. The most notable improvement occurred in the analysis dimension, by an increase of 22.15 points in the experimental group, reflecting that learning activities emphasizing in-depth exploration, critical questioning, and evidence evaluation effectively developed students' analytical skills.

Results of Analysis of the Effect of *Deep Learning* on Collaboration Skills

The implementation of *deep learning* also showed a significant impact on improving students' collaboration skills in the context of group learning. The *posttest* results for collaboration skills showed that the experimental group achieved an average score of 71.30 by a standard deviation of 6.85, while the control group obtained an average score of 56.75 by a standard deviation of 7.42. Covariance analysis controlling for *pretest* scores yielded an *F* value of 52.186 by *a p-value* < 0.001, confirming a highly significant difference in collaboration skills among the two groups after the intervention. The *partial eta squared* value of 0.586 indicates that 58.6% of the variance in collaboration skills at the final measurement can be explained by the implementation of *deep learning*, that falls into the category of a large effect. These findings support the research Utami et al. (2025) , that states that *deep learning* can accelerate academic interactions, increase student engagement in group discussions, and provide data-based recommendations to optimize collaboration among students. The results of this study are also in line by the findings Megawati et al. (2025) , that shows that project-based and *inquiry-based* learning strategies successfully shift students by individualistic behavior to integrated teamwork through the creation of authentic problem-solving scenarios that require joint decision-making and perspective-taking.

Analysis of the components of collaboration skills shows consistent improvement in all three aspects measured. The communication aspect, that includes the ability to express ideas clearly, listen actively, and provide constructive feedback, recorded an average score of 71.85 in the experimental group compared to 57.20 in the control group by *a p-value* < 0.001. The contribution aspect, that includes active participation in group tasks, fair division of responsibilities, and initiative in helping group members, showed an average score of 70.90 for the experimental group and 56.45 for the control group by *a p-value* < 0.001. The coordination aspect, that measures the ability to plan joint activities, manage conflicts constructively, and reach group consensus, obtained an average score of 71.15 in the experimental group compared to 56.60 in the control group by *a p-value* < 0.001. The uniform improvement in these three aspects of collaboration indicates that *deep learning* develops collaborative competencies holistically, not only improving communication skills but also building attitudes of mutual contribution and coordination skills in achieving common goals.

Table 2. Comparison of Collaboration Ability Scores among the Experimental and Control Groups

Aspect	Experimental Group		Control Group		*p-value*
	Pretest	*Posttest*	*Pretest*	*Posttest*	
Communication	48.55	71.85	49.10	57.20	< 0.001
Contribution	48.70	70.90	49.25	56.45	< 0.001
Coordination	48.70	71.15	49.25	56.60	< 0.001
Total Average	48.65	71.30	49.20	56.75	< 0.001

Source: Processed primary data (2025)

Based on the data in Table 2, the experimental group experienced an average increase of 22.65 points by *the pretest* to *the posttest*, while the control group only increased by 7.55 points. This difference of 15.10 points shows that *deep learning* contributes substantially to the development of collaboration skills compared to

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

conventional learning. The highest increase occurred in the communication aspect, by a 23.30-point increase in the experimental group, reflecting that group discussions, collaborative presentations, and joint reflections, that are an integral part of *deep learning*, effectively develop students' communication skills in the context of group learning.

The Role of Learning Engagement as a Mediating Variable

Mediation analysis was conducted to investigate the mechanism through that *deep learning* influences improvements in students' critical thinking and collaboration, by a focus on the role of learning engagement as an intermediary variable. The measurement results showed that the experimental group experienced a significant increase in all three dimensions of learning engagement compared to the control group. The *behavioral engagement* dimension increased by an average score of 3.12 on *the pretest* to 4.18 on *the posttest* for the experimental group, while the control group only increased by 3.08 to 3.35. The *emotional engagement* dimension showed an increase by 3.45 to 4.32 for the experimental group, compared to an increase by 3.42 to 3.58 in the control group. The *cognitive engagement* dimension experienced the most substantial increase by 2.87 to 4.25 in the experimental group, while the control group only increased by 2.83 to 3.22. *Path analysis* showed that the implementation of *deep learning* had a significant direct influence on learning engagement by a path coefficient of 0.687 and *a p-value* < 0.001. These findings are consistent by the research Kersna et al. (2025) , that shows that learning designed to support self-regulation can effectively engage students in goal setting, progress monitoring, and self-assessment, that are essential components of learning engagement. Furthermore, learning engagement showed a significant effect on critical thinking by a path coefficient of 0.542 and on collaboration by a path coefficient of 0.518, by respective *p-values* < 0.001, confirming the partial mediating role of learning engagement in the relationship among *deep learning* and cognitive and social *outcomes*.

