The Effectiveness of Using Discovery Learning-Based Student Worksheets to Improve Students' Critical Thinking Skills on Heat Transfer Topic

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ABSTRACT: Critical thinking skills are one of the skills that are very important for students to have in the challenging 21st century education era. Therefore, critical thinking skills need to be provided to students through appropriate and well-organized learning processes. One of the learning components that is able to assist teachers in preparing teaching and learning activities in class is to provide teaching materials that are in accordance with the expected learning objectives. One teaching material that can assist teachers in providing critical thinking skills and organizing student learning in class is Discovery Learning-based Student Worksheets. The purpose of this study was to determine the effectiveness of Discovery Learning-based worksheets in an effort to improve the critical thinking skills of fifth grade elementary school students on the topic of heat transfer. This research is a type of pre-experimental research using a one group pre test – post test design. The research subjects consisted of 30 fifth grade elementary school students at SDN 38 Parepare. The sampling technique for this study used a purposive sampling technique with a population of 99 fifth grade students consisting of three classes. The research instrument is a Discovery Learning-based worksheet and a critical thinking skills-test. The analysis technique was in the form of descriptive statistics in the form of N-Gain, effect size, and t-test. Based on the results of the analysis of the three measurements, it can be concluded that the use of Discovery Learning-based student worksheet was significantly effective in improving students' critical thinking skills on the topic of heat transfer.

KEYWORDS: Discovery Learning-based worksheets, Heat Transfer, Critical Thinking Skills, Higher Order Thinking Skills, 21st Century Education.

I. INTRODUCTION

The 21st century education that is being lived today integrates knowledge, skills, and attitudes (Raharjo & Muljani, 2022). Proficiency in this case is higher order thinking skills (HOTS) which are very much needed by students in maintaining their existence in a global society (T. Rahmawati et al., 2023; Sitohang, 2020). In the hierarchical structure of higher-order thinking skills, critical thinking skills occupy the second lowest position after problem-solving skills (Nurmi et al., 2020; Rabiudin, 2023). Based on the hierarchical levels of higher-order thinking, critical thinking skills are very suitable to be equipped as early as possible at the elementary school level. Students whose critical thinking skills develop will find it easier to solve problems (Amijaya et al., 2018; Cahaya Phasa, 2020; Ilhamdi et al., 2020). Therefore, efforts are needed as early as possible to equip students with critical thinking skills at the elementary school level.

In carrying out critical thinking actions there are several indicators in its implementation. The following are indicators of critical thinking skills proposed by Ennis (2011) (Ennis, 1995).

Table 1. Critical Thinking Skills Indicator

Indicators	Description of Critical Thinking Skills Indicator
Giving a simple explanation	Asking and answering questions about an explanation or challenge
Building basic skills	Observing and considering an observation report
Concluding	Deducing and considering induction or deduction results
Providing further explanation	Defining terms and consider a definition in dimensions
Setting strategy and tactics	Interacting with others

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Science learning material (Natural Science) is one of the subject matter contained in the structure of thematic learning materials at the elementary school level. The characteristics of the dominant science learning material content are abstract and emphasize aspects of cognitive process levels at a high level, such as applying, analyzing, evaluating, and creating. (Prihatni et al., 2016). Thus, critical thinking skills can be trained through science learning associated with the application of concepts in students' daily lives.

The results of exploring the critical thinking skills of fifth grade students at SDN 38 Parepare through specially designed tests show that students' critical thinking skills are still relatively low. Furthermore, the dominant learning process was cantered on the teacher so that students tend to be passive during the learning process. Meanwhile, the nature of science learning should direct students to learn meaningfully and actively. The results of the analysis of natural science material show that the material on the topic of Heat Transfer is one of the topics with the dominant substance at a high level cognitive level. Thus, the topic of Heat Transfer was decided to be studied in this study in order to train students' critical thinking skills and activeness.

