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Developing Creative Thinking Skills in Elementary School Students through the Implementation of Deep Learning

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ABSTRACT

Objective: *This study aims to analyze the feasibility and effectiveness of Deep Learning-based instructional materials in enhancing students' creative thinking skills. The results of this study are expected to contribute to the development of innovative learning approaches that support the enhancement of 21st-century competencies.* ***Method:*** *This study employed the Research and Development (R&D) method using the 4-D development model, which includes the Define, Design, Develop, and Disseminate stages. Data were collected through questionnaires, observations, and documentation. The research subjects consisted of 40 students at Muhammadiyah 2 Elementary School in Tulangan.* ***Results:*** *Validation results showed that the Learning Module received a score of 4.1 (95%) and the Student Worksheets (LKPD) received a score of 4.1 (95%), both falling into the "highly valid" category, while the creative thinking skills test instrument received a score of 3.9 (97%), falling into the "valid" category. The results of the effectiveness test based on N-Gain analysis showed that the improvement in students' creative thinking skills fell into the "high" category. These findings indicate that Deep Learning-based learning tools are feasible and effective for supporting the development of students' creative thinking skills.* ***Novelty:*** *This study proposes the application of Deep Learning-based learning tools as an innovative approach to developing 21st-century skills. The implementation of this approach serves as an alternative for preparing students to meet the educational demands of the Fourth Industrial Revolution era by strengthening their creative thinking abilities.*

INTRODUCTION

Elementary education plays a crucial role in building character, developing skills, and fostering students' higher-order thinking skills to equip them to face the complexities of life in the 21st century [1]. At this stage, the learning process is not only directed toward mastering knowledge but also toward developing competencies that enable students to think critically, generate creative ideas, collaborate, and communicate effectively. This aligns with the 21st-Century Learning Framework, which identifies creativity as one of the core competencies—alongside critical thinking, collaboration, and communication—that must be instilled starting in elementary school [2].

Nevertheless, teaching practices at the elementary level still face challenges in developing students' creative thinking skills. A learning approach that is predominantly rote-memorization-oriented tends to limit students' opportunities to understand concepts in depth, explore ideas, and build creative problem-solving skills [3]. These conditions contribute to low levels of higher-order thinking skills (HOTS) among students, particularly in developing countries, including Indonesia [4].

The results of the 2019 Trends in International Mathematics and Science Study (TIMSS) indicate that Indonesian students' analytical thinking skills remain relatively

low, as evidenced by only about 3% of fourth-grade students achieving the high-level analytical thinking category, while the international average stands at 10% [5]. This situation, which aligns with PISA results at higher education levels, indicates that the development of higher-order thinking skills—including creative thinking—still requires reinforcement starting in elementary school. These findings are consistent with the results of a preliminary study conducted at Muhammadiyah 2 Elementary School in Tulangan, which has implemented the Merdeka Curriculum and is currently developing a deep learning approach in its teaching process. The implementation of this approach must be supported by instructional materials aligned with the characteristics of the Merdeka Curriculum and the principles of deep learning, so that they not only support the achievement of learning objectives but also provide systematic stimulation for the development of students' creative thinking skills.

Creative thinking skills are a crucial cognitive aspect to be developed in students starting from the elementary education level. This competency is not only related to the ability to generate new ideas but also encompasses the cognitive processes involved in identifying problems, understanding various available information, and designing alternative solutions in a flexible and innovative manner. In learning activities, creative thinking encourages students to explore various possibilities, utilize their imagination, and develop ideas that are diverse and original. Therefore, the development of creative thinking should be understood as a process that encompasses the ability to discover, develop, evaluate, and refine ideas—not merely the production of a final product. In line with this, recent research shows that elementary school students' creative thinking skills can be enhanced through learning that provides space for students to explore problems, generate a variety of alternative ideas, and develop solutions independently [6].

Theoretically, creative thinking skills can be assessed through four main indicators: fluency, flexibility, originality, and elaboration. The fluency indicator reflects a student's ability to generate a number of ideas smoothly, while flexibility relates to the ability to view a problem from various perspectives and generate diverse alternative ideas. Furthermore, originality describes the ability to create unique and distinctive ideas, while elaboration refers to the ability to expand upon, develop, and provide details for the ideas that have been generated. These four aspects serve as key parameters for understanding the extent to which students are able to construct, process, and develop ideas during learning activities. Several studies indicate that learning that provides students with opportunities to explore, construct their thinking, and develop solutions independently can support the enhancement of these various aspects of creativity. This is reinforced by the research of Suryaningsih et al. [7], which shows that the application of the problem-posing approach in mathematics instruction can encourage students to generate and develop creative ideas through the process of formulating and solving problems.

