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The Effectiveness of Deep Learning to Improving the Critical Thinking Skills in Primary School

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ABSTRACT

Objective: *The purpose of this study is to analyze the feasibility and effectiveness of deep learning tools for training students' critical thinking skills.* ***Method:*** *The type of research used is R&D development research with a 4-D model consisting of four stages, namely Define, Design, Develop, and Disseminate. Data collection techniques consist of questionnaires, observation, and documentation. The research subjects were 40 fifth-grade students at Muhammadiyah 2 Tulangan Elementary School.* ***Results:*** *Based on the feasibility test, the Learning Module validation test scored 4.2 (96%) and the Student Worksheet scored 4.1 (95%) with a status of highly valid, while the critical thinking skills test scored 3.9 (97%) with a status of valid. The effectiveness test with the results of the N-Gain average analysis was in the high category. It can be concluded that the deep learning learning tools is suitable and effective for training students' critical thinking skills.* ***Novelty:*** *Deep learning provides learning opportunities to train 21st-century skills. Education in the era of the 4.0 revolution is a necessity that schools in Indonesia must implement to prepare students for 21st-century skills.*

INTRODUCTION

Basic education is the main foundation for shaping the character, skills, and higher-order thinking skills that students need to face the challenges of the 21st century [1]. The 21st Century Learning Framework document identifies critical thinking as one of four core competencies (critical thinking, creativity, collaboration, communication) that must be developed from elementary school [2]. Various studies show that basic education that focuses on rote learning tends not to produce deep conceptual understanding and does not effectively train students to think critically [3]. This results in low-level thinking skills (HOTS) among students in developing countries, including Indonesia [4].

The Trends in International Mathematics and Science Study (TIMSS, 2019) revealed that only about 3% of fourth-grade students in Indonesia achieved a "high" level of analytical thinking—far below the international average of 10% [5]. This national trend, reflected in low PISA scores in higher grades, reflects a persistent weakness in fostering critical thinking from an early age. Preliminary study results in the learning process at SD Muhammadiyah 2 Tulangan, which has implemented an independent curriculum and is currently being developed with a deep learning approach. The implementation provided must be adapted to the independent curriculum with deep learning, where learning tools are able to accommodate and stimulate students' critical thinking

Critical thinking is an important skill for students to face the challenges of the 21st century [6]. Students' critical thinking skills are relative thinking skills that train reasoning in structured understanding, which makes it easier for students to understand a subject [7]. Critical thinking is the ability that enables a person to solve problems logically and systematically in accordance with the rules of reasoning. This ability also includes a rational attitude in determining reliable information, as well as independence in thinking by considering various aspects in a balanced manner in the decision-making and problem-solving process [8].

In addition, this study also considers a number of aspects that could potentially influence the success of implementing the Deep Learning approach, including the level of teacher readiness in implementing the strategy, active student participation during the learning process, and adequate learning facilities and resources. The implementation of this approach follows a structured process that includes problem exploration, in-depth investigation, reflection, and real-world application [9]. Thus, it is hoped that this approach will not only improve student learning outcomes but also equip them with critical thinking skills that can be applied in various areas of life.

It emphasizes the effectiveness of the Deep Learning approach, which has three main principles: mindful, meaningful, and joyful. This study aims to provide a more comprehensive understanding of how concept-oriented learning strategies can support the development of students' critical thinking skills. In addition, this study also seeks to examine the possibility of systematically applying this approach in school learning practices. The results obtained are expected to serve as a reference in designing more innovative learning strategies that aim to create a conscious, meaningful, and joyful learning atmosphere.

RESEARCH METHOD

The design of this research uses pre-experimentation of One Group Pre-Test and Post-Test Design. Observations carried out before the experiments (O_1) were called pre-tests, and observations after the experiments (O_2) were called post-tests. This research uses the following design research [10]:

$$\mathbf{O_1\ X\ O_2}$$

Where:
O_1: Initial test delivery (pre-test)
O_2: Final Test delivery (pos- test)
X: Deep Learning

The researcher designed the learning devices and gave them to experts to evaluate. Two experts assessed them in validation's sheets in the form of value and gave suggestions and criticism. The results of the validation questionnaire and suggestions from the validator are documented. The validator assessed by checking (√) in the appropriate value column. The column contains the assessment scores that have been

determined, on each validation sheet there are four categories, namely: (a) not good (value 1), (b) not good (value 2), (c) quite good (value 3), (d) good (value 4), and (e) very good (value 5). Analysis of data from the learning devices validation was obtained through the values on the expert validation questionnaire sheet.

