IMPLEMENTATION OF PROJECT-BASED LEARNING (PjBL) MODEL IN GROWTH AND DEVELOPMENT LEARNING TO INCREASE THE STUDENTS' SCIENCE LITERACY AND CRITICAL THINKING SKILLS

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Abstract

Science literacy and critical thinking are very important skills for students. Some studies show the low skill of scientific literacy and critical thinking of students. Innovation in the learning process through the application of Project-Based Learning (PjBL) models in learning growth and development is needed to improve students' scientific literacy and critical thinking skills. This research aims to determine the effect of the implementation of the PjBL model on students' scientific literacy skills and critical thinking skills. This study used an experimental method with a pre-test post-test control group design. The research subjects were 128 grade XII Madrasa Aliah students who were divided into experimental and control groups. Each group consists of 64 students chosen at random. The experimental group used the PjBL learning model, while the control class continued to use the conventional learning model. The parameters measured are literacy and critical thinking skills. Data analysis of literacy skills and critical thinking is carried out through parametric statistical analysis which includes tests of normality, homogeneity, normalized gain (n-gain), and two-means comparison test. The two-means comparison test is carried out using an independent sample t-test by comparing the initial skill (pre-test results) with the final skill (n-gain). Meanwhile, the correlation of scientific literacy skill to critical thinking skill is known through correlation and regression analysis. The results showed a significant difference between the pre-test score and the n-gain score at a significant level of 95% (α = 0.05). The correlation coefficient obtained is 0.7493, which means there is a positive and strong relationship between literacy skills and critical thinking skills with the contribution of literacy skills of 56.16% to critical thinking skills. Increased literacy skill (n-gain) showed significantly different results between the experimental group and the control group. The difference of N-Gain between the experimental group and the control group was 14.25%. It shows that application of the PjBL model contributes well to improving students' scientific literacy skills.

Keywords: Science Literacy, critical thinking, Project-Based Learning

1. INTRODUCTION

Science literacy is one of the most important skills students have because it relates to using scientific knowledge, identifying questions, and drawing conclusions based on evidence. Science literacy helps humans to understand and make decisions related to nature and human activities in changing nature (Holbrook and Rannikmae, 2009).

Critical thinking skills also include skills that must be possessed by students because these skills will assist

students in making decisions and understanding scientific concepts and processes. Without the skill to think critically, students are not able to ask questions against existing scientific statements. Students' knowledge will not develop if they only gather information without questioning it (Hasanuddin, 2018).

Science literacy skills and students' critical thinking are still low. According to Diana et al. (2015), the average scientific literacy skills of students using Scientific Literacy Assessment (SLA) from the cognitive domain are in the very poor category, while those from the affective domain are included in the "sufficient" categories. The results of observations at several Madrasah Aliah (MA) in the city of Banda Aceh show the low literacy skills of students, especially in reading accuracy. Students are not accustomed to connecting information in the text to answer questions. Test results conducted on 50 students showed that only 37% achieved a score above the minimum passing score, while the other 63% were still below the minimum passing score. In the composition of answers, students are also still less able to read and interpret data in the form of pictures and graphics. It shows the lack of students' understanding of the basic concepts of science that have been taught so that they are less able to interpret data, explain causal relationships, and analyze simple problems. Students are also not very good at mastering the basic concepts of science and the relationship of these concepts with everyday life.

The results of interviews with biology teachers on growth and development materials show that the teacher usually uses teaching materials in the form of textbooks and Student Worksheets (LKPD) This is thought to cause the low interest of students to learn about plant growth and development materials; students are not in accordance with the textbook or LKPD used. Sanjaya (2008) stated that students do not like difficult material and far from their experience.

Science literacy is very important in modern society (digital era) because it is related to science and technology. Students who have good scientific literacy skills can make decisions / solve problems with the knowledge they have (Situmorang, 2016).

According to Diana et al. (2015), teachers can apply the learning process through experimental activities to improve science literacy and critical thinking skills. Learning through experimentation is contextual learning that can stimulate students to think higher. Besides, it can also help students manage and monitor scientific literacy and critical thinking skills.

