

The influence of project-based learning strategies on the metacognitive skills, concept understanding and retention of senior high school students

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ABSTRACT

Biology learning in the 21st century leads to the empowerment of metacognitive skills. Increased metacognitive skills can support concept understanding and maximize the students' retention of concepts. This research aimed at investigating the effect of project-based learning strategy on metacognitive skills, concept understanding and retention of class X students of Senior High School 1 Kairatu, West Seram District, Maluku. This research is a quasi-experimental research using pre test-post test nonequivalent control group design. The samples of this research were all students of class X₁ of Senior High School 1 Kairatu. The data obtained in this research were the learning results of metacognitive skills, concept understanding, and retention of the students. The data were analyzed by using analysis of covariance (ANCOVA). The research results showed that the implementation of project-based learning strategy had a significant effect on students' metacognitive skills, concept understanding, and retention. Furthermore, the results of post hoc LSD test showed some differences in the notation between the project-based learning strategy and the conventional learning strategy. These results indicated that the learning stages of project-based learning strategy could empower the students' metacognitive skills, concept understanding, and retention.

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1. INTRODUCTION

Biology learning in the 21st century is directed to student-centered learning. The orientation of student centered learning is to emphasize the student learning on inquiry or investigation. Windschitl [1] explains that the main focus of the students' 21st century learning is to solve complex problems, and the students' learning activities are focused on collecting relevant information, collecting data, testing the model, learning new concepts required to understand problems.

Biology learning process should also improve the skills of the 21st century, because the 21st century skills include logical thinking skill, metacognitive skill, and entrepreneurship thinking [2-4]. Metacognitive skill, one of the 21st century skills, can be interpreted as thinking about thinking. Tan [5] states that in the 21st century learning, students need metacognition as key to enhancing their thinking skills. Similarly, Greenstein [6] and Harun [7] explain that the demands of 21st century learning are that students know not only about the content of learning but also about how students learn and develop their metacognitive thinking skills. Yusnaeni and Corebima [8] adds that the students who have good metacognitive skills can become independent learners during the learning process. Independent learners means being able to determine how to

learn, when to learn, and to manage their own learning as well as to evaluate the results of the learning process. The development of the students' metacognitive skills can help students understand the learning process, thus, enhancing the students' concept gaining and retention. Listiana et al [9] found that independent learners are responsible for the improvement of their learning, and they can determine the best instructional strategies to accomplish the tasks set by the teachers.

Project-based learning strategy is a learning strategy which is oriented on investigation and requires the students' total activeness to complete a project. During the learning process, the teacher serves as a facilitator and motivator to direct the students, so that the students can work on the project well and finish it on time. The final stage of project-based learning is producing a scientific product in the form of scientific papers, reports, posters, leaflets, or media that can be displayed to the other groups. Meanwhile, Thomas [10] describes that project-based learning has five criteria, namely question-centered, constructivist-investigation, independence, realism, and focusing on the problems that can lead the students to experience the investigation process of the concepts and principles of the learning material. In line with the Thomas' opinion, Bell [11] explains that in the project-based learning, students construct new knowledge and build on the base knowledge, so that the students can master a lot of information when they learn by doing. Ilter [12] explains that the project-based learning is learning with a scientific approach, enhancing metacognitive strategies, producing a product which is suitable with the topic being discussed.

There have been many researches on the empowerment of metacognitive skills. Yusnaeni and Corebima [8] report that the integration of the SSCS + MS learning model has the potential to increase students' metacognitive skills. Listiana et al [9] report that metacognitive skills have a significant correlation with Biology cognitive learning results. Sele et al [13] in his research using conventional learning, TPS, RT and the integration of TPS and RT, reported that the metacognitive skills of senior high school students in Malang taught by using conventional learning strategy were very low compared to those taught by using TPS, RT and the integration of TPS+RT learning strategies. Furthermore, it was found that the lower the metacognitive skills were, the lower the students' critical thinking skills were.

If the students' metacognitive skills have a positive effect on students' concept gaining, the students' concept gaining also has an effect on students' retention. The research on the correlation between cognitive ability and retention was also reported by Setiawati and Corebima [14] that there was a significant correlation between the students' average-ability and the students' retention. Wicaksono and Corebima [15] report that metacognitive skills have a positive correlation with the students' retention. Thus, it can be concluded that to improve the students' retention, their metacognitive skills should be initially empowered. Some research findings have shown that empowering metacognitive skills has an effect on the students' cognitive abilities and retention. However, there has not been any research investigating the implementation of project-based learning strategy to empower students' metacognitive skills, retention, and concept gaining on the concepts of biodiversity. Therefore, the purpose of this research was to examine the effect of project-based learning strategy on metacognitive skills, concept understanding, and retention of class X students of Senior High School 1 Kairatu.

