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Learning Ecosystem Material with Project Based Learning (PjBL) Model to Improve Science Process Skills and Student Creativity

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Abstract

Based on the results of interviews conducted with biology teachers at SMA N 1 Andng Boyolali, it is known that understanding the concept of ecosystem material and students' opportunities to find and build their own knowledge is less than optimal, so that students are less able to develop their thinking skills which have an impact on the low process skills and student creativity. This research is a quasi-experiment with a non-equivalent control group design. The samples in this study were X1 and X2 grade students who were determined by cluster purposive sampling. Data collection techniques were carried out by distributing pretest and posttest. Data analysis used in this research is normality test, homogeneity test, independent sample t-test, and n-gain test. The results of this study showed that ecosystem learning with Project Based Learning (PjBL) model can improve science process skills and creativity. The N-Gain test results of science process skills of control class students were 0.30 which was categorized as low and the experimental class was 0.64 which was categorized as moderate. While the N-Gain test of student creativity in the control class was 0.29 which was categorized as low and the experimental class was 0.58 which was categorized as moderate. The conclusion of this research is that learning ecosystem material with the PjBL model can improve students' science process skills and creativity. Suggestions in this study are that teachers can apply the PjBL model to optimize student learning outcomes in other materials that are in accordance with the characteristics of the model and the PjBL learning model can be applied to biology learning with a wider scope of material

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INTRODUCTION

Education can produce high-quality human resources, which makes it a benchmark for the progress of a nation. If education is well implemented, a nation is said to be advanced. Thus, education is very important for the progress of a nation. Education is the result of efforts to improve the quality of education. Revamping education to adapt to changes and developments in modern life, the quality of education in Indonesia has increased (Sari *et al.,* 2021). Education in Indonesia is undergoing improvements that follow the changes and developments in life that are happening in the 21st century. One of the improvements made is by changing the curriculum from the 2013 curriculum to the independent curriculum. The independent curriculum focuses on increasing student activeness through scientific processes, so that learning not only creates active students, but is also able to create students both in attitudes and skills, especially in science fields such as biology (Kemendikbud, 2019). Biology learning not only includes products, but also processes and applications so that it provides meaning for students. The nature of science learning as science consists of hands on, minds on, hearts on so that biology learning takes place in accordance with its spirit as science (Singaraja *et al.,* 2017). In Senior High School (SMA), biology learning focuses on mastering science concepts and attitudes (Umara *et al.,* 2018).

Based on observations and interviews with biology teachers at SMA Negeri 1 Andong, it is known that the evaluation of the cognitive and psychomotor domains has been used to assess learning outcomes. Cognitive learning outcomes (UAS scores for the 2021/2022 academic year) show that 75% of students reach the established Minimum Completion Criteria (KKM) (KKM is more than 70). Psychomotor learning outcomes (report grades) show that 70% of students have achieved the KKM (KKM is more than 75). This shows that learning is focused on exam success, with the main focus on cognitive and psychomotor components. As a result, students do not have many opportunities which leads to low student learning creativity. In addition, there has been no development of the assessment of concept achievement or science process skills, so that the process aspect of the nature of science itself is often neglected in its application in learning. Finally, students are quickly bored and less enthusiastic in following thinking and developing their potentials and learning.

The results of interviews with biology teachers directly show that biology learning is only done in the classroom with conventional methods, where the teacher only conveys material verbally through lectures. The learning process is more often in the classroom so that student activities tend to memorize concepts more often without knowing how the process of discovering concepts can be obtained from direct experience. The application of the process of finding concepts in biology learning can be integrated in student learning activities, but a special learning model is needed so that students' science process skills and creativity continue to develop (Umara *et al.,* 2018). When applying the right learning model and learning resources, it can certainly make students more interested in learning and able to understand and find information by themselves (Wulandari *et al.,* 2020). One model that can improve science process skills and creativity is the Project Based Learning (PjBL) model (Susanti *et al.,* 2020).

PjBL is a learning model that uses projects or activities to improve students' attitudinal competencies. It helps students solve problems by using their ability to research, analyze, create, and present products (Singaraja *et al.,* 2017). The Project Based Learning (PjBL) model allows teachers to control classroom learning by using project work. Students are asked to complete complex tasks based on highly challenging questions and problems in the project. The Project Based Learning (PjBL) model requires students to think critically, analytically, use higher order thinking skills, work together, communicate, solve problems, and learn independently (Afifah *et al.,* 2017).