Creative thinking is one of the essential competencies that must be instilled starting in elementary school, as it plays a role in building students' capacity to generate ideas, consider various alternatives, and formulate solutions to the problems they face.

Developing this competency requires a learning environment that provides space for students to actively engage in the process of exploring, creating, and developing ideas. Research by Zakiatuz et al. [8] shows that the implementation of Project-Based Learning supported by three-dimensional media can enhance the creative thinking skills of elementary school students. These findings suggest that project-based learning that provides real-world experiences can encourage students' engagement in constructing knowledge while optimally developing their creativity. Therefore, learning tools are needed that are not only focused on delivering content but are also capable of facilitating the creative thinking process through activities that involve generating, developing, and evaluating ideas.

In the application of the Deep Learning approach, learning success is also influenced by various supporting factors, such as teachers' readiness to design and implement learning strategies, students' active engagement during the learning process, and the availability of facilities and learning resources. This approach is implemented through systematic learning stages, including problem exploration, in-depth investigation, reflection activities, and the application of understanding in real-life contexts [9]. Through these stages, Deep Learning is expected not only to contribute to improving students' academic achievement but also to develop creative thinking skills relevant to facing various situations in life.

This study focuses on the development and implementation of the Deep Learning approach to enhance creative thinking skills among elementary school students. The approach is based on three fundamental principles: mindful, meaningful, and joyful learning, which emphasize active engagement, meaningful understanding, and enjoyable learning experiences. This research aims to investigate how the implementation of Deep Learning can support the development of students' creative thinking skills through structured and concept-oriented learning activities. Furthermore, this study explores the potential application of the developed learning approach in elementary school contexts as an innovative strategy to strengthen 21st-century skills. The findings are expected to provide insights into the design of effective learning practices that foster creative thinking abilities among elementary school students.

RESEARCH METHOD

This study employed a pre-experimental research design using the One Group Pre-Test and Post-Test Design**.** In this design, measurements were conducted before and after the implementation of the treatment. The initial measurement (O_1) was conducted as a pre-test to identify students' abilities before the intervention, while the final measurement (O_2) was administered as a post-test to determine changes in students' abilities after the treatment. The research design is presented as follows [10]:

$$O_1 \; X \; O_2$$

Where:
O_1: Initial test administration (pre-test)
O_2: Final test administration (pos- test)
X: Implementation of the *Deep Learning* approach

The researcher developed learning devices that were subsequently evaluated through an expert validation process. Two experts assessed the developed learning devices using validation sheets containing evaluation scores and provided constructive suggestions and feedback for improvement. The validation results and recommendations from the validators were documented as part of the evaluation process. The assessment was conducted by placing a check mark (√) in the appropriate score column on each validation sheet. The validation instrument consisted of five assessment categories: (a) very poor (score 1), (b) poor (score 2), (c) fairly good (score 3), (d) good (score 4), and (e) very good (score 5). The validity of the learning devices was determined based on the scores obtained from the expert validation questionnaire.

The data regarding students' creative thinking skills were collected through the results of the pre-test and post-test. The obtained data were then analyzed using the N-Gain test to determine the improvement in students' creative thinking skills after the implementation of the *Deep Learning* approach [11]. The N-Gain value was calculated using the following formula (Hake, 1999):

$$N\text{-Gain} = \frac{\text{Spost}-\text{Spre}}{\text{Smax}-\text{Spre}} \quad \text{(Hake, 1999)}$$

Description:
S_{post} = post-test score
S_{pre} = pre-test score
S_{max} = maximum score

The results of the N-Gain calculation were subsequently classified based on the criteria presented in Table 1.

Table 1. N-Gain Criterion.