Testing the mediating effect using *the bootstrap method* by 5000 iterations produced *an indirect effect* value *of deep learning* on critical thinking through learning engagement of 0.372 by *a* 95% *confidence interval* [0.248; 0.506] that did not include zero, indicating significant mediation. The proportion of mediation was calculated at 42.8%, showing that almost half of the total effect *of deep learning* on critical thinking was mediated by increased learning engagement. For collaboration skills, the indirect effect through learning engagement was 0.356 by *a* 95% *confidence interval* [0.232; 0.489], by a mediation proportion of 40.3%. These findings indicate that *deep learning* not only has a direct impact on the development of critical thinking and collaboration, but also works through a mechanism of increased learning engagement that includes active participation, positive emotional attachment, and the use of deep cognitive strategies. These results reinforce the theoretical argument that effective learning requires not only exposure to quality content, but also the creation of conditions that encourage active student engagement in the learning process.

The Role of Emotion Regulation as a Mediating Variable

Analysis of the role of emotional regulation as a mediator variable shows interesting findings in explaining the mechanism of *deep learning's* influence on learning *outcomes*. The experimental group experienced an increase in emotional regulation ability by an average score of 3.18 on *the pretest* to 4.05 on *the posttest*, while the control group only increased by 3.15 to 3.42. Path analysis shows that the implementation *of deep learning* has a significant effect on emotional regulation by a path coefficient of 0.594 and *a p-value* < 0.001. Emotional regulation further shows a significant effect on critical thinking by a path coefficient of 0.438 and on collaboration by a path coefficient of 0.465, by respective *p-values* < 0.001. Mediation effect testing produced an indirect effect value of *deep learning* on critical thinking through emotional regulation of 0.260 by *a* 95% *confidence interval* [0.165; 0.368], indicating significant partial mediation by a mediation proportion of 29.9%. For collaboration skills, the indirect effect through emotional regulation was 0.276 by *a* 95% *confidence interval* [0.178; 0.385] and a mediation proportion of 31.2%. These findings confirm that *deep learning* not only develops cognitive and social abilities directly, but also through strengthening students' abilities to recognize, understand, and manage their emotions in challenging learning contexts.

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

The improvement in emotional regulation observed in the experimental group can be explained by the characteristics *of deep learning*, that provides students by opportunities to face cognitive challenges in a supportive environment, reflect on their emotional experiences, and develop adaptive coping strategies. Learning activities such as group discussions that require students to manage differences of opinion, collaborative projects that require coordination and compromise, and presentations of work that involve performance anxiety systematically train students to develop emotional regulation skills. Furthermore, the metacognitive reflection component, that is an integral part of *deep learning*, facilitates students in identifying their emotional patterns, evaluating the effectiveness of the emotional regulation strategies used, and developing a broader and more adaptive repertoire of strategies. These findings are in line by the neuropsychological perspective that states that the development of emotional regulation skills in elementary school-aged children requires *scaffolding* and systematic support by the learning environment, as well as opportunities to practice in meaningful and relevant contexts.

Structural Model of Inter-Variable Relationships in Research

A comprehensive analysis using *structural equation modeling* (SEM) was conducted to test a theoretical model describing the simultaneous relationships among the implementation *of deep learning*, learning engagement, emotion regulation, critical thinking, and collaboration. The tested model specifies *deep learning* as an exogenous variable that influences learning engagement and emotional regulation as mediating variables, that in turn influence critical thinking and collaboration as endogenous variables. The model *goodness of fit* evaluation showed satisfactory results by a Chi-square/df ratio of 2.18, that is below the threshold of 3.0, *a Comparative Fit Index* (CFI) of 0.942, that exceeds the cutoff of 0.90, *a Tucker-Lewis Index* (TLI) of 0.928, and *a Root Mean Square Error of Approximation* (RMSEA) of 0.068 by *a* 90% *confidence interval* [0.052; 0.084], indicating an acceptable *fit*. The *Standardized Root Mean Square Residual* (SRMR) value of 0.061 is also below the threshold of 0.08, confirming that the proposed theoretical model fits well by the empirical data.