From the results of pre-tests and post-test data obtained by learners and then analyzed by using N-Gain to know the critical thinking of learners after using the deep learning [11].

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

Description:

S_{post} = value of post-test

S_{pre} = value of pre-test

S_{max} = maximum value

Next from the N-Gain calculation results are then converted with the criteria in Table 1.

Table 1. N-Gain Criterion

N−Gain Score	**Normalized *Gain***
0,70 < N − Gain	High
0,30 ≤ N − Gain ≤ 0,70	Moderate
N−Gain < 0,30	Low

Significance of improving Critical Thinking Skills is obtained from hypothesis testing using t-tests with the condition that the analyzed n-gain data should be normally distributed. The formula is[12]:

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

With:

d : average value of the difference between paired observations

sd : standard deviation of differences between paired observations

n : number of samples

RESULTS AND DISCUSSION

This study produced data covering the feasibility and effectiveness of developing Deep Learning-based learning tools to train students' critical thinking skills. To obtain feasible and effectiveness that are optimal and can be used appropriately in the learning process, selecting an appropriate development model is very important. Therefore, the process of developing this learning tool refers to the 4D model, which includes the stages of defining, designing, developing, and disseminating.

In the defining stage, the first step taken by the researcher was to observe the school and analyze the learning criteria by analyzing the curriculum, students, and concepts. This analysis is important to ensure that the learning tools are in line with the principles of an independent curriculum. The analysis of students is carried out to assess their ability to face the challenges of the 21st century, while the analysis of concepts aims to ensure that the material taught can be well understood by students.

The design stage is the process of compiling and developing a deep learning-based learning tool structure that aims to train critical thinking skills. The first step is to determine the title and design the systematic content of the learning tools. Next, the Teaching Module, Student Worksheets (LKPD), and critical thinking skills test instruments are developed and compiled with reference to the principles and characteristics of the deep learning approach, with the main principles being mindful, meaningful, and joyful.

The development stage aims to produce deep learning learning tools that have been revised based on input from education experts. This process includes assessing the suitability of the learning tool content. The first stage of development is to design the initial learning tool, which is then reviewed by supervisors to improve the structure and content of the tool that is not suitable. These improvements result in a draft that is then validated by education experts using a tool validation sheet.

The dissemination stage is the process of widespread use of the developed learning tools to test their effectiveness in training critical thinking skills. The process of using the developed learning tools is disseminated after the pre-test stage with students and continued in the post-test stage after being processed by researchers.

Whether a device to be developed before being tested on students must first be reviewed and validated by a team of validators, the validated learning tools include Teaching Modules, Student Worksheets, and Critical Thinking Skills Tests. The results of the assessment conducted by expert education validators on deep learning learning tools show the feasibility that results in the validation of learning instruments as follows:

Table 2. Validation Results

Device	Average	Presentase (%)	Category
teaching module	4.2	96 %	SV
Learner Worksheet	4.1	95 %	SV
Critical Thinking Skills Test	3.9	97 %	V

The purpose of the validity of this learning tool is to determine how accurate the study measurement instrument is in relation to the actual content to be measured. The results show that all materials and instruments are valid and reliable for use in the learning process. The assessment of learning tools and instruments is measured based on the validation results [13]. The suitability of the Learning Module achieved a score of 96%

with a status of highly valid, the suitability of the Student Worksheet (LKPD) achieved a score of 95% with a status of highly valid, and the suitability of the critical thinking skills test achieved a score of 97% with a status of valid. These results were obtained because they had been adjusted to the achievement indicators in accordance with the student worksheets.

The validated learning tools were followed by a calculation of the effectiveness of the learning tools in training students' critical thinking skills, which was evaluated by comparing the pre-test and post-test results using normalized gain (N-Gain). The following presents the N-gain results 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	

Table 3 was obtained from data on 20 students in the experimental class and 20 students in the control class who took the critical thinking test. Based on the N-Gain test score calculations, it can be seen that the average N-Gain score for the control class was 66.6, which is in the moderate category, while for the experimental class, the N-Gain calculation was 76.7%, which is in the high category. Therefore, it can be concluded that the use of deep learning learning tools is effective for training students' critical thinking skills. This is in line with the research written by Harapit entitled Development of Problem-Based Learning Tools to Facilitate Mathematical Reasoning Skills [14].