2. RESEARCH METHOD

2.1. Research Design

This research is a quasi-experimental research which is conducted to compare the effectiveness of conventional learning strategy and project-based learning strategy in improving the students' metacognitive skills, concept understanding, and retention. Confounding variables such as gender, initial students abilities, and students skills are controlled by placing heterogeneous students into study groups. The design of this research was pre test-post test nonequivalent control group design Table 1.

Table 1. Research Design

Group	Pretest	Learning Strategy	Posttest
Conventional Learning Strategy (Control)	O ₁	X ₁	O ₂
Project Based Learning Strategy	O ₃	X ₂	O ₄

Description:
 O₁ and O₃ : Pretest
 O₂ and O₄ : Posttest
 X₁ : Conventional learning strategy
 X₂ : Project-based learning strategy

2.2. Research Sample

This research was conducted in Senior High School 1 Kairatu West Seram District. The sample of this research was 40 students of class X Senior high school 1 Kairatu in the first semester of the 2017/2018 academic year.

2.3. Instruments

The instruments used in this research were in the form of an essay test using metacognitive rubric and concept understanding rubric and retention developed by Corebima [16]. The essay test was given at the beginning (pretest) and at the end (posttest) of the research. Before used, the instruments had been validated by experts.

2.4. Experimental Process

Two classes were used as the research samples, namely class X₁ and X₂. Class X₁ was taught by using conventional learning strategy, while class X₂ was taught by using project based learning strategy. The learning material used in this research was about Biodiversity. The conventional learning in the control class was carried out by the teacher without any intervention from the researcher. The experimental class was taught by using project based learning by the researcher. A pretest and posttest were administered before and after the research was conducted.

2.5. Data Analysis

The data were analyzed by using ANCOVA test followed by post hoc LSD test (Least Significant Different test). The pre test, metacognitive skills, concept understanding, and post test were used as the covariates. Before the ANCOVA test was performed, the normality of the data were initially tested using Kolmogorov-Smirnov test, and the homogeneity of the data was tested using Levene's test.

3. RESULTS AND ANALYSIS

The results of the normality test of the students' metacognitive skills, concept understanding, and retention using Kolmogorov-Smirnov test showed that the data were normally distributed ($p > 0.05$). The results of the homogeneity test of the students' metacognitive skills, concept understanding, and retention using Levene test of Equality of Error Variances indicated that the data came from homogeneous population ($p > 0.05$). Therefore, the data had normal distribution and were homogeneous. Thus, the covariance analysis of the students' metacognitive skills, concept understanding, and retention could be performed. The results of ANCOVA test on the students' metacognitive skills, concept understanding, and retention are presented in Table 2; Table 4; and Table 6. While the LSD post hoc test of each variable is presented in Table 3; Table 5 and Table 7.

Table 2. The Results of ANCOVA on the Metacognitive Skills of Senior High School 1 Kairatu

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1273.556 ^A	2	636.778	20.242	.000
Intercept	14566.466	1	14566.466	463.046	.000
Pre-test	28.661	1	28.661	.911	.346
Strategy	1079.512	1	1079.512	34.316	.000
Error	1163.944	37	31.458		
Total	306503.906	40			
Corrected Total	2437.500	39			

The results of ANCOVA test Table 2 show that the learning strategy variable has an effect on the metacognitive skills of students of Senior High School 1 Kairatu ($p < 0.05$). Once it was found that learning strategy had an effect on the students' metacognitive skills, the LSD test was then performed. The post hoc LSD test was to determine differences in the metacognitive skills between the students taught by using project based learning strategy and those taught by using conventional learning, as shown in Table 3.