Based on the description of the problems above, there is a need for science learning innovations that can equip students with critical thinking skills and activeness. One form of science learning innovation that can be pursued is providing teaching materials that accommodate student-centred learning. One learning model that can activate students in learning is Discovery Learning (Himawan, 2020; Subekti & Suparman, 2019). Furthermore, the Discovery Learning model is one of the learning models recommended in the 2013 curriculum (Ernawati & Safitri, 2017; Fajri, 2019). Rahmayani et al. (2019) explained that one of the learning models that can help students learn actively is the Discovery Learning model. Furthermore, (Rahmawati et al., 2012) in their research emphasized that this learning model can also assist students in activating thinking and reasoning processes through investigative activities, discovery, and training students in critical thinking. The stages of the Discovery Learning model include: (1) stimulation or provision of stimulation; (2) problem identification; (3) data collection; (4) data processing; (5) proof; and (6) draw conclusions (Dari & Ahmad, 2020). Meanwhile, the teaching and learning process can take place in an active, efficient, interesting and enjoyable manner if it is supported by the availability of teaching materials. One of the teaching materials that can assist teachers in facilitating students to learn actively and easily understand the material is Student Worksheets (Amali et al., 2019).

The results of previous research indicate that the Discovery Learning model with the help of Student Worksheets can improve the learning achievement of class XI junior high school students in Fluid material. (Sartono, 2019). Similar research shows that the motivation and learning outcomes of physics students in class X have increased by using the Discovery Learning model with the help of worksheets (Marsila et al., 2019). Other research shows that the use of Discovery Learning-oriented worksheets assisted by Mind Mapping can improve the high-level thinking skills of fifth grade elementary school students (Apriani et al., 2022). Furthermore, the results of a similar study show that the use of Geogebra-assisted Discovery Learning-based can help students easily understand the concept of Geometry in grade V elementary school (Nopitria et al., 2022). The study results of the (Subekti & Suparman, 2019) show that the Discovery Learning model with the help of E-worksheet student was able to help seventh grade junior high school students improve their critical thinking skills. Himawan (2020) in his research shows that the application of the Discovery Learning model assisted by worksheet can increase the activity of junior high school students in reading folk poetry texts. Furthermore, the results of research by (Perdana et al., 2017) explained that the worksheet teaching media with the Discovery Learning model could help high school students in class XI easily understand concepts in Physics learning material.

Based on the explanation of the problem and the study of some of the results of previous research, this research is focused on improving critical thinking skills using Discovery Learning-based Student Worksheets for fifth grade students at SDN 38 Parepare on the topic of Heat Transfer.

II. METHODE

This research is a type of pre-experimental research with a one group pre test post-test design (Sugiyono, 2010). Based on this design, critical thinking skills tests were administered before and after treatment in one group or experimental class without using the control class as the comparison group. The population of this study were all fifth grade students at SDN 38 Parepare, totalling 99 students. The research sample was obtained by purposive sampling technique and one class consisted of 30 students. In this study, there are two research variables, namely one independent variable and one dependent variable. The independent variable in this study is the provision of worksheet based on Discovery Learning while the dependent variable is critical thinking skills.

The research instruments are worksheet and critical thinking skills test sheets. Data collection technique is done by using test technique. The purpose of this study was to test the effectiveness of using Discovery Learning-based worksheets. For this reason, the analytical techniques used in this study are descriptive statistics and inferential statistics. The descriptive statistical analysis is in the form of N-Gain analysis and effect size analysis. Meanwhile, inferential statistical analysis is in the form of a t-test. effect size analysis is used to test the effectiveness of the use of LKPD. Meanwhile, the N-Gain analysis and t-test were used to analyse the improvement of students' critical thinking skills. The following is an equation to determine the value of the N-Gain coefficient.

$$N - Gain = \frac{Skor\ post\ test - Skor\ Pre\ test}{Skor\ Ideal - Skor\ Pre\ test}\ x\ 100\% \dots (1)$$

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The N-Gain coefficient values can be categorized into three levels as shown in Table 2.

Table 2. Categorization of Interpretation of N-Gain Effectiveness

Percentage of N-Gain Value (%)	Categorization
> 75	Effective
56-75	Middle Effective
40-55	Less effective
< 40	Ineffective

(Hake, 1999)

To see the level of students' critical thinking skills, a categorization of the score obtained is carried out. The categorization of critical thinking skill levels is presented in Table 3.