$N-Gain\ Score$	**Normalized *Gain***
$0{,}70 < \text{N} - \text{Gain}$	High
$0{,}30 \leq \text{N} - \text{Gain} \leq 0{,}70$	Moderate
$\text{N}-\text{Gain} < 0{,}30$	Low

The significance of the improvement in students' creative thinking skills was analyzed through hypothesis testing using a t-test**.** Before conducting the hypothesis test, the N-Gain data were required to meet the assumption of normal distribution. The t-test formula used in this study was based on the following equation [12]:

$$t\text{-}test = \frac{\mathrm{d}}{\frac{sd}{\sqrt{n}}}$$

With:
d : mean value of the difference between paired observations
sd : standard deviation of the differences between paired observations
n : number of samples

RESULTS AND DISCUSSION

This study produced data on the feasibility and effectiveness of developing *Deep Learning*-based instructional materials to foster students' creative thinking skills**.** The development of instructional materials requires a systematic model to ensure that the resulting products align with learning needs and can be effectively implemented. Therefore, this study employed the 4D development model, which consists of the definition (*define*), design (*design*), development (*develop*), and dissemination (*disseminate*) stages. During the definition (*define*) stage, the researcher conducted school observations and analyzed several learning components, including the curriculum, student characteristics, and subject matter concepts. The curriculum analysis was conducted to ensure that the learning resources developed align with the principles of the Merdeka Curriculum, while the student analysis aimed to identify students' abilities in meeting 21st-century competency demands. Additionally, the conceptual analysis was conducted to ensure that the learning material can be systematically understood by students.

The definition phase is a crucial part of developing Deep Learning-based instructional materials because the results of the analysis at this stage serve as the foundation for determining a learning design that meets students' needs. The Deep Learning approach emphasizes learning that encourages students to build deep understanding through exploration, active engagement, and reflection on the learning process. Therefore, an understanding of student characteristics and the structure of the learning material is necessary so that the developed resources can support the development of creative thinking skills. Alignment between the instructional materials and the characteristics of the Merdeka Curriculum is also a key factor in creating learning experiences relevant to 21st-century competency requirements.

The design phase involves the process of organizing the components and structure of Deep Learning-based instructional materials aimed at supporting the improvement of students' creative thinking skills. In this phase, the researcher first establishes the title and designs the framework of the instructional materials as the foundation for product development. Next, the materials—comprising Instructional Modules, Student Worksheets (LKPD), and creative thinking skills assessment instruments—were

developed in accordance with the core principles of the Deep Learning approach: mindful, meaningful, and joyful. The development stage was then carried out to produce instructional materials that had undergone refinement based on feedback from education experts. At this stage, the initial design of the instructional materials is first reviewed by the supervisor to identify shortcomings in both the structure and content of the material. The results of these revisions are then used as a development draft to be validated by education experts using an instructional materials validation sheet.

The dissemination stage serves as the final stage in the 4D development model, involving the implementation of the developed instructional materials to assess their effectiveness in enhancing students' creative thinking skills. The implementation of the instructional materials involves an initial assessment using a pre-test before instruction begins and a final assessment via a post-test after the learning process is complete. The data obtained from these two assessment stages are then analyzed by the researcher to determine changes in students' creative thinking abilities following the implementation of the Deep Learning-based instructional materials. This series of development stages demonstrates that every process within the 4D model plays an interrelated role—from instructional material planning and product validation to effectiveness testing—ensuring that the resulting instructional materials can be used in a more targeted manner to support a learning process oriented toward fostering students' creativity.

Before being used in the pilot testing phase with students, the developed learning materials first underwent an evaluation and validation process by a team of validators to ensure their suitability and alignment with learning objectives. The components of the materials subject to validation include the Instructional Modules, Student Worksheets (LKPD), and the Creative Thinking Skills Test instrument. The assessment results from education experts regarding each material indicate the level of suitability obtained through the validation process of the learning instruments, as presented below:

Table 2. Validation Results.

Device	Average	Presentase (%)	Category
Teaching Module	4.1	95 %	SV
Learner Worksheet	4.1	95 %	SV
Creative Thinking Skills Test	3.9	97 %	V

The validity of the learning materials was tested to determine the level of suitability and accuracy of the instruments developed in measuring competencies in accordance with the established learning objectives. The validation process was carried out through an assessment of the learning materials and instruments based on the evaluators' findings [13]. The validation results showed that all of the learning materials and instruments developed met the criteria for suitability for use in the learning process. The learning module achieved a suitability level of 95%, falling into the "highly valid" category; the

Student Worksheet (LKPD) scored 95%, also falling into the "highly valid" category; while the creative thinking skills test instrument achieved a suitability level of 97%, falling into the "valid" category. These validity results indicate that the instructional materials were designed in accordance with the learning outcome indicators and demonstrate a strong alignment between the content, learning activities, and instruments for measuring student abilities.