The chosen project should be appropriate for the students' level of development and not

burden the students. One example of a project that can accommodate students' knowledge of ecosystem material is to make a terrarium. Terrariums are made of glass, bottles, aquariums, or transparent plastic and contain plants (Pratama, 2020). In this study, terrariums were chosen because they have the capacity to display ecosystem materials and encourage student creativity and teach processing skills. Learning can also be done in the school environment or in the classroom, which makes it easier for teachers to supervise. A total of 3 biology teachers agreed to use the Project Based Learning (PjBL) model to make terrariums. There is a need to develop innovative project-based learning models, so researchers conducted research on "Learning Ecosystem Material with Project Based Learning (PjBL) Models to Improve Science Process Skills and Student Creativity."

RESEARCH METHOD

This type of research is experimental research using the *Quasi Experimental Design* in the form of *Nonequivalent Control Group Design*. The population in this study were all class X students at SMA N 1 Andong Boyolali. Sampling was carried out using a cluster purposive technique consisting of 2 classes, namely class X1 and X2. This research uses two types of data, namely primary data and secondary data. Primary data taken include the value of science process skills and creativity. While secondary data in the form of student worksheets, projects and student response questionnaires. The test instrument was prepared using multiple choice questions consisting of 25 questions and essay questions consisting of 10 questions. The occurrence of improvement in this study is determined by the increase or difference in the average score of students with the Learning Objective Completeness Criteria (KKTP) score set in Biology learning at SMA N 1 Andong Boyolali. Techniques to analyze the improvement of science process skills and creativity through the Project Based Learning (PjBL) learning model. is determined from the following criteria:

1. 85% of students score ≥ KKTP or ≥ 70
2. The N-Gain value is in the medium to high category with students score ≥85%

RESULTS

This research was conducted at SMA Negeri 1 Andong Boyolali in class X1 as the experimental class and class X2 as the control class. Primary data in this study include pretest scores and posttest scores. Secondary data includes student worksheets, project scores and student response questionnaires regarding the implementation of the learning process using the Project Based Learning (PjBL) model.

Science Process Skills

Science process skills are measured using pretest and posttest questions with indicators of science process skills, namely observing, classifying, analyzing, predicting and hypothesizing. The experimental class used the Project Based Learning model while the control class used the conventional learning model.

Table 1. Recap of science process skill scores

Description	Experimental Class			Control Class		
	Pretest	*Posttest*	*LKS*	*Pretest*	*Posttest*	*LKS*
Number of Students	36	36	36	36	36	36
Maximum Value	76	100	100	72	82	100
Minimum Value	48	60	80	40	56	72
Average Value	56,9	81,4	73,3	54,7	67,5	65,7

Number of students completed	4	32	36	1	14	36
Number of tudents not completed	32	4	0	35	22	0
Clasical Completeness (%)	11	89	100	2,8	39	100

The criteria for achieving learning objectives (KKTP) for biology subjects at SMA N 1 Andong Boyolali is 70. The average pretest score of both classes is almost the same, indicating that their initial knowledge is the same. Posttest scores, on the other hand, obtained from student test results after Project Based Learning (PjBL) learning is applied to the experimental class have increased than the control class using a conventional learning model. As for the supporting values in the form of Student Worksheets (LKS), it shows that 100% of students reached classical completeness (≥85), so that ecosystem learning with the Project Based Learning (PjBL) model can improve students' science process skills.

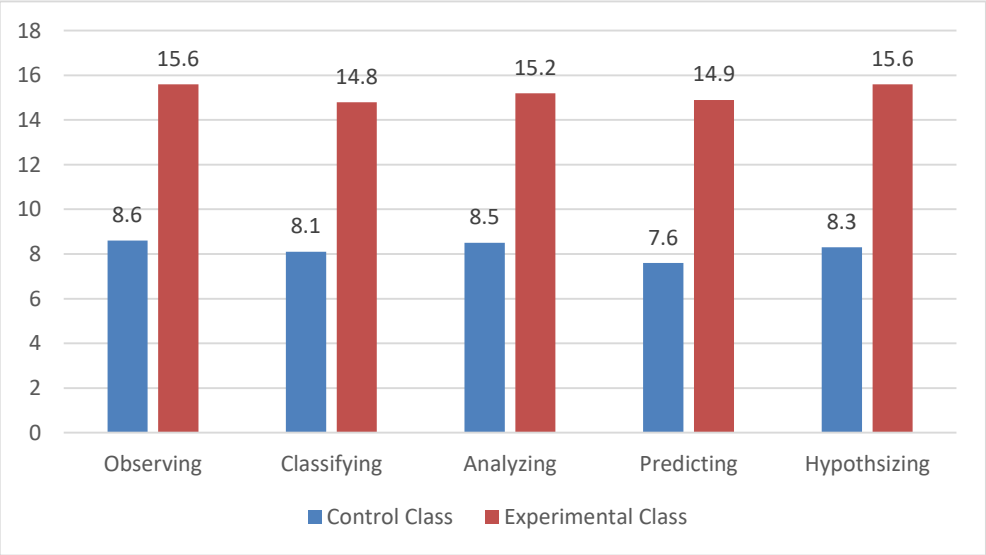

Figure 1. The results of the posttest scores of students' science process skills in the control class and experimental class