One learning model that meets these criteria is the learning model Project-Based Learning (PjBL). PjBL trains students to complete tasks or questions related to a problem maximally in accordance with the learning objectives. Several studies on the application of the PjBL model have been carried out (Macphee, *et al*., 2001; Grant, 2005; Ardianti, et al., 2017; Agin, 1974; Arsal, 2017; Becerra-Labra *et al*., 2012; Yance, 2013; Bennett *et al*. 2018; Cheung and Chow 2011; Chin and Chia 2004; Evans and Elisan-Visperas, 2018; Hadjichambis *et al*. 2016; Jarjoura *et al*., 2015; Kang and Keinonen, 2017; Li *et al*., 2019; Sammet *et al*., 2015; Sevian *et al*., 2018; Stagg and Donkin, 2013; Swirski *et al*., 2018; Tsybulsky *et al*., 2018. The results of these studies only reveal the effect of PjBL implementation on problem-solving skills, creativity, critical thinking, learning outcomes, and interactions between students. There has been no research on the effect of PjBL on scientific literacy skills and critical thinking. Therefore, this study was conducted to determine the effect of the implementation of the PjBL model on improving scientific literacy skills and critical thinking.

2. RESEARCH METHODOLOGY

This research used experiment method with group control of pre-test and posttest design (Gall *et al*., 2003). The details of research design can be seen in Table1.

Table1. Pre-test post-test Control Group Design

Sample	Classes	Pre-test	Treatments	Post-test
Random	Experiment	O_1	P_1	O_2
Random	Control	O_3	-	O_4

Information:

O_1: Pre-test before treatment is given to class of experiment

O_2 : Post-test before treatment is given to class of experiment

O_3 : Pre-test before treatment is given to class of control

O_4 Post-test before treatment is given to class of control

P_1 Treatment to class of experiment

The research subjects consisted of 128 Senior High School grade XII students who were divided into experimental and control groups. Each group consists of 64 students chosen at random. The experimental group was given the PjBL learning model, while the control group continued to use the conventional learning model. The study was conducted for two months, from July-August at one of the Senior High Schools in Banda Aceh City.

The parameters measured for data collection in this study are literacy skills and critical thinking. Literacy skills are measured using multiple-choice tests with four answer choices whose indicators include the role of science, thinking and working scientifically, science and society, as well as mathematics and science. Critical thinking skills are measured using subjective tests (essays) with six indicators, namely focus, reason, Inference, Situation, Clarity, and Overview. Both data (literacy skills and critical thinking) were obtained using pretest and posttest.

3. DATA ANALYSIS

Literacy and critical thinking skills data were analyzed by tests of normality, homogeneity, normalized gain (n-gain), and two-means comparison test. The two-means comparison test was carried out using independent sample t-test by comparing initial skills (the results of the pre-test) with the final skills (n-gain), while the correlation of science literacy skills to critical thinking skills is known through correlation and regression analysis.

4. FINDINGS AND DISCUSSION

4.1 Improving Science Literacy Skills

Figure 1 shows student literacy skill data consisting of the roles of science, thinking and working scientifically, science and society, as well as mathematics and science in the experimental and control groups.