Table 3. The Results of Post Hoc LSD Test on the Metacognitive Skills of the Students of Senior High School 1 Kairatu

Class	X Metacognitive	Y Metacognitive	Difference	LSD Notation
Control_Conventional Strategy	6.59	27	20.41	a
Experiment_Project-Based Learning Strategy	9.57	32.3	22.73	b

Project-based learning strategy has better potential in improving students' metacognitive skills compared with the conventional learning strategy with the score difference between the pretest and posttest scores as much as 22.73 Table 3. The results of this research show that the implementation of project-based learning strategy can train the students to be independent learners in planning the project, responsible for the implementation of the project, and reporting the results / products obtained, so that their metacognitive skills are empowered. When the students are engaging in the project-based strategy, their metacognitive skills, whose characteristics include independence, planning, responsibility and evaluation, are raised and honed to become more quality. Through the project-based learning strategy, the students' metacognitive skills are honed and developed. This is because the project-based learning strategy emphasizes on the students' activities and on their cognitive constructivist. Tan [5] revealed that the project-based learning directed the students to build their knowledge. Suwono [17] explains that the project-based learning is a student-centered learning, using a variety of ways, and is an active learning approach in education. Thomas [10] and Hellstrom et al [18] explain that one characteristic of the activity in project-based learning is that the projects involve the students in a constructive investigation. Palennari [19] explains that through metacognition, students become an independent learners, students can organize and plan the learning process. In line with this, Yusnaeni and Corebima [8] and Corebima [16] reveal that independent learners are responsible for their own learning progress and their own efforts, able to monitor and evaluate their learning activities before and after the learning activity.

During the conventional learning strategy, the students were assigned to answer the student worksheet. This made the students not learn to be independent and responsible for the planning process and the resulting products. Therefore, the metacognitive skills of students in conventional learning class were lower than those in the project-based learning strategy class. The research by Listiana et al [20] reported that the conventional learning activity, such as answering student worksheets and discussions, made the students passively receive information from teachers. In addition, such activity did not empower the students' skills. Project-based learning strategy can be used to enhance the students' concept understanding Table 4. The research by Suparti [21] proves that the project-based learning can improve the students' learning results, so that the students' research skill can be achieved because project-based learning facilitates the students to identify problems.

Table 4. The Results of ANCOVA Test on the Concept Understanding at Senior High School 1 Kairatu

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	300.833 ^a	2	150.416	38.901	.000
Intercept	1480.507	1	1480.507	382.888	.000
Pre-meta	4.176	1	4.176	1.080	.305
Strategy	201.294	1	201.294	52.059	.000
Error	143.067	37	3.867		
Total	36564.000	40			
Corrected Total	443.900	39			

The results of ANCOVA test Table 4 show that the learning strategy variable makes a difference toward the concept understanding of the students of senior high school 1 Kairatu ($p < 0.05$). This shows that learning strategy has a significant effect on the students' concept understanding. Having been found that learning strategy has a significant effect on the students' concept understanding, the LSD test is performed. On the other hand, the post hoc LSD test Table 5 was performed to determine the significant difference in the students' concept understanding between the project based learning strategy and conventional learning strategy. The results show that project-based learning strategy has a greater potential in improving the students' concept understanding than does the conventional learning strategy, with a score difference between pretest and posttest as much as 4.19. The research by Koparan and Guven [22] reports that project-based learning method is more effective than conventional learning method, moreover, project-based learning can improve the students' collaboration by using student-centered principle which is more effective and efficient. project-based learning method is more effective than conventional learning method, moreover, project-based learning can improve the students' collaboration by using student-centered principle which is more effective and efficient.

Table 5. The Results of LSD Test on the Concept Understanding of the Students of Senior High School 1 Kairatu

Class	X Concept Understanding	Y Concept Understanding	Difference	LSD Notation
Control_Conventional Strategy	22.79412	80.69853	57.9	a
Experiment_project based learning strategy	29.8913	91.9837	62.09	b

The influence of project-based learning strategies on the metacognitive skills ... (Domingus Rumahlatu)

The difference in the concept understanding between the students taught by using the project-based strategies and those taught by using conventional learning strategy is because the students in the project based learning strategy experienced a series of stages of doing a project. The implementation of the project consists of some stages, namely planning, investigation, presentation of results / products, and evaluation. In line with this, Han and Bhattacharya [23] state that the project-based learning consists of three stages, namely planning, creation, and process. Furthermore, Colley [24] reveals that the project-based learning includes the stages of identifying and determining a project, seeking information, planing the project, working on the project, reporting the results of the project, and evaluating the project that has been carried out.