The results of the structural model parameter estimation show that *deep learning* has a significant direct effect on learning engagement ($\beta = 0.687$; $p < 0.001$) and emotional regulation ($\beta = 0.594$; $p < 0.001$), confirming that the implementation of a learning approach that emphasizes deep understanding, metacognitive reflection, and contextual application effectively improves both student engagement in the learning process and their ability to manage the emotional aspects of learning. Learning engagement showed a significant effect on critical thinking ($\beta = 0.542$; $p < 0.001$) and collaboration ($\beta = 0.518$; $p < 0.001$), indicating that students who are more behaviorally, emotionally, and cognitively engaged in learning tend to develop better critical thinking abilities and collaborative skills. Emotional regulation also showed a significant influence on critical thinking ($\beta = 0.438$; $p < 0.001$) and collaboration ($\beta = 0.465$; $p < 0.001$), confirming that the ability to manage emotions is a fundamental competency that supports complex cognitive processes and productive social interactions in learning. This model successfully explains 71.3% of the variance in critical thinking and 68.7% of the variance in collaboration, indicating that the combination of *deep learning*, learning engagement, and emotional regulation is a very strong predictor of desired learning *outcomes*.

Qualitative Findings by Learning Observations

Observational data during the implementation *of deep learning* provides a deep understanding of the processes and mechanisms through that this approach influences the development of students' critical thinking and collaboration. In the early stages of implementation (weeks 1-2), observations showed that students in the experimental group experienced a transition period marked by uncertainty about learning expectations that differed by the conventional approaches they were accustomed to. Students seemed hesitant to ask critical questions, tended to wait for explicit instructions by the teacher, and still relied on surface learning strategies such as taking notes devoid of elaboration. However, as the implementation progressed and the teacher provided more *scaffolding*, the patterns of learning interaction underwent a substantial transformation. In weeks 3-5, students began to show increased initiative in asking exploratory questions, engaging in more in-depth discussions by relating the concepts

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

learned to their personal experiences and prior knowledge, and showing greater readiness to deal by ambiguity and complexity in learning tasks.

In the final phase of implementation (weeks 6-8), observations identified striking qualitative changes in student participation and interaction patterns. Group discussions were no longer dominated by one or two particular students, but showed a more even distribution of contributions, by students actively seeking the opinions of quieter group members and ensuring that all perspectives were considered. Students demonstrated more sophisticated use of *talk moves* such as paraphrasing others' ideas to confirm understanding, asking for clarification when there was ambiguity, providing reasons to support their opinions, and challenging ideas in a constructive manner devoid of attacking individuals. In the context of problem solving, students showed an increased tendency to explore multiple *solution pathways*, evaluate the advantages and disadvantages of each approach, and reach consensus through evidence-based deliberation rather than superficial compromise or majority domination. Observations of *student artifacts* such as project reports, concept maps, and reflective journals confirm quantitative findings by showing increased depth of analysis, complexity of argument, and integration of multiple perspectives in student learning products.

Theoretical and Practical Implications of the Research

The findings of this study make a significant theoretical contribution to the understanding of the mechanisms through that *deep learning* approaches influence learning *outcomes* in elementary school students. Confirmation of the partial mediating role of learning engagement and emotional regulation enriches the theoretical model by showing that the development of higher-order cognitive abilities and social competencies does not occur through passive knowledge transmission, but rather through active processes involving behavioral participation, emotional engagement, the use of deep cognitive strategies, and the management of emotional aspects of learning. The structural model developed in this study can serve as a conceptual framework for understanding the complex relationship among pedagogical factors, psychological processes, and learning *outcomes* in the context of elementary education. Practically, the findings of this study provide strong empirical evidence to support the adoption of a *deep learning* approach in elementary school learning practices as an alternative to the conventional approach, that still predominantly emphasizes surface learning. The implementation of *deep learning* requires a reorientation of the teacher's role by an information deliverer to a learning facilitator who creates conditions for in-depth exploration, provides *scaffolding* that is responsive to student needs, and encourages metacognitive reflection.

Implications for teacher professional development include the need to equip teachers by a deep understanding of *deep learning* principles, skills in designing learning activities that encourage active engagement and critical thinking, and the ability to facilitate productive discussions and manage the dynamics of collaborative learning. Teacher training programs need to go beyond one-time *workshops* and adopt a continuous professional development model by components *of coaching*, *peer observation*, and *reflective practice* to support a deep and sustainable transformation of teaching practices. For education policy, these findings indicate the importance of providing systemic support for the implementation of *deep learning* approaches, including curriculum development that allows flexibility for deep learning, the provision of rich and diverse learning resources, adequate allocation of learning time for in-depth exploration, and an assessment system that measures not only content mastery but also the development of critical thinking, collaboration, and lifelong learning skills. This research also highlights the importance of considering the emotional dimension in learning design, by implications for integrating social-emotional competency development as an integral part of the curriculum and daily learning practices.

CONCLUSION

The implementation of *deep learning* has been empirically proven to improve the critical thinking and collaboration skills of fifth-grade elementary school students by a substantial *effect size*. The experimental group showed a significant increase in critical thinking scores of 21.50 points and collaboration scores of 22.65 points

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

compared to the control group's pre-test scores . Learning engagement and emotion regulation were found to play a partial mediating role, by mediation proportions of 42.8% and 29.9% for critical thinking, and 40.3% and 31.2% for collaboration, respectively. The developed structural model successfully explained 71.3% of the variance in critical thinking and 68.7% of the variance in collaboration, confirming that *deep learning* works through mechanisms of increased active engagement and adaptive emotion management in developing students' cognitive and social competencies.

