



The influence of project-based learning models and creativity on critical thinking

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ABSTRACT

Project-based learning offers alternatives that can potentially improve students' critical thinking skills. This study examines the effect of project-based learning models and creativity on the critical thinking of students in ecosystem learning in class V SDN Kaloy Tamiang Hulu Aceh Tamiang. The quantitative research approach uses the quasi-experimental method and the two-path ANAVA test. Based on the hypothesis testing, it is known that there is an influence of the project-based learning model on critical thinking skills with the results of analysis of variants of learning outcomes of students who learn to use the project-based learning model and have high creativity and students who have low creativity. Furthermore, the results of the variant analysis, the interaction between the Project-Based Learning Model and students' creativity and critical thinking students, show that groups of students with high creativity get a higher critical thinking value than those with low creativity tested for truth. There is an interaction between the Project-Based Learning Model on the creativity of students and critical thinking skills, as evidenced by the graph of the model interaction based on the results of the calculation between the Project-Based Learning Model on the creativity of students and the critical thinking skills of students in Class V SD Kaloy Tamiang Hulu Aceh Tamiang.

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ABSTRAK

Project-based learning menawarkan alternatif yang berpotensi untuk meningkatkan kemampuan berpikir kritis peserta didik. Penelitian ini bertujuan untuk mengkaji pengaruh model project-based learning dan kreativitas terhadap berpikir kritis peserta didik dalam pembelajaran Ekosistem di kelas V SDN Kaloy Tamiang Hulu Aceh Tamiang. Pendekatan penelitian yakni kuantitatif dengan metode quasi eksperimen dan menggunakan uji ANAVA dua jalur. Berdasarkan uji hipotesis yang dilakukan diketahui bahwa terdapat pengaruh model project-based learning terhadap kemampuan berpikir kritis dengan hasil analisis varian hasil belajar peserta didik yang belajar menggunakan model project-based learning dan memiliki kreativitas tinggi serta peserta didik yang memiliki kreativitas rendah. Selanjutnya hasil analisis varian, interaksi antara model project-based learning dan kreativitas peserta didik terhadap berpikir kritis peserta didik menunjukkan kelompok peserta didik yang memiliki kreativitas tinggi memperoleh nilai berpikir kritis lebih tinggi dari kelompok peserta didik dengan kreativitas rendah teruji kebenarannya. Terdapat interaksi antara model project-based learning terhadap kreativitas peserta didik dan kemampuan berpikir kritis yang dibuktikan dengan grafik interaksi model berdasarkan hasil perhitungan antara model project-based learning terhadap kreativitas peserta didik dan kemampuan berpikir kritis IPA peserta didik kelas V SD Negeri Kaloy Tamiang Hulu Aceh Tamiang.

Kata Kunci: berpikir kritis; kreativitas; pembelajaran berbasis proyek

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INTRODUCTION

In the era of globalization, education needs to adapt to 21st-century skills so that when graduating, students can think critically, communicate, collaborate, and be creative (4C). Education adjustment can be done by implementing learning models that encourage learners' ability to collaborate, think critically, and creatively. Project-based learning is one of the appropriate learning models to support students in having 4C skills (Riskayanti, 2021). Project-based learning is a learning model that focuses on a problem, helping students improve their critical and creative thinking skills in solving a problem given by the teacher. This learning model invites students to collaborate with their classmates in solving the problem (Mora et al., 2020). Project-based learning can be applied to Natural Science Subjects by utilizing resources around students in doing projects (Barkah, 2024; Syawalia et al., 2024).

Ilmu Pengetahuan Alam (IPA) lessons must be appropriately managed and receive more attention to provide strong provisions for students as a foundation to keep up with technological developments. In this case, elementary school science learning must be strengthened, which will be a strong foundation for students at the next level. Science is one of the subjects in elementary school that requires thinking and problem-solving skills, so it does not only learn about living things, such as plants or animals (Astuti, 2024). Some science material is difficult for students to understand due to abstract concepts and the use of foreign terms that are not understood. Therefore, selecting learning methods in science subjects significantly affects students' understanding of the material. Project-based learning is appropriate to solve this problem because this method focuses on students.

Project-based learning significantly affects students' science learning outcomes regarding specific subjects, levels, and the number of samples used (Balemen & Keskin, 2018). Other research also showed an increase in students' creativity using the project-based learning model. This is evidenced by the increase in cycle I and II activities that occurred in the study (Mustika, 2020). In addition, project-based learning also improves students' activities and learning outcomes so that students' learning completeness increases (Fatmawati, 2023).