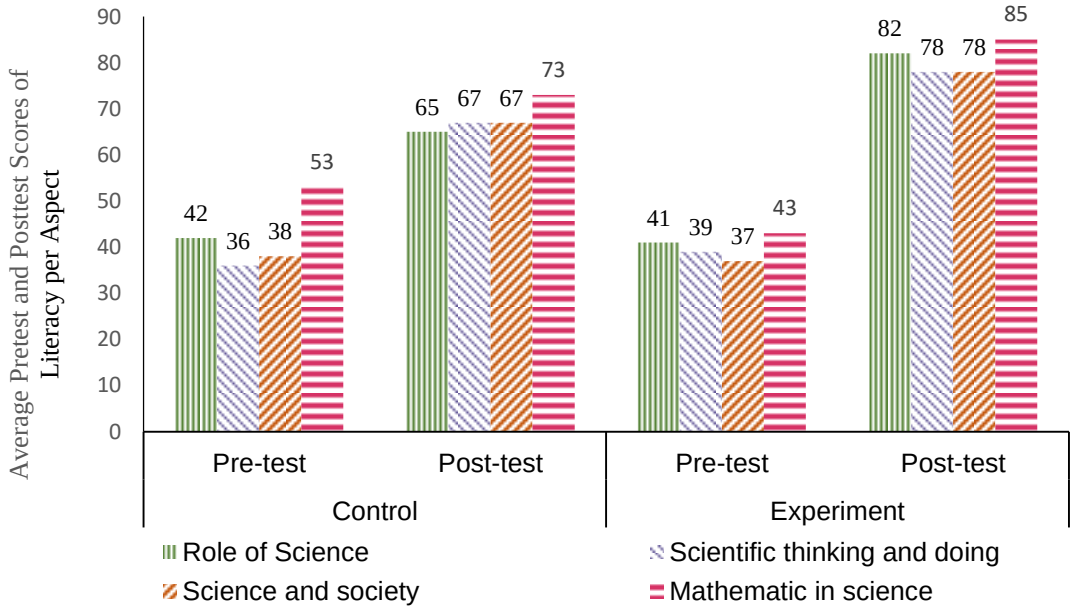

Figure-1. Average Percentage of Literacy Skills by Aspect

The data of the pre-test and posttest of literacy skills per aspect in the experimental group and the control group (Figure-1) show the differences in the average student literacy skills in each aspect. However, the initial literacy skills of students as a whole did not have a significant difference between the experimental group and the control group (Table-2). It shows that before applying the PjBL model, students had the same level of initial literacy skills. The average percentage of the overall literacy skills of the experimental and control groups is presented in Figure 2).

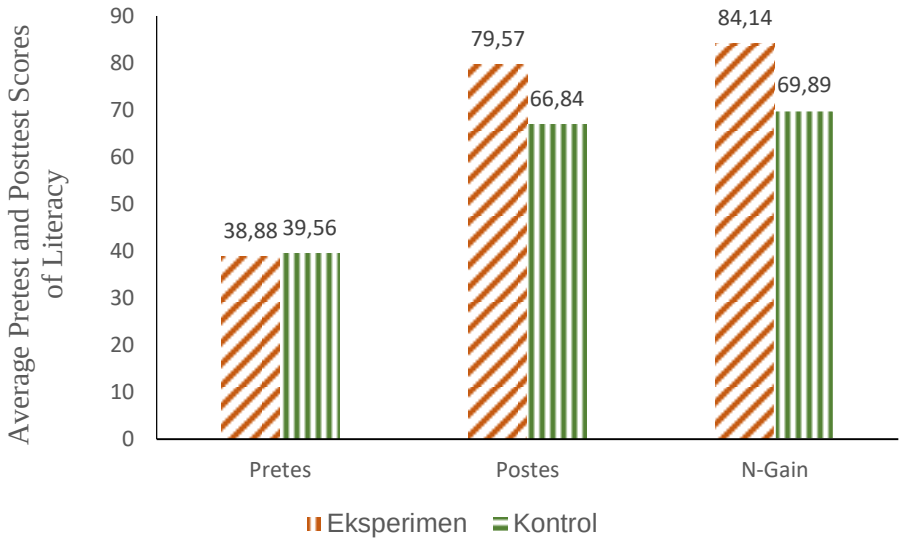

Figure-2. Pre-test, Post-test, and n-Gain Average Scores

Table 2 shows the significant difference in the increase in literacy skills (n-Gain) (Table-2) caused by the application of the PjBL model to the experimental group. The difference between n-gain in scientific literacy skills in the experimental and control groups was 14.25% (Figure-2). It shows the application of the PjBL model positively contributes to the improvement of students' scientific literacy skills in the experimental group compared to the application of conventional learning models in the control group.

Table 2. Recapitulation of Means comparison test of Pre-test and n-Gain

Outcome	**Group**	**Normality***	**Homogeneity****	**Hypothesis test (t-test)**	**description**
Pre-test	Experiment	X^2count 1.54 < X^2tab. 9.488 (Normal)	F_{cout} (1.14) < $F_{tab.}$ (1.51) homogeneous	T_{cout} (0.62) < $t_{-tab.}$ (1.997)	Not Significantly Different
	Control	X^2count 7.37 < X^2 tab. 9.488 (Normal)			
n-Gain	Experiment	X^2count 5.91 < X^2tab. 9.488 Normal)	F_{cout} (1.30) < $F_{tab.}$ (1.51) homogeneous	T_{cout} (3.571) >$t_{-tab.}$ (1.997)	Significantly Different
	Control	X^2count 7.81 < X^2tab 9.488 (Normal)			