The test instrument designed according to the indicators of science process skills shows that observing and hypothesizing skills are indicators that show the best improvement among indicators of classifying, interpreting and predicting.

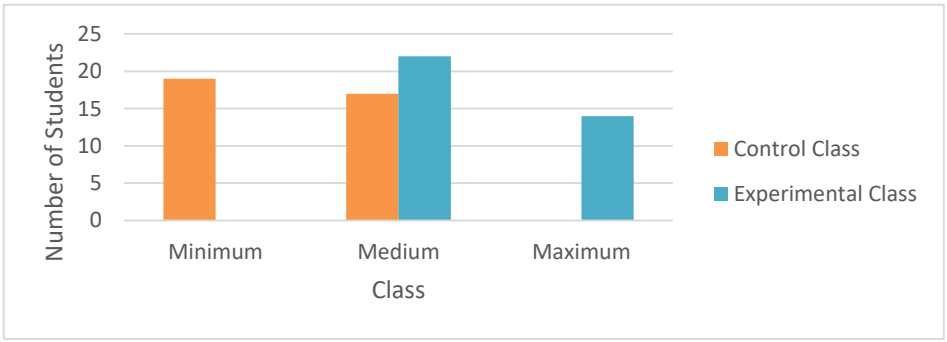

Figure 2. N-Gain Graph of Science Process Skills

Figure 2 shows that the average N-Gain of the experimental class is in the moderate category as much as ≥ 85%. Based on the average N-Gain category, which is moderate, it can be stated that ecosystem learning with the Project Based Learning (PjBL) model can improve students' science process skills.

Creativity

Creativity is measured using pretest and posttest questions with creativity indicators, namely fluency, flexibility, originality and elaboration. The experimental class used the Project-Based Learning model while the control class used the conventional learning model.

Table 2. Recap of creativity scores

Description	Experimental Class			Control Class		
	Pretest	*Posttest*	*Project*	*Pretest*	*Posttest*	*Project*
Number of Students	36	36	36	36	36	36
Maximum Value	76	80	98	72	76	92
Minimum Value	48	62	90	42	42	88
Average Value	60,1	72,5	75,6	59,6	64,2	74,7
Number of students completed	8	32	36	8	12	36
Number of tudents not completed	28	4	0	28	24	0
Clasical Completeness (%)	22	89	100	22	33	100

The average pretest score between the two classes is almost the same. While the average posttest value between the experimental class using the Project Based Learning (PjBL) learning model and the control class applying the conventional model is different. The average posttest value of the experimental class was 72.5 while in the control class it was 74.7. In addition, the project value shows that 100% of students reach classical completeness (≥85), so that ecosystem learning with the Project Based Learning (PjBL) model can increase student creativity.

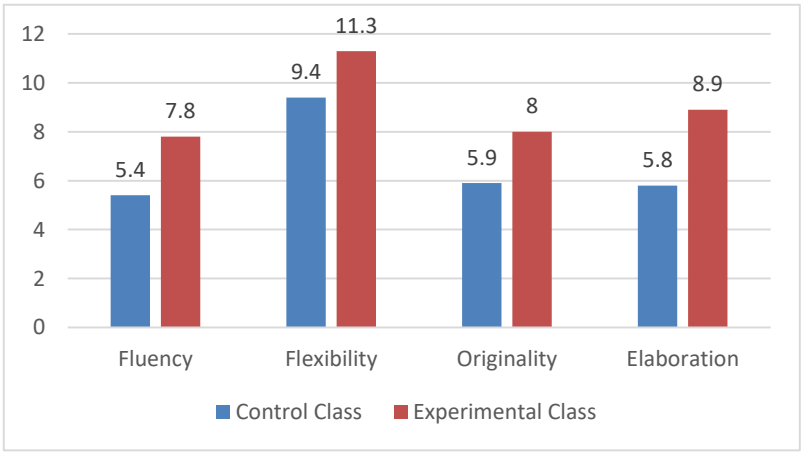

Figure 3. The results of the posttest scores of the creativity of control class and experimental class

The results of the student creativity test show that the flexibility indicator is more improved than the fluently, originality and elaboration indicators.