Several things distinguish this research from previous research; The first relevant research shows the effect of the project-based learning model on student learning outcomes. Meanwhile, this study discusses the project-based learning model and creativity towards critical thinking. The second relevant research shows the effect of the project-based learning model on creativity. Therefore, this research must complement previous research to examine project-based learning, student creativity, and critical thinking in science learning. This study examines the effect of project-based learning models and creativity on students' critical thinking, especially in learning ecosystem material in class V, SDN Kaloy Tamiang Hulu Aceh Tamiang. Thus, this study highlights the importance of improving learning methods to improve science learning outcomes and proposes project-based learning as an alternative that can potentially increase learner engagement and learning outcomes.

LITERATURE REVIEW

The Essence of Ilmu Pengetahuan Alam (IPA) in Elementary School

Ilmu Pengetahuan Alam (IPA) or science is a science about nature that studies events that occur in nature. Science discusses natural phenomena that humans organize (Fahrezi, 2020). Also, science is only a collection of knowledge about living things, but it requires work, thinking, solving problems regarding products and processes, and attitude development. That is, learning science has a process dimension, a

product dimension, and a dimension of developing scientific attitudes, all three of which are generally interrelated, covering the basic fields, namely biology, physics, and chemistry. The scientific process involves several skills to study natural phenomena in specific ways to obtain and further develop that knowledge (Aris, 2022).

Science is a way of working to solve a problem, commonly called the scientific method. The scientific method in elementary school is developed gradually and continuously (Somayana, 2020). One of the efforts to improve the quality of science education is through the learning process in the classroom, both at the primary and secondary education levels. Learners need various skills to carry out this scientific process. The skills needed are observation, classification, interpretation, prediction, hypothesis, controlling variables, planning and conducting research, inference, application, and communication (Inayah et al., 2020; Rusmini et al., 2021).

Project-Based Learning Model

The project-based learning model has been widely developed in developed countries like the United States. Translated into Indonesian, project-based learning means project-based learning (Santika, 2022). Project-based learning is a learning approach that pays attention to understanding. Learners explore, assess, interpret, and synthesize information meaningfully. This learning is derived from constructivist learning theory, where learners actively build their knowledge and mental models to think and understand the world around them. Project-based learning is a process-centered, relatively timed, problem-focused, meaningful learning unit that integrates concepts from several components, be it knowledge, disciplines, or experiences from the field (Chen & Yang, 2019; Yuliansyah & Ayu, 2021). Project-based learning is a comprehensive teaching approach that engages learners in cooperative and sustained inquiry activities (Arwan, 2023).

Project-based learning allows learners to choose, design, and lead their thoughts and work. The goal is to train students to think scientifically, logically, and systematically (Guo, 2020). This project-based learning model replaces the use of a still teacher-centered learning model, which tends to make learning more passive compared to the teacher (Permatasari, 2021). Project-based learning is a learning model that focuses on the main (central) concepts and principles of a discipline, involves learners in problem-solving activities and other meaningful tasks, provides opportunities for learners to work autonomously, construct their learning, and culminates in producing valuable and realistic student work products (Davidi, 2021). The project-based learning model allows teachers to manage classroom learning by involving students in project work. Project work contains complex tasks based on questions and problems that are very challenging and lead students to design, solve problems, make decisions, carry out investigative activities, and provide opportunities for students to work independently and in groups (Amelia, 2021).

Critical Thinking

Critical thinking is deciding what to believe or do reasonably and reflectively (Cahya, 2021). It is a high-thinking activity that includes analyzing, applying rationale, synthesizing, recognizing problems and their solutions, concluding, and evaluating (Alsaleh, 2020). The focus of critical thinking is to determine what to believe and do reasonably and reflectively. Thus, critical thinking is needed to make decisions reflectively and rationally (Susilawati, 2020).

Critical thinking is responding to an accepted thought involving the ability to think systematically. Critical thinking is the ability to analyze facts, create and organize ideas, defend opinions, make comparisons, draw conclusions, and solve problems. Critical thinking is an intellectual process of conceptualizing, applying, analyzing, and evaluating various information obtained from observation, experience, and reflection, where the results of this process are used as a basis for action. From the definitions of several

experts, it refers to thinking critically in making decisions, considering various facts, and evaluating various evaluations received (Misidawati, 2021). Critical thinking creates information through assessment by analyzing (interpretation), then evaluating and providing further arguments. It can be characterized by an attitude that becomes fair, open-minded, and active (Warsah, 2021).

Creativity

The characteristics of children who have creativity are a big curiosity drive; often asking good questions, providing many ideas or suggestions for a problem; free in expressing their own opinions and can express them; not easily influenced by others; strong imagination; high originality; can work alone and like to try new things (Munar, 2021). Creating a new way of dealing with a challenge or problem requires creativity, a product of creative thinking. Creative thinking is termed as a mental activity that a person uses to build new ideas. Creative thinking involves logic and intuition together (Putri, 2023). So it can be concluded that creativity is the basic word for creative, which involves generating new ideas or ideas that will later lead to innovations, and is part of a person's uniqueness in obtaining knowledge or information. Creativity can be explained by product, person, process, and press (Wardana, 2023).

