



The Development of Worksheet Based on Project-Based Learning to Increase Critical Thinking Skills Of Alternative Energy Themes



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Abstract

This research problem begins with the results of the needs analysis of the learning carried out by students in Indonesian schools. It aims to produce a student worksheet (SW) product based on project-based learning that is feasible and effective in improving students' critical thinking skills. According to Borg and Gall, it is a kind of Research and Development (R&D) that refers to the development of theory. The steps of this research are research and information collecting, planning, developing a preliminary product, preliminary field testing, main product revision, main field testing, dan operational product revision. The population in this study was fourth-grade elementary school students. Subjects in this study amounted to 20 students. The data analysis technique used N-Gain and obtained an average result of 0.75 in the medium category. In addition, the calculation of the t-test pooled variance in the experimental and control classes using the help of SPSS 25. Based on the calculation results obtained, Sig (2-tiled) data of $0.000 < 0.05$. The results of this study stated that the Student Worksheet developed was feasible and effective in improving students' critical thinking skills.

1. Introduction

The quality of national education continues to be emphasized to improve development in education. For that, the government continues to improve the quality of education at every level even though the quality improvement indicators have not shown satisfactory results (Patta, 2006).

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The results of the 2012 Program for International Student Assessment (PISA) study show that Indonesian students' average reading, math, and science literacy achievement scores are still below the international average. The low quality of education requires a thorough evaluation of every element within the framework of the formal education system. Therefore, in the 21st century, it is necessary to review the implementation of the four pillars of education that UNESCO has proclaimed. The four pillars are learning to know, learning to do, learning to be, and learning to live together.

The results of observations made by researchers at Elementary School2 Karanganyar educators convey more material directly to students (learning to know) so that students cannot carry out the discovery process. Thus, the various thinking abilities of students that are expected to appear in learning will be less than optimal. According to Ennis (Quitadamo et al., 2008), one of the important abilities that become hampered by such learning is the ability to think critically, which is an ability composed of behavioral tendencies (such as curiosity and open-mindedness) and cognitive skills (such as analysis, inference, and evaluation). Wijaya (2007) proposed critical thinking skills that critical thinking is an activity to analyze ideas or ideas in a more specific direction, distinguish sharply, select, identify, study and develop in a perfect direction.

The low critical thinking ability of students is influenced by several aspects such as (1) the use of learning resources that have not been functioned optimally, (2) educators also only using the classical lecture method, (3) learning is still teacher-centered, and (4) some students do not pay attention to educators when explaining subject matter so that it affects student learning outcomes and result in learning objectives are not achieved. Teaching materials are all materials used to assist educators in learning activities in the classroom (Abdul Majid, 2012). The researcher, in this case, aims to develop teaching materials in the form of Student Worksheets (SW). SW is printed teaching material in the form of sheets containing material, summaries, and instructions for the implementation of tasks that students must do to achieve certain basic competencies (Andi Prastowo, 2011).

The principle of Project Based Learning emphasizes the activities of students to solve problems by applying the skills of researching, analyzing, creating, and presenting learning products based on real experience (Hosnan, 2014). So that Project Based Learning is one model that can improve students' critical thinking skills because in completing projects, students must first identify problems, formulate hypotheses, analyze, and communicate results. Some of these activities are part of critical thinking skills. Educators can use an alternative to improve students' critical thinking skills is to develop learning materials like PjBL-based SW. For example, SW can be useful in terms of academic achievement as a supporter of textbooks (Lee, 2014). Therefore, applying the PjBL model can improve students' critical thinking skills.

Based on this, research is needed to develop PjBL-based SW in improving students' critical thinking skills. Further analysis was carried out to see the effectiveness of learning using PjBL-based SW products to improve students' critical thinking skills.

2. Materials and Methods

This research is a Research and Development (R&D) study referring to the development steps of Borg&Gall. The SW developed is a project-based learning SW for fourth-grade elementary school students. The product development steps are as follows. Research and information collecting; Included in this step are the study of literature related to the problem being studied and the preparation for formulating a research framework. At this stage, the researchers distributed a

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questionnaire on the needs of educators. Based on the questionnaire results, the researcher obtained data that learning is still teacher-centered, and the SW used does not contain aspects that can bring up students' critical thinking skills. Planning; This step includes formulating a PjBL-based SW framework, determining systematics, planning evaluation tools in the form of multiple-choice questions, and preparing research instruments in the form of questionnaires made from choices 1 to 4. Develop a preliminary form of product, namely developing the initial product of the product being developed. This step includes preparing supporting components, preparing guidelines and manuals, and evaluating the feasibility of supporting tools. The development of the initial product in the form of PjBL-based SW using a reference to the integrated thematic book of curriculum 2013. Preliminary field testing, namely conducting initial field trials on a limited scale. At this step, data collection and analysis can be done employing interviews, observations, or questionnaires. The questionnaire instrument created was used to validate the product with the target of material experts, media experts, and language experts. The following is a recapitulation of the validator's assessment results.

Table 1. Recapitulation of Expert Validation Results

No	Validation	Skor	Information
1	Content	89,8	Very Valid
2	Language	91	Very Valid
3	Media	98	Very Valid

Main product revision, namely making improvements to the initial product produced based on the initial trial results. This fix. This activity is carried out as a step to improve PjBL-based SW products. The main field is testing the main trial used to evaluate the product; The main product trial was carried out on the fourth-grade students of SDN 2 Karang Anyar, with as many as 20 students. The following is the data on the value of student learning outcomes in the experimental class.

