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The Effect of Project-Based Learning Integrated STEM Toward Critical Thinking Skill

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Abstract

The global challenge needs people who can solve the problem in everything. Students can't solve the problem well. It caused by the lesson only for memorizing, so student's critical thinking skill is not yet maximum. This study aims to identify the effect of project-based learning integrated STEM toward critical thinking skill of students. The method of this study was quasi-experimental with pre-test – post-test control group design. Sampling technique was used nonprobability sampling. Data collection technique used description test critical thinking skill. Data analysis used N-gain score test and t-test. The result of t-test student's critical thinking skill showed sig (2-tailed) 0.002 it means there was a different average in critical thinking skill between experiment class and control class. The average of experiment class was higher than the control class. It showed that the implementation of project-based learning lesson integrated STEM affected towards student's critical thinking skill.

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INTRODUCTION

Critical thinking skill is one of high order thinking the skill needed in education development of the 21st century. Ramos, Dolipas, and Villamor (2013) said that high order thinking skill is ability consist of critical thinking and creative, analysis, problem-solving, and visualization. (Beers, 2011). Stated that logical thinking skill, analysis, critic, and creative is so important for the student to connect the concept and material, so that can understand and solve the problem. From the statements above, critical thinking skill is a skill which has by someone to solve a problem with analyzing an idea in a specific direction.

The TIMSS questions can be used to measure one of a student's high order thinking the skill that is critical thinking ability. The evaluation result of TIMSS 2015 showed that science ability of Indonesia was 4th from the bottom, 45th from 48 countries with 397 points. It showed that the student's critical thinking skill was low (Tajudin, and Chinnappan, 2016).

The observation result showed there were some problems in the lesson such as less student involvement in the learning process; teacher wasn't paying attention for student's critical thinking skill; the question to asses in daily test did not yet show critical thinking skill and creative because it still used cognitive step C1-C3 in training student thinking abilities. The average of natural science grade supported the problem was still below standard of minimum competences that was 70. It showed from student's grade in Public Elementary School Sukorejo 02 Semarang, 13 from 33 students (39%) got below the standard of minimum competencies and data from 5th graders Public Elementary School Sadeng 02 Semarang, 13 from 31 students got below the standard of minimum competences.

Based on the problem described, it needs to apply a learning model that can develop critical thinking skill. One of the learning models that can be applied is project-based learning integrated with STEM. Bédard, Lison, Dalle, Côté, and Boutin (2012) stated that project-based learning could develop critical thinking skill, creativity, and encourage the student to teamwork. Lestari, Sarwi, and Sumarti (2018) project-based learning is a lesson model that centered on students to develop and apply the concept from a project that produced from exploration and solves the problem in real life independently. The lesson with project-based learning will train the student's critical thinking skill scientifically. Maula, Prihatin, and Fikri (2014) reveals that STEM is a learning method which uses the connection from many approaches and the application in active learning-based on the problem.

Using treatment with STEM in the lesson is expected to make students more critic and able to solve the problem through life experience to find new knowledge. Lesson using model project-based learning integrated with STEM is expected to develop a student's thinking skill to solve problems in daily life.

The process for critical thinking is students learn from their own experience, construct the knowledge and then give the meaning for the knowledge so critical thinking going to be a need that must be gotten by the student (Wijaya, Sumarni, and Haryani, 2017). Critical thinking skill is so important to the student because it can develop a student's thinking skill to solve the problems and also able to analyze and evaluate the information carefully and appropriately. The habit of thinking critically and creative need to be taught to a student from an early age to train student's thinking skill to solve problems through creative ideas from students.

The research result of Saripudin, Haryani, and Wardani (2015) shows that project-based learning is so effective to improve student's thinking skill. Jamaludin (2017) reveals that project-based learning can improve student's critical thinking skill if it compared with the conventional lesson. This study aims to identify the effect of project-based learning integrated STEM toward critical thinking skill.

METHODS

This research method is quasi-experimental with pre-test – post-test control group design. Design form of the study proposed by Sugiyono (2015) can be seen in Table 1.

Table 1. Research Form and Design

Group	Pre-test	Treatment	Post-test
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Information:
O_1 and O_3 : Pre-test result
O_2 and O_4 : Post-test result
X_1 : Implementation project-based learning integrated with STEM
X_2 : Project-based Learning

This research subject was divided into two groups. There was an experiment group and control group. Both of them was given pre-test and then analyzed to know the condition. Next step, the experiment group was given the treatment lesson with project-based learning integrated STEM, and the control group used project-based learning. At the end of learning, both of them was given post-test.