Table 3. Categorization of Critical Thinking Skills

Score Range	Categorization
90-100	Very high
80-89	High
70-79	Currently
60-69	Low
0-59	Very low

(Sani, 2016)

The indicators of critical thinking skills used in this study consist of five indicators, namely: (1) providing simple explanations; (2) build basic skills; (3) concluded; (4) giving further explanation; (5) set strategies and techniques. Assessment of critical thinking skills is based on the scoring guidelines that have been developed. For clarity, the following guidelines for scoring critical thinking skills are given as shown in Table 4.

Table 4. Scoring Rubric of Critical Thinking Skills

Indicator	Criteria for Student Answers to Critical Thinking Questions	Score
Giving a simple explanation	No answer	0
	Wrong in identifying or formulating questions/problems	1
	Inaccurate in identifying or formulating questions/problems	2
	Almost precise in identifying or formulating questions/problems	3
	Accurate in identifying or formulating questions/problems	4
Building basic skills	No answer	0
	Incorrectly choosing a problem-solving strategy to come up with the correct conclusion and incorrectly giving reasons	1
	Able to choose the right problem-solving strategy to produce the right conclusions but give wrong reasons	2
	Able to choose the right problem-solving strategy to produce the right conclusions but not give the right reasons	3
	Able to choose the right problem-solving strategy to produce the right conclusions but give the right reasons	4
Conclude	No answer	0
	Inaccurate conclusions with incomplete reasons	1
	Inaccurate conclusion with complete reasons	2
	Accurate conclusion with incomplete reasons	3
	The conclusion is right with full reasons	4
Providing further explanation	No answer	0
	Wrong in explaining a problem	1
	Able to give the right explanation but wrong in giving reasons	2

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Indicator	Criteria for Student Answers to Critical Thinking Questions	Score
	Able to provide explanations correctly but not precise in giving reasons	3
	Able to provide explanations precisely and precisely in giving reasons	4
Set strategy and tactics	No answer	0
	Making the wrong resolution step	1
	Making an answer that is not quite right but the steps for solving it are correct	2
	Making the right answer but the solution steps are not quite right	3
	Making answers and with the right completion steps	4

III. RESULT AND DISCUSSION

The improvement of students' critical thinking skills is measured from the results of the pre-test and post-test evaluations. The results of the pre-test and post-test evaluations are shown in Table 5.

Table 5. Evaluation Results of Critical Thinking Skills

Score Range	Categorization	Pre test		Post test	
		Frequency	Percentage (%)	Frequency	Percentage (%)
90-100	Very High	0	0	0	0
80-89	High	0	0	5	16,7
70-79	Currently	0	0	21	70
60-69	Low	8	26,7	4	13,3
0-59	Very low	22	73,3	0	0
Total		30	100	30	100

Table 5 showed that the highest percentage of pre-test evaluation results for critical thinking skills is in the very low category with a large percentage of 73.3%. Meanwhile, the very high, high, and medium categories each have a percentage of 0%. Unlike the results of the evaluation on the post test, the highest percentage is shown in the medium category (70%) and the lowest percentage is in the very high and very low categories with a large percentage of 0% each.

The next analysis is determining the N-Gain value and effect size to determine the increase in students' critical thinking skills. The form of the questions used is in the form of a description test with a total of seven items containing five indicators of critical thinking skills. N-Gain analysis results obtained by 74%. The N-Gain percentage value indicates that the use of Discovery Learning-based worksheets is quite effective in improving critical thinking skills.

Based on the analysis of the results of the pre-test and post-test evaluations, an increase in the average pre-test and post-test average scores was obtained, namely 53.2 and 79 respectively. Furthermore, from the increase in the average pre-test and post-test average scores, an effect size value of 0.9 was obtained in the large category. The results of the N-Gain and Effect Size analysis are shown in Table 6.