Table 2. Student Value Data

Category	Data	
	<i>Pre-test</i>	<i>Post-test</i>
Highest Score	75	95
Lowest Score	25	60
Mean	57,62	81,67
Median	60	80
Modus	65	80
Standard Deviation	11,8	9,1

The t-test and N-gain test was carried out to determine the effectiveness of the developed SW product. Based on the calculation results, the results of the t-test calculation are as follows.

Table 3. T-test Calculation Results

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper	
Hasil Belajar	Equal variances assumed	0,852	0,362	4,714	39	0,000	12,167	2,581	6,946	17,388
	Equal variances not assumed			4,750	36,592	0,000	12,167	2,562	6,974	17,359

After the t-test was carried out, the N-gain test was calculated to determine the significance of increasing students' critical thinking skills. Based on the calculation results obtained, the following data.

Table 4. Recapitulation N-Gain Value of Students

No	Aspect	<i>pre-test</i>	<i>Post-tests</i>	<i>N-Gain</i>	Effectiveness
1	Total Value	1145	1625	11,30	1129,65
2	Average	57,25	81,25	0,56	56,5
Information				Medium	Effective

To see the improvement in students' critical thinking skills, the researcher will explain the results of the analysis of critical thinking indicators used in research on each student. The results of the analysis can be seen in the following table:

Table 5. Recapitulation of N-Gain Analysis Results for Each Critical Thinking Indicator

No	Indicator	<i>N-gain</i>	category
1	Interpret	0,68	Medium
2	Analysis	0,49	Medium
3	Evaluate	0,43	Medium
4	Inferencing	0,90	High

Operational product revision, namely making improvements to the results of wider trials, so that the product developed is already an operational model design that is ready to be implemented. The main product revision at this stage is based on suggestions and input on the developed product.

3. Results and Discussions

The appropriateness and Validity of worksheets based on project-based learning

The results of the study stated that the developed project-based learning-based worksheets were declared "feasible" to be implemented in learning. According to Borg and Gall, SW development is carried out by referring to the development steps using seven of the ten existing steps. The assessment obtained from the material expert got a value of 89.8, which is included in the very valid category, and the assessment obtained from the media expert got a score of 98, which is

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included in the very valid category. While the value obtained by the linguist, which is 91, is included in the very valid category. Based on the results of the validation test by the experts, it can be concluded that the project-based learning worksheets based on process standards and developed using Borg & Gall development research steps are valid and can be used.

Development of Project-Based Learning-based SW to Improve Students' Critical Thinking Ability.

The worksheet developed is adapted to the steps of the project-based learning (PjBL) model. The steps for developing SW are as follows.

Determining Fundamental Questions

At this stage, the researcher gives students basic questions to stimulate them and discover their initial abilities.

Design Products and Prepare a Manufacturing Schedule

In this step, the researcher presents project tasks that students will carry out independently and in groups.

Monitoring Project Activity and Progress

In this step, the teacher monitors the activity of students during the project, monitors the realization of development, and guides students if they experience difficulties.

Test Results

At this stage, researchers provide opportunities for educators to test student learning outcomes by asking questions through discussion activities and let's practice.

Evaluation of Learning Experience

At this stage, educators provide opportunities for students to express their feelings regarding the learning material that has been done. Educators put a checkmark in the box below the available motion pictures. First interpretation. This indicator requires students to be able to explain their opinions or theoretical views on an interpretation. Second, Analysis. Analyzing is a person's ability to observe object activity by describing the object's composition and rearranging its components to be studied in detail. Third, evaluating. Evaluating is the process of determining the value of a thing or object based on certain references to achieve certain goals. Fourth, Inferring. Inferring is the ability of students to conclude temporarily with logical conclusions.

Effectivity worksheet based on project-based learning

The effectiveness test is carried out by calculating an independent sample t-test to determine the effectiveness of project-based learning-based worksheets. The effectiveness test was conducted on 20 students of class IV B Elementary School2 Karanganyar.

The results of observations of student learning completeness obtained data that 18 students completed and two students who did not complete. Based on the tests conducted to determine the significance of the differences between the two groups, the independent sample t-test was used. Based on calculations with $DK = 39$ obtained Sig (2-tailed) of $0.000 < 0.05$, it can be concluded that there are differences in students' critical thinking skills using project-based learning-based worksheets with those that do not use fourth-grade elementary school students. The results of the effectiveness test using N-Gain obtained data that there was an increase in the average N-Gain value of students before and after learning was carried out using project-based learning SW. The average pre-test score of students is 57.62, while the average post-test score is 81.67. The increase occurred by 24.05. The recapitulation results of the average N-Gain of students, namely 0.57, are in the "Medium" classification. Then the level of effectiveness is effective.

Then the calculation of the increase in critical thinking skills on each indicator of students is carried out, and the following data are obtained. The indicator of interpreting the average N-Gain value of students, which is 0.68, is included in the very high category. The average N-Gain indicator for analysis is 0.51, including in the medium category, on the indicator evaluating the average N-gain of students. I.e, 0.43 is included in the medium category, the average N-Gain on the inference indicator is 0.60 is included in the medium category

4. Conclusion

Based on the research and development data analysis with the title "Development of Project Based Learning-Based Student Worksheets to Improve Critical Thinking Skills for Fourth Grade Students of Elementary School2 Karanganyar," the following conclusions can be drawn.

1. The project-based learning-based Student Worksheet product that was developed is feasible to be implemented to improve the critical thinking skills of fourth-grade elementary school students.
2. The developed project-based worksheets are effectively used in the teaching and learning, especially for fourth-grade elementary school students.

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