The N-Gain results show that almost all students experienced an increase in critical thinking skills after learning deep learning-based integration, namely 19 students in the moderate category and 21 students in the high category. The increase in the N- Gain calculation results shows that deep learning is effective in improving Students' critical thinking skills can develop well if teachers are able to create a comfortable learning environment that allows students to interact and discuss [15].

The following Table 4 presents the distribution of critical thinking skills and students based on critical thinking skill indicators:

Table 4. Calculation Results of Critical Thinking Indicator Completeness

No	Indicator	question number	Pre-test				Post-test				N-Gain	Category
			T	TT	%K	X (%)	T	TT	%K	X (%)		
1	Provide a basic statement	2	26	14	65	65.0	36	4	90	90.0	0.71	High
		7	26	14	65		36	4	90			
2	provide a follow-up statement	3	20	20	50	63.8	34	6	85	92.5	0.79	High
		8	31	9	78		40	0	100			
3	Decision making	1	25	15	63	57.5	36	4	90	92.5	0.82	High
		9	21	19	53		38	2	95			
4	Inferensi	4	24	16	60	47.5	35	5	88	80.0	0.62	High
		10	14	26	35		29	11	73			
5	Estimating	5	26	14	65	62.5	35	5	88	88.8	0.70	High
		6	24	16	60		36	4	90			

Based on Table 4, there are five indicators that obtained a high N-Gain, namely in the indicator of presenting basic statements analyzing arguments from a pretest score of 65.0%, there was an increase of 25.5% in the post-test score to 90.0%; the indicator of presenting further statements from a pretest score of 63.8% saw an increase of 28.7% in the post-test score to 92.5%; the indicator of decision making to observe and consider from a pretest score of 57.5% increased by 35.0% in the posttest score to 92.5%, the indicator of inference from a pretest score of 47.5% increased by 32.5% in the posttest score to 80.0%, and the assumption and problem estimation indicator from the pretest value of 62.5% increased by 26.3% in the post-test value to 88.8%.

The effect before and after the use of independent curriculum-based learning tools to train critical and creative thinking skills can be calculated using a paired sample t- test or a paired t-test. The analysis used to determine the results of the paired t-test is by using statistical tests on the critical thinking test results. The results of the paired t-test analysis can be seen 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 values in Table 10, it is known that the difference between the results of students' critical thinking skills from the pretest and posttest, namely the pretest results showed an average score of 60.00 and the posttest results showed an average score of 90.50. It can be seen that the p-value is 0.000 < 0.05, so H0 is rejected and Ha is accepted [16]. Therefore, it can be concluded that the Deep Learning learning tool is valid and effective for training the critical thinking skills of Class A students.

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 values in Table 6, it is known that the difference between the results of students' critical thinking skills from the pretest and posttest, namely the pretest results showed an average score of 58.50 and the posttest results showed an average score of 87.00. It can be seen that the p-value is 0.000 < 0.05, so H0 is rejected and Ha is accepted [16]. Therefore, it can be concluded that the Deep Learning learning tool is valid and effective for training the critical thinking skills of Class B students.

CONCLUSION

Fundamental Finding : Based on the results of research and development of Deep Learning-based learning tools to train students' critical thinking skills, it can be concluded that the tools developed have been systematically arranged and meet the criteria for component completeness. The product's feasibility was proven through validation tests by two experts, namely a curriculum expert and a learning design expert. The assessment results showed that the Learning Module scored 4.2 (96%) and the Student Worksheet scored 4.1 (95%) in the highly valid category, while the critical and creative thinking skills test instruments scored 3.9 (97%) in the valid category. In terms of effectiveness, the field test results show that the average N-Gain in the control class was 66.6, which is in the moderate category, while the experimental class achieved 76.7%, which is in the high category. In addition, the results of the paired sample t-test showed a significance value of $\alpha < 0.05$, so H0 was rejected and HA was accepted. This indicates that the use of Deep Learning-based learning tools has a significant effect on improving students' critical thinking skills of students. **Implication :** Thus, the learning tool developed is declared suitable for use because it meets the aspects of validity, practicality, and effectiveness in training students' critical thinking skills. **Limitation :** The research subjects were 40 fifth-grade students. **Future Research :** The type of research used is R&D development research with a 4-D model consisting of four stages, namely Define, Design, Develop, and Disseminate.