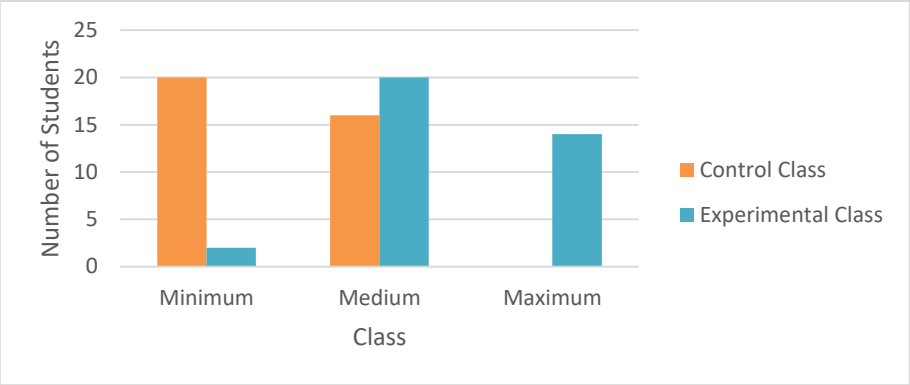

Figure 4. Creativity N-Gain Graph

Figure 4 shows that the average N-Gain of the experimental class is in the moderate category as much as ≥ 85% so that it can be stated that ecosystem learning with the Project Based Learning (PjBL) model can increase creativity.

The student response questionnaire was filled in by students after all series of learning in the experimental class with the Project Based Learning model through the terrarium making project was completed.

No.	Statement	Presentation (%)	Criteria
1	Favoring biology over other subjects	92,3	Excellent
2	Biology lessons are fun and exciting	88,9	Excellent
3	Biology lessons are useful in everyday life	89,5	Excellent
4	Biology lessons provide an understanding of the importance of maintaining the survival of other creatures in the surrounding environment.	92,3	Excellent
5	Ecosystem material is material that is difficult to understand	95,8	Excellent
6	Group activities encourage asking questions and expressing opinions	88,9	Excellent
7	The opportunity to discuss and learn with friends makes it easier to understand the material and easier to do the project.	97,2	Excellent
8	Loved the terrarium project	98,6	Excellent
9	More active and excited with terrarium making project	97,7	Excellent
10	Terrarium projects are easy to do	95,8	Excellent
11	Terrarium making project found a lot of information related to ecosystem material	91,7	Excellent
12	Presentation of the results of the terrarium making project makes the class atmosphere more active	92,3	Excellent
13	Terrarium-making project makes ecosystem material easier to understand	97,2	Excellent
14	Terrarium making project can increase creativity in creating a new product	97,2	Excellent
15	Agree if the terrarium making project is applied in ecosystem material	97,2	Excellent

DISCUSSION

Science Process Skills

The results showed that students' science process skills were influenced by the Project Based Learning (PjBL) learning model. This is because the application of the Project Based Learning (PjBL) learning model can improve students' skills in working on the science projects given. Students can directly see the application of the theory they have learned and can use their skills to innovate and be creative with the project assignments given. The results of this study are consistent with previous research by Rahayu (2017), who found that the application of the Project Based Learning (PjBL) model can improve students' ability to assess the results of scientific work (science process) and written tests (daily tests). Istiana et al. (2015) also found that the application of the Project Based Learning (PjBL) model can increase student activity and process skills because it makes students more active in finding material concepts.

Students' science process skills in the experimental class can be seen during the terrarium project activities. Students will be trained to think systematically by interacting directly with the object of study, namely the terrarium. Students learn to assemble terrariums while observing, interpreting and classifying the components of the ecosystem that are in it, besides that project-based learning is also very well applied to learning topics related to the environment because students can directly intersect with nature, as a contextual learning object. Previous research conducted by (Wijanarko *et al.,* 2017) also stated that the guided PJBL model effectively improved students' science process skills on the material of natural events and their impact on living things and the environment, the PJBL model is student-focused learning, where students are given the opportunity to be able to understand a concept and principle by conducting experiments on a problem and finding the right solution (Rahmasiwi *et al.,* 2015).