The sampling technique of this study was nonprobability Sampling; the form was purposive sampling that took the sample from consideration and obtained Public Elementary School Sukorejo 02 Semarang as experiment group and Public Elementary School Sadeng 02 Semarang as a control group. These subject were applying Curriculum 2013 and in the same neighborhood. The data collection technique of this study was a matter of description that adapted from critical thinking indicator. The result was analyzed with a t-test to find the critical thinking student after students were given treatment project-based learning integrated with STEM and project-based learning.

RESULTS AND DISCUSSION

Critical thinking skill was needed by the student to solve the problem and analyze an idea in a specific direction (make a decision). Critical thinking skill is a skill to define, formulate, argue, and also deduce in solving a problem (Amanda, Muharrami, Rosidi, and Ahied, 2018). Student's critical thinking skill needs to be developed to make sure students understand how to solve the problem with the alternative solution that they have.

Critical thinking skill data was collected from pre-test and post-test from both groups. N-Gain score analysis was done to measure the difference between pre-test and post-test grade. The result of the gain score can be seen in Table 2.

Table 2. The Result of Gain Score Test Critical Thinking

Group	Pre-test	Post-test	N-Gain score	Category
Experiment	60.76	85.53	0.631	Medium
Control	60.8	78.9	0.462	Medium

Table 2, the average pre-test score from the experiment group was 60.76 (enough), and the control group was 60.80 (enough). Next step was are giving treatment to experiment group used project-based learning integrated STEM and control group used project-based learning. After they have given treatment, the average post-test score for experiment group was 85.53, and the control group was 78.90, and both of them were in good criteria.

The improvement student's critical thinking skill can be seen from N-gain test. The N-gain score for experiment group was better than the control group that was 0.631 and 0.462. Both of them was in the same criterion that is medium. That was shown experiment group has better improvement than the control group in critical thinking, so the lesson used project-based learning integrated with STEM was better than project-based learning alone. It caused by the integration with STEM in the experiment group. Integrated learning with STEM can improve student's thinking activity that is shown with the skill to solve the problem, make a decision, assumption analysis, evaluate and investigation (Khoiriyah, Abdurrahman, and Wahyudi, 2018).

Çakici, and Türkmen (2013) implementation project-based learning can train scientific thinking to solve the problem that student faced. Sart (2014) project-based learning with solve problem is possible for a student to

develop student's ideas. The skill is so useful for a student's life because the student will habitually solve the problem by using their thinking skills. Every indicator's thinking skill result can be seen in Table 3.

Table 3, the average score of the experiment group was better than that of the control group. Student's skill to answer the test in the experiment group was better than that of the control group. It can be seen from the student's answer when they got a post-test score. Many students answered the questions briefly, but also, some students answered the questions correctly and completely. The experiment group has bigger improve than that of the control group, so project-based learning integrated with STEM was better than project-based learning.

Table 3. Critical Thinking Test Result between the Control Group and the Experiment Group

Indicator	Experiment group score	Range (%)	Criteria	Control group score	Range (%)	Criteria
Focused question	119	90	Very good	107	86	Good
Argument analysis	109	83	Good	103	83	Good
Ask and answer question	106	80	Good	96	77	Good
Correction and consider observation report	114	86	Good	94	76	Good
Induction and consider induction result	121	92	Very good	108	87	Good
Determine action	112	85	Good	99	80	Good
Defining terms	108	82	Good	81	65	Moderate

Based t-test result that done to measure critical thinking skill from both group showed that sig. The value was 0.002. It means that there was a difference between the control group and experiment group. Experiment group has a better score than that of the control group. It means that the implementation of project-based learning integrated with STEM was better than project-based learning. It can be concluded that there was an effect of project-based learning integrated with STEM towards student's critical thinking skill.

The study result from Insyasiska, Zubaidah, and Susilo (2015) showed that project-based learning could train the student to critically think towards contextual problem through themes that they have chosen so it could improve student's cognitive such as analysis, synthesize, evaluate and create. The finding is in line with Tiruneh, Verburgh, and Elen (2013), who said that a student's critical thinking skill affected by the learning environment.

Noviani, Hartono, and Rusilowati (2017) state that student who has high critical thinking skill will get learning result in a high category. The teacher should create a learning condition that could develop a student's thinking skill. Wijayanti, and Fajriyah (2018) reveal that STEM project-based learning can grow critical thinking, creative, analytics, and can improve high order thinking skill for the student. Thus learning program with STEM project-based learning can facilitate student to improve scientific skill; one of them was critical thinking.

CONCLUSION

The conclusion of this study is there was effective project-based learning integrated with STEM towards student's critical thinking skill. It has shown from t-test analysis that Sig. (2-tailed) 0.002, which means there was an average difference between the control group and experiment group in a critical thinking test. The average of the experiment group was higher than the control group, so the implementation of project-based learning integrated with STEM affected critical thinking skill.

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