REFERENCES

[1] Loyens, S. M. M., van Meerten, J. E., Schaap, L., & Wijnia, L., "Situating Higher-Order, Critical, and Critical-Analytic Thinking in Problem- and Project-Based Learning Environments: A Systematic Review," Educational Psychology Review, vol 35, no 3, 2023. doi: 10.1007/s10648-023-09757-x

[2] Rapanta, C., "Argumentation as Critically Oriented Pedagogical Dialogue." Informal Logic, vol. 39(1), no. 1–31, pp. 201, 2019. doi: 10.22329/il.v39i1.5116

[3] Khanal, S., & Guha, P., "Exploring the Relationship Between School-Based Management and School Climate Using PISA Data." Asia Pacific Education Review, vol. 24, no. 4, pp. 617– 631, 2023. Doi: 10.1007/s12564-023-09846-0

[4] Hardiansyah, F., & Zainuddin, Z., "The Influence of Principal's Motivation, Communication, and Parental Participation on Elementary School Teachers' Performance." Al Ibtida: Journal of MI Teacher Education, vol. 9, no. 2, pp. 319–334, 2022. doi: 10.24235/al.ibtida.snj.v9i2.9936

[5] Martin, M. O., & Mullis, I. V. S., "TIMSS 2019 Assessment Frameworks. TIMSS & PIRLS International Study Center," ERIC ,2017.

[6] Azzahra, U., Arsih, F., & Alberida, H., "The Effect of Project-Based Learning (PjBL) on Students' Creative Thinking Skills in Biology Learning," Literature Review. Biochephy: Journal of Science Education, vol. 3, no. 1, pp. 49–60, 2023. doi: 10.31004/jptam.v8i1.12766

[7] Musliman, A., & Damayanti, F., "Use of Science Process Skills Indicators in the "Avicom" Science Creativity Competition to Improve Student Critical Thinking," Indonesian Journal of Science Education, vol. 11 no. 2, pp. 236–250, 2023 doi: 10.24815/Jpsi.V10i4.27696

[8] Fita, M. N., Jatmiko, B., & Sudibyo, E, "Studies in Learning and Teaching: The Effectiveness of Problem-Based Learning (PBL) Based on Socioscientific Issues (SSI) to Improve Critical Thinking Skills," vol. 2, no. 3, pp. 1–9, 2021. Doi:10.46627/Silet

[9] Bintang, Y. K., & Imaduddin, H., "Development of a Deep Learning Model for the Detection of Diabetic Retinopathy Using the Transfer Learning Method," JIPI (Scientific Journal of Informatics Research and Learning), vol. 9 no.3, pp. 1442–1455, 2024. doi: 10.2100/jipiv913.5588.

[10] Arikunto, Suharsimi, "Research Procedures: A Practical Approach, Revised Edition VI." Jakarta: Rineka Cipta, 2014.

[11] Hake, R., "American Education Research Association's Division D, Measurement and Research Methodology: Analyzing Change/Gain Scores." USA: Woodland Hills, 1999.

[12] Arikunto, Suharsimi, "Research Procedures: A Practical Approach, Revised Edition VI." Jakarta: Rineka Cipta, 2014.

[13] Nieveen, N., & Folmer, E, "Formative evaluation in educational design research", Educational Design Research, vol. 153, pp 152-169, 2013.

[14] Harapit, S., Murani Hutapea, N., & Riau, U., " "Development of Problem Based Learning Tools to Facilitate Mathematical Reasoning Skills". BSIS, Vol 4 No 2, pp 21–27, 2022. doi: 10.25299

[15] Ahaddin, M. A., Jatmiko, B., & Supardi, Z. A. I., "The Improvement Of Critical Thinking Skills Of Primary School Students Through Guided Inquiry Learning Models With Integrated Peer Instructions". Studies In Learning And Teaching, vol. 1 no. 2, pp 104–111, 2020. Doi: 10.46627/Silet

[16] Martin, D. J., Elementary Science Methods a Constructivist Approach, Sixth Edition. Belmont: Wadsworth, 2012

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