Description:

* Square test (Normal: $X^2_{count} < X^2_{table}$;α =0,05)

** F-test (Homogeneous): $F_{count} < F_{table}$;α =0,05),

In learning the PjBL model, students are required to design projects independently, so that they are indirectly trained to understand the reading. Students are required to synthesize, analyze, interpret, and evaluate texts to achieve reading goals (Yore, 2003). Osborne (2002) also stated that reading comprehension skills are related to scientific literacy skills because reading involves thoughts that can build conceptual understanding, support investigation and culture of scientific thinking. Therefore, scientific literacy skills can be obtained by processing information critically and creatively through reading. Besides, Ayu et al. (2018) also revealed a positive relationship between reading habits and scientific literacy in high school students; reading contributed 51.8% of scientific literacy.

Significance test results show that the PjBL affects scientific literacy skills. Nugraheni (2017) and Krjick (2010) showed that literacy skills influenced by constructivism learning models, and increased scientific literacy skills are characterized by increased verbal and written communication skills. This study also showed that the students responded positively to learning activities by making project reports, recording their project work, and actively presenting the results of the project in front of the class.

Research conducted by Permanasari (2011) and Soobard & Rannikmae (2011) also shows that the development of science literacy skills can be done through student-centered science learning. Student-centered learning is certain to improve inquiry skills with the principle of constructivism. Subratha (2004) also revealed that learning community technology science (STM) was very effective in increasing scientific literacy. The study also showed that student-centered learning (including the PjBL model) places students as individuals who have initial knowledge where the initial knowledge can be developed into meaningful understanding.

4.2 Contribution of Literacy Skills to Critical Thinking Skills

Literacy skills have an impact on critical thinking skills. The results of data analysis showed a positive and significant relationship between the two (Table-3). The positive correlation is the impact of the relationship between science literacy skills and critical thinking skills.

Table 3. Pearson Correlation test results on literacy skills and critical thinking

Correlation (r)	Coefficient of Determination	Test of Significance * (r)	Description
0.7493	0.5616	t-count ≥ t-tab. 8.90 ≥ 1.99	Significant

Table 3 shows that the correlation value (r) in science literacy skills and critical thinking in the experimental group is 0.7493 with the interpretation value of the correlation coefficient by 0.60 - 0.799 (strong relationship). The relationship between science literacy skills and critical thinking skills can be seen from the results of the analysis of the coefficient of determination with $r^2 = 0.5616$. It means that scientific literacy skills affect 56.16% of critical thinking skills. The relationship between literacy skills and critical thinking skills can be seen in the results of the regression test (Figure-3)

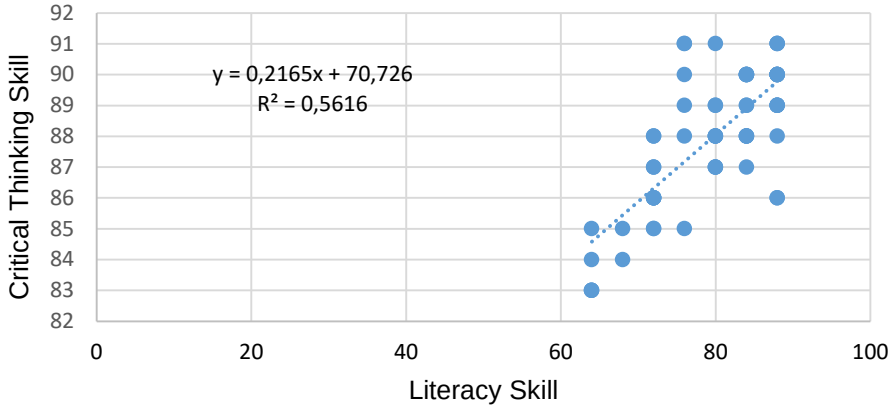

Figure 3. Regression of Literacy and Critical Thinking skills

The existence of a positive relationship between science literacy skills and critical thinking skills shows that the application of PjBL learning models can improve students' scientific literacy skills and critical thinking skills. Students who have good literacy skills will also have better critical thinking skills. Each student has the potential for critical thinking skills that can be measured, trained, and developed through the application of the PjBL learning model.

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