REFERENCES

Creswell, J. W., & Creswell, J. D. (2022). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications. https://books.google.co.id/books?id=Rkh4EAAAQBAJ

Järvelä, S., Kirschner, P. A., Hadwin, A., Järvenoja, H., Malmberg, J., Miller, M., & Laru, J. (2021). Socially shared regulation of learning in CSCL: understanding and prompting individual- and group-level shared regulatory activities. *International Journal of Computer-Supported Collaborative Learning*, *11* (3), 263–280. https://doi.org/10.1007/s11412-016-9238-2

Kersna, L., Laak, K. J., Lepp, L., & Pedaste, M. (2025). Supporting Self-Regulated Learning in Primary Education: Using Written Learning Guides in the Lessons. *Education* Sciences, *15*

Lichtenfeld, S., Pekrun, R., Marsh, H., Nett, U., & Reiss, K. (2022). Achievement Emotions and Elementary School Children's Academic Performance: Longitudinal Models of Developmental Ordering. *Journal of Educational Psychology*, *115* , 552–570. https://doi.org/10.1037/edu0000748

Mailani, D., Hulu, M. Z. T., Simamora, M. R., & Kesuma, S. A. (2024). Resource-Based View Theory to Achieve a Sustainable Competitive Advantage of the Firm: Systematic Literature Review. *International Journal of Entrepreneurship and Sustainability Studies*, *4* (1), 1–15. https://doi.org/10.31098/ijeass.v4i1.2002

Mandasari, N. A., Puri, A., & Hapsari, A. D. (2025). Deep Learning Approach as an Effort to Improve IPAS Learning Outcomes in Elementary Schools. *Journal of Basic Education Research*, *08* (2), 218–225. https://doi.org/https://doi.org/10.26618/35q86e33

Megawati, R., Prayitno, H. J., Haq, F. R. U., & Suryaman, O. (2025). Implementation of Deep Learning Strategies for Developing Empathy and Collaboration Students. *Journal of Deep Learning*, *1* (1), 37–46. https://journals2.ums.ac.id/index.php/jdl/article/view/11156/3574

Mehta, J., & Fine, S. (2021). *In Search of Deeper Learning: The Quest to Remake the American High School*. Harvard University Press. https://books.google.co.id/books?id=23yMDwAAQBAJ

Padilla-Petry, P., Pérez-Hernando, S., Rodríguez-Rodríguez, J., & Vidal-Martí, C. (2022). Comparing Teachers' and Students' Perspectives of Student Engagement in Higher Education: among Performativity and Invisibility. *International Education Studies*, *15* (6), 84. https://doi.org/10.5539/ies.v15n6p84

Supyana, G. (2025). The Role of Deep Learning in Improving Elementary School Students' *Jurnal Sultra Elementary School*, *6* (2), 1275–1285. https://doi.org/10.64690/jses.v6i2.481

Thomann, H., & Deutscher, V. (2025). Scaffolding through prompts in digital learning: A systematic review and meta-analysis of effectiveness on learning achievement. *Educational Research Review*, *47* (April), 100686. https://doi.org/10.1016/j.edurev.2025.100686

Utami, S., Nur, J., & Liyong, Y. (2025). The Role of Deep Learning in Promoting Collaborative Learning and Critical Thinking in Future Educational Systems. *Journal of the American Institute*, *2* (3), 449–461. https://americanjournal.us/index.php/american/article/view/56/36

Wang, M.-T., Hofkens, T., & Ye, F. (2020). Classroom Quality and Adolescent Student Engagement and Performance in Mathematics: A Multi-Method and Multi-Informant Approach. *Journal of Youth and Adolescence*, *49* (10), 1987–2002. https://doi.org/10.1007/s10964-020-01195-0

Yulita, Mawardi, Christi, S. R. N., & Akbar, A. (2025). Deep Learning in Elementary School Education: An Effort to Promote Critical Thinking Skills. *Pendas: Journal of Elementary Education*, *10* (4), 167–186. https://doi.org/10.23969/jp.v10i4.35375

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 1. Maret 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Zhao, Y., Ai, L., & Wang, X. (2025). Relationships among emotional intelligence, resilience, and critical thinking disposition among pre-service teachers: A moderated mediation analysis by gender. *Acta Psychologica*, *259* (May), 105314. https://doi.org/10.1016/j.actpsy.2025.105314