Test instruments designed according to indicators of science process skills show that observing and hypothesizing skills are indicators that show the best improvement among indicators of classifying, interpreting and predicting. The effect of increasing the ability to observe and students in the experimental class is due to the learning process that applies project-based learning syntax can contain indicators of science process skills. Observing indicators are loaded in the introduction and syntax of monitoring project progress so that students are able to make direct observations in the surrounding environment (Yunita, 2021). This is in line with Kasdum's research (2019) which says that with the project students become more active in making direct object observations.

In the project-based learning model, there is a syntax for monitoring project progress which contains hypothesizing indicators by conducting experiments on a problem, observing the surrounding environment and making hypotheses from the observations that have been made, so that students experience a meaningful learning process with their own knowledge (Akhmad *et al.,* 2020). In constructivism learning, students only get information through teacher explanations (Nur, 2022). This is in accordance with research conducted by Alviana (2018) which states that there is a significant effect on the experimental class because students get meaningful learning in the process of completing the project given.

In the learning process, teachers facilitate students by providing Student Worksheets (LKS) which are used as supporting data in this study. The worksheet contains illustrations that students will identify and questions related to science process skills that are trained to students. There are 3 worksheets given according to the sub-chapters being discussed, namely ecosystem types, energy flow and biogeochemical cycles. According to Sudibyo *et al.,* (2019) which states that the activities and questions in the LKS help students in fostering students' scientific attitudes towards science learning process skills. This is also supported by Barokah's research (2019) that

implementing indicators of science process skills into the LKS made can improve students' process skills through the questions available.

Creativity

The application of the Project Based Learning (PjBL) model provides an increase in student creativity because this model is one of the innovative learning models that involves students actively in building knowledge, developing various student potentials through a series of processes that help students understand what they learn through actions and facilitate students to realize ideas and ideas through products with a series of creative and meaningful processes. This is in accordance with the research of Mardhiyana *et al.,* (2016), that project-based learning has the advantage of actively involving students in problem solving, which helps the acquisition of new knowledge and skills, encourages group cooperation, and provides opportunities to plan projects so as to increase student creativity.

Creativity in the experimental class with the Project Based Learning (PjBL) model is seen in the terrarium making project. Students will be trained to think systematically and creatively by interacting directly with the object of study, namely the terrarium. Students learn to assemble terrariums while observing, interpreting and classifying the components of the ecosystem that are in it, besides that project-based learning is also very well applied to learning topics related to the environment because students can directly intersect with nature, as a contextual learning object (Wijanarko *et al.,* 2017). This is in accordance with the research of Setiawan *et al.,* (2022) which states that the application of project learning effectively increases student creativity because the knowledge gained through the material will be realized in the work of a project, so that students experience a meaningful learning process with their own knowledge.

Project-based learning was applied in the experimental class using the Project Creation Guidance Sheet which aims to facilitate students in the process of making project stages in groups. According to Permatasari (2023) at the project creation stage, students are given time to discuss the terrarium project that will be made. This is in line with the research of *Marhaeni et al.,* (2022) that before the application of project-based learning, students have not been able to imagine planning a project, even students do not understand where to start the project, but after starting the terrarium project which is done by students in groups, with guidance and supervision from the teacher, students are able to plan experiments better and structured so that they can complete project tasks properly and on time.

In the conventional model, students do a poster-making project that contains information about ecosystem material used to see the level of creativity in the control class. This result is in line with the research of Sudibjo *et al.,* (2020) which states that implementing project activities into education is a new breakthrough that allows students to be more creative when learning. Project-based learning provides opportunities for students to discuss and solve problems individually or in groups and compete with other groups during the project (Nurpitasari *et al.,* 2018).

The results of the student creativity test showed that the flexibility indicator increased more than the fluently, originality and elaboration indicators. This is because flexibility can provide students with a variety of ideas that vary in the application of the project to be made, so that in this case students can see problems or deficiencies from various points of view (Hartono *et al.,* 2018). Since students are given the opportunity to experiment with product design, this skill can be improved. According to Wulandari (2019), this skill can be improved, because students are given the freedom to explore designing a product. Through this activity, students are given the idea to use their ideas by discussing among students to create a product. This is in line with Murtafiyah's research (2023) which shows that collaborative activities in project-based learning

can increase flexibility in thinking during the project design process.

The student response questionnaire shows that students feel the positive impact of terrarium project learning. Students also like biology and like this learning because they feel biology is useful for daily life. They also agree that terrarium project learning can be used again to teach material about ecosystems.

CONCLUSION

Based on the research results, data analysis and discussion that have been described, it can be concluded that ecosystem learning with the Project Based Learning (PjBL) model can improve students' science process skills and creativity.

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