The instructional materials, having undergone the validation phase, were subsequently tested for their effectiveness in supporting the development of students' creative thinking skills. The effectiveness test was conducted by analyzing improvements in student abilities through a comparison of pre-test and post-test results. This analysis of improvement used the normalized gain (N-Gain) method to determine the level of change in creative thinking abilities following the implementation of the Deep Learning-based instructional package. The calculated N-Gain values obtained from the research data are presented in Table 3.

Table 3. N-Gain Results (%).

Descriptives				
	class		Statistic	Std. Error
N-gain (%)	Experiment	Mean	76.6667	3.29362
		Minimum	50.00	
		Maximum	100.00	
	control	Mean	66.6190	4.46608
		Minimum	33.33	
		Maximum	100.00	

Based on the data in Table 3, the effectiveness of the learning tool was tested on 20 students in the experimental class and 20 students in the control class who took the creative thinking skills test. The results of the analysis using N-Gain scores showed a difference in skill improvement between the two groups. The control class achieved an average N-Gain score of 66.6, classified as moderate, while the experimental class achieved an N-Gain score of 76.7%, classified as high. This difference in achievement indicates that the use of Deep Learning-based instructional tools provides a more optimal improvement in training students' creative thinking skills compared to instruction in the control class. This finding aligns with Harapit's research titled "Development of Problem-Based Learning Tools to Facilitate Mathematical Reasoning Skills" [14], which shows that the development of systematically designed instructional tools can support improvements in students' thinking abilities.

The N-Gain analysis also revealed that the majority of students experienced an improvement in their creative thinking skills after participating in learning integrated with the Deep Learning approach. Of all students, 19 were in the moderate category and 21 were in the high category. This improvement indicates that the implementation of

Deep Learning provides a learning experience that fosters students' creativity through a learning process involving exploration, interaction, and discussion. The effectiveness of this approach is influenced not only by the instructional materials used but also by the teacher's ability to create a learning environment that supports students' active engagement in developing ideas and solving problems [15]. The distribution of students' creative thinking skills based on creativity indicators is presented in Table 4.

Table 4. Calculation Results of Completeness of Creative Thinking Indicators.

No	Indicator	question number	Pre-test				Post-test				N-Gain	category
			T	TT	%K	X (%)	T	TT	%K	X (%)		
1	Fluency	6	24	16	60	47.5	36	4	90	81.3	0.64	High
		10	14	26	35		29	11	73			
2	Originality	1	25	15	63	56.3	36	4	90	87.5	0.71	High
		3	20	20	50		34	6	85			
3	Elaborasi	2	26	14	65	67.5	36	4	90	92.5	0.77	High
		4	24	16	60		35	5	88			
		8	31	9	78		40	0	100			
4	Flexibility	5	26	14	65	60.8	35	5	88	90.8	0.77	High
		7	26	14	65		36	4	90			
		9	21	19	53		38	2	95			

Based on the analysis results in Table 4, the implementation of Deep Learning-based instructional materials showed improvements across all indicators of students' creative thinking skills. All four indicators achieved N-Gain scores in the high category, indicating that the instructional materials developed were able to positively influence the improvement of students' creative thinking abilities. The fluency indicator increased by 33.8%, from a pre-test score of 47.5% to 81.3% on the post-test. The originality indicator increased by 31.2%, from 56.3% to 87.5%. Furthermore, the elaboration indicator increased by 25.0%, from 67.5% on the pre-test to 92.5% on the post-test, while the flexibility indicator increased by 30.0%, from 60.8% to 90.8%. These results indicate that Deep Learning-based instructional materials are capable of facilitating students in developing various aspects of creativity, ranging from the ability to generate ideas, create diverse concepts, to expanding and refining solutions to a problem.

The improvement in each creative thinking skill indicator suggests that the implementation of learning tools designed based on Deep Learning principles can foster

a more active, reflective, and meaningful learning process for students. Through exploration, discussion, and idea development, students gain the opportunity to build a deeper understanding and optimize their higher-order thinking skills. Furthermore, to determine the significance of the improvement in creative thinking skills before and after the implementation of the Merdeka Curriculum-based learning tools, an analysis was conducted using a paired-sample t-test. This test aimed to identify differences in students' abilities based on the pre-test and post-test results. The results of the paired-sample t-test analysis of students' creative thinking skills are presented in Table 5.