In the planning process, the teachers direct the students to develop questions about biodiversity issues which are typical of Maluku, Indonesia. After that, the students are guided to prepare a design of investigation procedures for problem solving. Project-based learning is a strategy to encourage students to do research based on questions or problems [25]. The following stage is implementing the project through the investigation procedure to investigate the diversity level of genes, species and ecosystems which are typical of Maluku. Through this investigation procedure, the students are significantly trained to develop a concept for themselves.

The research by Ergul and Kargin [26] showed that very few students forgot their experiences during the process of project-based learning, because students could understand the concepts and were able to make a presentation of it. The next stage to develop the students' concept gaining is the presentation stage of the results of the project in the form of posters or leaflets of biodiversity. Movahedzadeh et al [27] explains that open discussion gives a contribution toward the students who have better understanding to share with other students. Through this scientific sharing, the students also explain their understanding and the findings of their projec. They even can tell about their confusion they encountered during the implementation of the project. In line with this, the research by Thompson et al [28] reveals that students develop the level of their concept understanding, problem solving and communication skills better, so that it helps them both in the academic world and in the future. The use of project-based learning strategy can improve the students' concept understanding of biodiversity better than the conventional strategy can.

A good metacognitive skill and good concept understanding will certainly have a contribution toward the students' retention. The effect of learning strategy on students' retention can be seen in Table 6 below.

Table 6. The Results of ANCOVA Test on the Retention of the Students of Senior High School 1 Kairatu

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1586.500 ^a	2	793.250	244.027	.000
Intercept	126.857	1	126.857	39.025	.000
post_test	730.472	1	730.472	224.715	.000
Strategy	54.211	1	54.211	16.677	.000
Error	120.275	37	3.251		
Total	275113.000	40			
Corrected Total	1706.775	39			

The results of ANCOVA Table 6 show that learning strategy variable makes a difference on the retention of the students Senior High School 1 Kairatu ($p < 0.05$). This shows that learning strategy has an effect on the students' retention. Having been found that learning strategy has an effect on the students' retention, the LSD test is performed. The post hoc LSD test was performed to know the significant difference in the students' retention between the project based learning strategy and the conventional learning strategy. The results of the LSD test are presented in Table 7.

Table 7. The Results of the Post Hoc LSD Test on the Retention of the Students of Senior High School 1 Kairatu

Class	X Retention	Y Retention	Difference	LSD Notation
Control_Conventional Strategy	75.3	77.3	2	a
Experiment_Project based learning Strategy	84.09	87	2.91	b

The project based learning strategy has a greater potential in improving the students' retention than does the conventional learning strategy with a score difference between pretest and post-test as much as 0.91 Table 7. Research shows that when the students who learn by using project-based learning strategy have high metacognitive skills, they will also have a good concept gaining and retention. Similarly, Bahri [29] found

that the use of appropriate learning strategies could empower the students' metacognitive skills, so that it could increase the students' cognitive retention. The research by Listiana et al [20] also shows that metacognitive skills are consistent and have a correlation with the improvement of the students' cognitive ability. Retention is an ability of memory to store information within a specified period. In this case is the students' retention ability of the biodiversity material. Anderson and Krathwohl [30] explain that retention is the ability to remember learning material until a certain period of time. The students' activity during the project-based learning strategy supports the students' retention ability. During the process of collecting information and doing investigation, the students discover concepts and experience real and meaningful learning. Gaines [31] states that one of the factors that affect student retention is meaningful learning, because when the learning material is meaningful, the students will understand it more easily.

Through this research, the students are invited to do a project on biodiversity which is typical of Maluku. In this case, the students will study the conditions and living things around them, so that it will become a meaningful experience for them. The research by deWinstanley and Bjork [32] reported that the students would remember the information they discover by themselves better than that they read. Retention is also associated with the student's ability to store information in long-term memory. The information which is obtained from doing a project and meaningful learning will certainly be stored in long term memory. This can increase students' retention better than the conventional learning strategy. Furthermore, Finley et al. [33] states that the students constructing knowledge by themselves will have an effect in their involvement in learning, encoding information, so that the information stored in long term memory can be quickly retrieved.

4. CONCLUSION

Based on the results of this research, it can be concluded that the implementation of project based learning strategy can improve metacognitive skills, concept gaining, and retention on biodiversity learning material of the students of Senior High School 1 Kairatu. This is proven with the differences in the notation which indicate that project-based learning strategy can improve metacognitive skills, concept, and retention more significantly compared to the conventional learning strategy done by the teacher.

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