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THE EFFECT OF PROJECT-BASED LEARNING ON SCIENTIFIC THINKING SKILL

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Abstract

Scientific thinking skill as the demand and a solution for the various diverse issues of the 21st century skills is necessarily crucial to be acquired by the students. The present research aims to investigate the effect of project-based learning on scientific thinking skills by employing a *quasi-experimental* design. The sample of this study consisted of 60 students, divided into 2 groups. In the experimental group, a project-based learning model was applied, while the control group implemented it through a communicative learning method. The data were collected using the instrumental test of scientific thinking skill which was carried out in both pre and post-learning. The data analysis of this study adopted *paired sample t test* and *independent-sample t test.* The results showed that 1) there was an effect of project-based learning models identified on scientific thinking skill, thus H_1 was accepted while H_0 was rejected, 2) there was no effect of communicative learning methods founded on scientific thinking skill, thus H_0 was accepted and H_1 was rejected. This research shows the effect of project-based learning models on scientific thinking skills.

Keywords:, Project-Based Learning Model; Communicative Learning Methods; Scientific Thinking Skill.

INTRODUCTION

Each individual possesses various diverse issues that differ from the others. Therefore, an immediately well-resolved process is required to fix the issues and challenges hold by those individuals. Meanwhile, solving problems absolutely needs the problem-solving skills and strategies in order to solve them without potentially causing new issues and continual impactful problems (Mulyati, 2016). Different problem-solving steps are required by each problem. In addition, the diverse strategies in handling the problems interpreted the level of each individual's problem-solving skill.

Generally, the 21st century skills which are available in a book entitled ATCS (*Assessment and Teaching for 21st Century Skills*), contain four primary

things allied with the 21st century skills including thinking methods, working methods, work instruments, and life skills (Griffin & Care, 2014). Thinking skill is interpreted as some understanding that must be possessed by students in the 21st century. These concepts arose along with the fulfilment of the current increasingly complex needs and competencies. Specifically, a thinking skills that must be owned by students in the 21st century identified by the *National Education Association* include critical thinking, scientific thinking, creative thinking, decision makings, and metacognition (Griffin & Care, 2014; (Redhana, 2019).

Scientific thinking skill as a 21st century skill is a compulsory need in students' lives. Not only to fulfill the demands of the subjects, but as well as a problem solving, identity formation, and to some competencies that must be occupied in the learning curriculum. The students who consider their logical ideas will differ from those who no longer get the logic thought involved in their thinking process. It is a logic that deals with one's progress and mindset.

Scientific thinking skill is a fundamental skill that must be owned by students. The urgency of it is to solve various problems encountered by students and as the demands for 21st century skills (Pratiwi, Cari, & Aminah, 2019). Through the competence of good scientific thinking skills, they will be able to observe every piece of information to prevent and minimizing the spread of fake news or hoaxes that frequently occur in the public.

Currently, the recent problem that emerged is that the majority of Indonesian students no longer have good scientific thinking skills. Issued in the data presented by *the Organization for Economic Co-Operation and Development* (OECD) which is based on the results of the *Program for International Student Assessment* (PISA) in 2018 showing that the students' scientific reasoning skills in Indonesia was at below average level with the score of 395 from the score of 501 set by the OECD (Avvisati, et. al., 2019). Based on this data, it shows that the scientific thinking skills of the

Indonesian students are categorized as low and should be provided various efforts to improve these results.

The students' low scientific thinking skill level must be boosted through collaborative way between students and teachers (Andriani, 2016). The possible constructive resolutions to use in order to improve the scientific thinking skill such as by applying several learning models and methods in accordance with the achievement of Higher-Order Thinking Skills (HOTS). Improving the Higher-Order Thinking Skills can be applied into several constructivistic-based learning models including, problem-based learning, project-based learning, discovery learning, inquiry learning, and many others (Mahanal, 2019).

The sort of activities in the project-based learning model are in the form of creating certain projects set by the teacher according to the subject field. The process of solving the problem of these projects are conducted using the scientific method. The conception process of the project, product results, and the report of the projects are the important unit in the project-based learning model. The arranged projects are not only consisted of making products, but there are several other requirements of the projects, including the accordance with the learning objectives, the appropriate schedule between the project and the study program, cost, the students abilities, and the potential risks that might be happened (Jariyah, 2019). This is a form of work to improve the students' scientific thinking, so the students are expected to be involved in the logical thinking process.

The implementation of project-based learning model is in line with students' characteristics and the problems surround them such as in the case of SMA Negeri 1 Kandanghaur, Indramayu Regency. The high complexity of societies tends to have caught more by many problems. The schools and the heterogeneous students' residences can also trigger this to happen. Despite the fact that the heterogeneity occurs in other sectors, the homogeneity itself in the livelihood sector can still be founded. It is characterized by the type of

community work with similarities in the agricultural sector. Various kinds of problems that emerge require students to have good scientific thinking skills, in order to support them to have good problem solving skills.