Table 5. Pairwise T-Test Results Class A.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	60.0000	20	13.37712	2.99122
	Posttest	90.5000	20	6.04805	1.35239

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	20	.455	.044

Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	-3.05000E1	11.90975	2.66310	-36.07393	-24.92607	-11.453	19	.000

Based on the data presented in Table 10, there was a difference in students' creative thinking skills before and after the implementation of the Deep Learning-based instructional materials. The analysis results show that the average pre-test score was 60.00, while the average post-test score increased to 90.50. This change indicates an improvement in students' creative thinking skills after participating in the learning process using the developed instructional materials. Furthermore, the results of the statistical test showed a p-value of 0.000 < 0.05; therefore, the test decision was to reject H0 and accept Ha [16].

These statistical test results indicate that there is a significant difference between students' creative thinking abilities before and after the implementation of the Deep Learning-based learning tool. Thus, the developed learning tool is deemed valid and effective in supporting the improvement of Class A students' creative thinking abilities.

These findings demonstrate that the implementation of a systematically designed learning tool can provide a learning experience that supports the development of higher-order thinking skills through a more active and meaningful learning process.

Table 6. Pairwise T-Test Results Class B.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	58.5000	20	12.68028	2.83540
	Posttest	87.0000	20	8.01315	1.79179

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	20	.161	.499

Paired Samples Test

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest - Posttest	-2.85000E1	13.86969	3.10136	-34.99122	-22.00878	-9.190	19	.000

Based on the analysis results in Table 6, there was an improvement in students' creative thinking skills following the implementation of Deep Learning-based instructional materials. This was demonstrated by the difference in average scores between the pre-test and post-test results. In the pre-test phase, students achieved an average score of 58.50, whereas in the post-test phase, there was an improvement, with the average score reaching 87.00. Furthermore, the results of the statistical test show that the p-value is 0.000 < 0.05; therefore, the test decision is to reject H0 and accept Ha [16].

These results indicate that the implementation of Deep Learning-based instructional materials has a significant effect on improving the creative thinking skills of Class B students. The difference in results before and after instruction suggests that the developed materials are capable of supporting a more effective learning process in developing students' creative thinking skills. Thus, the Deep Learning instructional materials are deemed valid and effective for use as an alternative in enhancing students' creative thinking skills through targeted and meaningful learning activities.

CONCLUSION

Fundamental Finding:

The results of the development study indicate that the Deep Learning-based instructional tool designed to enhance students' creative thinking skills has met the criteria for feasibility and effectiveness as a learning support tool. The development process was conducted systematically, ensuring the completeness of the instructional components to produce a product aligned with learning needs. The tool's feasibility was demonstrated through a validation process involving two experts: a curriculum expert and an instructional design expert. Based on the validators' assessments, the Learning Module received a score of 4.1 (95%) and the Student Worksheet received a score of 4.1 (95%), both falling into the "highly valid" category, while the creative thinking skills test instrument received a score of 3.9 (97%), falling into the "valid" category. These results indicate that the developed tools demonstrate alignment among the learning components, content, and instruments for measuring student abilities.

From the perspective of effectiveness, the implementation of the Deep Learning-based instructional package showed an improvement in students' creative thinking skills based on the results of the field test analysis. The average N-Gain score in the control class reached 66.6, categorized as moderate, while the experimental class achieved a score of 76.7%, categorized as high. This difference in achievement indicates that the use of the Deep Learning-based instructional package contributes more effectively to supporting the development of students' creative thinking skills. This is reinforced by the results of statistical testing using a paired-sample t-test, which yielded a significance level of $\alpha < 0.05$; thus, the test results indicate that H0 is rejected and HA is accepted. Consequently, Deep Learning-based learning tools have been proven to have a significant impact on improving students' creative thinking skills and have the potential to serve as an alternative learning tool that supports the development of 21st-century competencies.

Implication: The findings of this study suggest that the Deep Learning-based learning tools developed are sufficiently viable for use in learning activities. This is demonstrated by the fulfillment of three key aspects validity, practicality, and effectiveness thereby enabling these tools to support a learning process focused on enhancing students' creative thinking skills. **Limitation:** Although this study yielded positive results, there are limitations regarding the characteristics of the study participants. The study involved only 40 elementary school students; therefore, the generalizability of the findings is still limited to the context and characteristics of students with similar conditions. **Future Research:** Further research is recommended to expand the implementation of Deep Learning-based instructional materials through a Research and Development (R&D) approach using the 4-D model, which includes the Define, Design, Develop, and Disseminate phases. Future development efforts may consider applying these materials to a wider variety of subjects, educational levels, or learning contexts to gain a more comprehensive understanding of the effectiveness of the developed materials.

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