Table 6. Result of Effect Size and N-Gain Analysis

Type of Analysis	Value	Categorization
N-Gain	74%	Effective enough
Effect Size	0,9	Great

Further analysis was carried out with inferential statistics via t-test to prove that there were significant differences in students' critical thinking skills between the pre-test and post-test. The requirements that must be met to carry out the t-test are that the data must be tested for normality and homogeneity before testing the hypothesis through the t-test. The following describes the results of the normality test (Table 7) and homogeneity test (Table 8) of critical thinking skills test data using the IBM SPSS version 25.0 application.

Table 7. Data Normality Test Results of Critical Thinking Skills Test

Test of Normality	Class	Kolmogorov-Smirnov(a)		
		Statistic	df	Sig.
Critical Thinking Skills Test	Pre-Test	,138	28	,200
	Post-Test	,151	28	,102
* This is a lower bound of the true significance.				
a. Lilliefors Significance Correction				

The results of the Kolmogorov Smirnov normality test show that the sig. value for the pre-test and post-test values is greater than the significant level α = 0.05 (sig. > 0.05), so it can be concluded that the data on the critical thinking skills test results are normally distributed.

Table 8. Data Homogeneity Test Results of Critical Thinking Skills Test

Test of Homogeneity		Levene Statistic	df1	df2	Sig.
Critical thinking skills	Based on Mean	,935	1	54,00	,338
	Based on Median	,921	1	54,00	,341
	Based on Median and with adjusted df	,921	1	51,448,00	,342
	Based on trimmed mean	1,005	1	54,00	,321

Based on the Levene Statistical test as shown in Table 8, a significance coefficient value of greater than 0.05 is obtained, so it can be concluded that the critical thinking skills test data is homogeneous. Furthermore, the test analysis of differences in critical thinking skills test results between the pre-test and post-test was carried out with the t-test. The results of the t-test are shown in Table 9.

Table 9. Results of the t-test Pre Test and Post Test Data on Critical Thinking Skills

T-Test		95% Confidence Interval of The Difference		t-test for Equality of Means		
		Lower	Upper	t	df	Sig. (2-tailed)
Critical thinking skills	Pre Test – Post Test	-46,22	-37,78	-18,81	29	,000

Table 9 shows that the sig. (2-tailed) t test results (Paired Sample T-Test) of 0.000. This significance value is less than 0.05, so it can be concluded that there is a significant difference in critical thinking skills between before and after treatment with Discovery Learning-based worksheet.

In line with the research that has been done, there are a number of related studies and support the findings in this study. Research conducted by (Marsila et al., 2019) shows that the Discovery Learning learning model can develop the motivation and learning outcomes of Class X SMA students. The results of this study are also supported by other studies conducted by (Amijaya et al., 2018) in his research showed that the Discovery Learning learning model can improve critical thinking skills and physics learning achievement of Class X High School students in Biology learning with Biodiversity material. The results of a similar study were also carried out by (Nahak & Bulu, 2020) in his research using the guided discovery learning model assisted by Scientific-based Student Worksheets can improve scientific literacy skills and learning outcomes of Class VI Elementary School students. Furthermore, research conducted by (Ramli et al., 2020) shows that the use of STEAM-based Student Worksheets can improve critical thinking skills. In connection with that matter, (Putra et al., 2018) in his research using Student Worksheets based on Guided Discovery can improve conceptual understanding and mathematical reasoning abilities of class X high school students.

IV. CONCLUSIONS

Based on the results of the descriptive statistical analysis of N-Gain and Effect Size as well as the inferential statistical analysis of the t-test, it can be concluded that the use of Discovery Learning-based worksheets on Heat Transfer material is effective in improving the critical thinking skills of fifth grade elementary school students. The results of the N-Gain analysis showed a value of 74% in the quite effective category and the effect size analysis obtained a value of 0.9 in the large category. Meanwhile, the results of the t-test analysis of the pre-test evaluation scores and post-test scores showed a t-test coefficient of greater than 0.005, which means that the treatment with Discovery Learning-based worksheets led to a very significant difference in critical thinking skills between the pre-test and post-test.

V. ACKNOWLEDGMENT

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