This is an obligatory for teachers to decide which models or methods considered appropriate to improve the students scientific thinking skills. Conventionally, project-based learning is one of the constructivistic methods to effectively enhance the skills (Mahanal, 2019). The constructivism learning seeks students to independently construct their knowledge actively and sustainably (Priartini, Hendriani, & Fitriani, 2017). However, it is only one that is more optimal from the two learning models provided. Then, the learning model will be discovered in this study.

The objectives of this study include: 1) Knowing the implementation effect of project-based learning on scientific thinking skills, 2) knowing the effect of the use of communicative methods on scientific thinking skills, 3) knowing the difference between the effect of project-based learning and communicative methods on scientific thinking skills.

METHOD

This research adopted an experimental design, specificaly in the form of quasi-experimental research. The quasi-experimental research involves the existence of a control group in which they restrict others to control other variables, which means that the research can be carried out properly. Then, the reason for selecting the quasi-experimental design is to limit the problem that might affect the control and experimental groups, it considers the time efficiency and cost of research. The sample of this study was 60 students at the grade of 11 of SMA Negeri 1 Kandanghaur which were grouping into 2 classes. The research design was non-equivalent group consisted of test instruments usage, student worksheets, and student performances. The instrumental tests that had been given before and after the learning process or famously known as pret-est and post-test examined the scientific thinking

skills. This is determined as the beginning of the conducted research activities. Finally, the research data analysis conducted using *paired sample- t test* and *independent sample-t test.*

FINDINGS AND DISCUSSION

This study presents the data in the form of the data testing results. The section provides presentation of the numerous data in the table forms, accompanied by a brief description that describes the implementation of characteristics from both learning models as well as the table of data.

The Effect of Project-Based Learning on Scientific Thinking Skills.

The application of the project-based learning model which was set at XI grade of social studies class 1, was also basically as an experimental class. On each meeting, the learning was carried out over three times. This test was aimed to test the presence of an effect on the application of a project-based learning model on the students scientific thinking skills. However, before testing the effect, the pretest and posttest results carried out during 3 meetings were first presented.

Table 1. The *Pretest* and *Posttest* Results of the class implemented *Project Based Learning*

Detail of Information		Frequency (Criteria/People)	Percentage (% / Criteria)
Meetings	Pretest	26 Students (Low)	86,7%
		4 Students (Low)	13,3%
	Posttest	1 Siswa (Medium)	3,3%
		29 Siswa (Medium)	96,7%
	Average Pretest	38,91	
	Average Posttest	44,76	

Source: Data Processing Results, 2022

Paired sample t test with the program, namely SPSS 23 had been used to test the samples. Thus, the mean obtained through *the t test* process was -5,800, which translated that the difference in the average *(mean)* of pretest and posttest scored of 5,800. The pretest of experimental 1 resulted of 38.91 (mean), while in the posttest resulted of 44,76. The results showed the

difference of *pretest* and *posttest (mean)* descriptively. Therefore, to assure that the difference was significant, an interpretation toward the output result of *paired sample t test*, particularly at the calculated t value was conducted.

Table 2. t Test Results: The Effect of Project-Based Learning On Scientific Thinking Skills

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	Pretest Skill Scientific Thinking Class Experiment 1 - Posttest Scientific Thinking Experimental Class 1	-5,800	2,382	,435	-6,690	-4,911	-13,340	29	,000

Source: Data Processing Results, 2022.

The calculated t value reached in experimental class 1 was -13,340. Meanwhile, the t table was determined based on the df value of 29, and the significance value (α/2) which was 0,025, the t table value was in the range of 2,042. Then, it was concluded that in the experimental class 1, t value was successfully counted as (13,340) > t table (2,042). The result of significance value (Sig. 2-tailed) 0,000 was smaller (<) than 0,05. Then, the result became the reinforcement in the process of drawing conclusions. Both results presented the differences of pre and post learning. Thus, H1 was accepted and H0 was rejected. Therefore, based on these calculations, it was conceivably interpreted that there was a significant effect on the application of project-based learning over the scientific thinking skills.

The results actualized a relevancy as contained in the constructivist theory of learning. This theory declaired that "The Higher-Order Thinking Skills are accepted when implemented by constructivist-based learning such as problem-based learning, project-based learning, discovery learning, inquiry learning, and other methods" (Mahanal, 2019; Lubna, 2020). The reason why comparison between both terms made was due to the existence of the similarities. Scientific thinking is included in the competence of the

Higher-Order Thinking Skills. Furthermore, there are several things from the implementation of project based learning that are potentially to boost the growth of scientific thinking skill, such as students spend their practical time on scientific thinking during learning activities. This is in line with the statement from Van Clave's states, "The active involvement of students' scientific thinking along with the use of scientific method can hone their scientific thinking skills" (Tinenti, 2018).

Based on the exposure of the theory, it can be inferred that the project-based learning (PjBL) affects the scientific thinking skills. This was based on the average (mean) of the pretest and posttest results showing a difference in the test results of 5,800. An increase in the average test results where the posttest score was slightly upper the pretest score was also indicated. The effect of project-based learning model on scientific thinking skills granted support to several existing theories, namely the constructivist learning theory (one of which is project-based learning) that can improve the Higher-Order Thinking Skills, including: the scientific thinking skills.

The Effect of Communicative Learning Methods on Scientific Thinking Skills

The use of communicative learning methods was established at XI grade of social studies 2, as well as the control class. The learning process was carried out for 3 meetings, each meeting conducted for 90 minutes. The purpose of this test was to examine the presence of an effect from collaborative learning models on the scientific thinking skills possessed by students. The test was carried out as a control over the experiments of project-based learning model. However, before testing the effect, the pretest and posttest results which were carried out during 3 meetings were first presented.

Table 3. The Pretest and Posttest Results: The Class Implementing Communicative Learning Methods

Details		Frequency (Criteria /people)	Percentage (% / Criteria)
Meeting 3	*Pretest*	26 Students (Rendah)	86,7% (Low)
		4 Students (Sedang)	13,3% (Medium)
	Posttest	24 Students (Rendah)	80% (Low)
		6 Students (Sedang)	20% (Medium)
	Average *Pretest*	38,65	
	Average *Posttest*	39,01	

Source: Data Processing Results, 2022

The test adopted the *paired sample t test* along with the program of SPSS 23. The results of the t test showed that the mean of the two tests was -0.359, means that the difference between the average (mean) of *pretest* and *posttest* score was 0.359, the posttest score was over the pretest score. The average (mean) of experimental class 3 on the *pretest* results was 38.65, while it was 39.01 on the posttest. These results descriptively showed that there was no difference in the average (mean) of the *pretest* and *posttest*, because when the numbers are accumulated, they will gain the same scores. This is relevant to research conducted by Syafitri, Asyhar, & Asrial, (2016) ended up by bringing no change in *pretest* and *posttest* scores. However, an interpretation of the output results of the paired sample t test needs to be conducted, to particularly calculated the t-value output, in order to prove whether the significant difference does exist or being absence.

Table 4. T-Test Results: The Effect of Communicative Learning Methods On Scientific Thinking Skills.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair1	Pretest Skill Scientific Thinking Class Experiment 3 - Posttest Scientific Thinking Skill Experimental Class 3	-,359	1,046	,191	-,750	,0311	-1,882	29	,070

Source: Data Processing Results, 2022

The t value obtained in the experimental class 3 was -1,882. While the t table was determined based on the df value of 29 and the significance value of (α/2) was 0,025, the t table value is 2,042. It was concluded that in the experimental class 3, t value (1,882) > t table (2,042). Based on the t value, there was no effect of the communicative learning method on scientific thinking skills. This is because the communicative method is inappropriate to improve Higher Order Thinking Skills (Moedjiono & Hasibuan, 2012). The results of the significance value (Sig. 2-tailed) obtained 0,070 greater (>) than 0,05. This is relevant to the t value and reinforce the conclusion. Both results indicated that there was no difference of pre and post learning using the communicative method. Thus, H0 was accepted and H1 was rejected. The output of the t test interpreted that there was no significant effect on the use of the communicative method on students' scientific thinking skills, as indicated by unproduced difference, both before and after the implementation of the communicative method.

Referring to the similar research resulted the same conducted by Syafitri, Asyhar, & Asrial, (2016), discusses the absence of the effects from communicative learning method on scientific thinking skills. What only differentiate them lies in the term of diverse education levels. This study adopted a quasi-experimental design, and discovered that in the control group implementing communicative learning method, the specific improvement on students' scientific thinking skills was lessly brough. Furthermore, another study which adopted the Research and Development (R&D) method by Fitriyanti, Hidayat, & Munzil, (2017) found that the Higher-Order Thinking Skills in the control group implemented communicative method were lower compared to the the one which applied the inquiry learning model. These studies reached into the conclusion that the communicative learning method was not the appropriate model to improve students' scientific thinking skills.

Based on the obvious illustration presented, a compatibility between the results of this study and the hypothesis of several other theories were discovered. It was inferred that the communicative method has no effect on scientific thinking skills. This belongs to the output of the calculated t value (1,882) obtained a smaller number than t table (2,042). The findings also displayed that there was no raise in the average test results at the third meeting, it means that the average posttest score *(mean)* would be mean equal to the pretest score if they both were accumulated. By the absence of Communicative learning methods' effects over scientific thinking, provides supports to the several existing theories, namely the theory proposed by Zaini, et. al., (2012), which states that communicative learning method is feasibly used at the low levels. Indirectly, if the thinking level's achievement is high, then it is less successful.

CONCLUSION

Based on the results, it is seen that the implementation of project-based learning affects the scientific thinking skills. This is interpreted from the statistics showed that the H1 is accepted and H0 is rejected in the groups who implemented the *project-based learning*. There was no effect on the use of communicative learning methods on the scientific thinking skills obtained from the control group. This corresponds to the results of the hypothesis testing that obtained, H0 is accepted and H1 is rejected.

The teacher must be attentively aware in considering the implementation of classroom learning. The characteristics of students, teachers' skills, and supporting facilities also required to be in their lists. Moreover, the learning objectives and outcomes surely be the crucial and unlivable part that teacher must deal with in applying learning models. Subsequently, the uncomplicated learning methods, such as the communicative learning method can be implemented into the Lower-Order Thinking Skills' learning outcomes.

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