METHODS

This research uses a quasi-experiment to determine whether there is an effect of something added to the subject, namely, students. The quasi-experimental method was chosen because the population in this study is certainly heterogeneous and does not form new groups (Gopalan, 2020). In this quasi-experiment, the samples taken were divided into two classes: the experimental and control classes. The total population is 48 students, consisting of class V-A students, as many as 24 students, and class V-B, as many as 24 students. This research was designed as a quasi-experimental research design using a 2 x 2 factorial design with data analysis techniques using two-way analysis of variance (ANOVA). This study uses independent variables, namely experimental variables consisting of learning with project-based learning models and learning with direct interaction models, and dependent variables, namely students' critical thinking skills. Moderator variable of creativity of IPA students.

RESULTS AND DISCUSSION

The pretest was given before the learning steps in the experimental class, which were project-based learning, and in the control class, which used the direct interaction model. The pretest results are described in Table 1 below, which were calculated manually on the tabulation.

Table 1. Description of Students' Pretest Scores

Class	Ideal Score	N	x_{min}	x_{max}	\bar{x}	s
Experiment Class (PJBL)	100	24	53	69	61	4,92
Control Class (DI)	100	24	50	71	58,66	5

Source: Research 2024

Table 1 above shows that the average pretest value in the experiment using the PJBL model is 61. By applying the direct interaction model, the average pretest value of students in the control class is 58.66, so it can be concluded that the average value in the experimental class is superior to that of students in

the control class, with a slight difference. The pretest students can be classified into low, medium, and high-ability students; the results of the ability of these students are grouped as in **Table 2** below.

Table 2. Average Pretest Score

Category	Statistics	Class	
		Experiment	Control
High	N	15	9
	\bar{x}	64,2	63,9
	S	2,73	3,22
Low	N	9	15
	\bar{x}	55,7	55,5
	S	2,35	2,67

Source: Research 2024

Table 2 above shows that in the pretest scores in the experimental class, there were 15 students in the high category and 9 students in the low category, while the control class had nine students with high abilities and 15 students with low abilities.

Description of Post-test Results of Science Critical Thinking Ability of Students

The post-test of students' critical thinking skills was given to experimental and control class students to measure students' critical thinking skills after treatment. Based on the post-test data, the lowest value (X_{min}), the highest value (X_{max}), and the determination of the average value (\bar{x}) and standard deviation (s) in the experimental class were obtained. The data is in **Table 3** below.

Table 3. Description of Critical Thinking Ability Post-Test Score Results

Class	Ideal Score	N	x_{min}	x_{max}	\bar{x}	s
Experiment Clas (PJBL)	100	24	76	100	92,88	5,85
Control Class (DI)	100	24	64	100	88,63	8,37

Source: Research 2024

Table 3 above shows that the minimum value in the experimental class is 76, while the minimum value in the control class is 64. The maximum value for both classes is 100. The mean of the experimental class's critical thinking skills post-test results was 92.88, and the control class was 88.63. The standard deviation value in the experimental class was 5.85, and the control class was 8.37. The average post-test of students' science critical thinking skills based on high and low levels of critical thinking is presented in **Table 4** below.

Table 4: Average Post-test Critical Thinking of Learners

Category	Statistics	Class	
		Experiment	Control
High	N	14	9
	\bar{x}	96,7	96,1
	S	3,05	4,26
Low	N	10	15
	\bar{x}	87,7	84
	S	4,81	6,54

Source: Research 2024

From **Table 4** above, the average critical thinking ability of the experimental class is obtained in the high category. The experimental class average is 96.7 with a standard deviation of 3.05, and in the control class, the average value is 96.1 and 4.26. As for the average value and standard deviation of the low category, 87.7 and 4.81 were obtained, and the control class average was 84 and 6.54.

Description of Student Creativity Results

The processing and analysis of the students' creativity questionnaire aims to determine the students' creativity level after being given treatment. Then it is analyzed to determine students' creativity with very creative criteria, good creativity, sufficient creativity, and lack of creativity in science learning, with project-based learning in the experimental class and students applying direct interaction learning in the control class. This is summarized and can be understood in **Table 5** below.

Table 5. Description of Student Creativity Results

Class	Ideal Score	N	x_{min}	x_{max}	\bar{x}	S
Experiment Class (PJBL)	100	24	70	100	89,17	8,57
Control Class (DI)	100	24	70	100	87,54	6,41

Source: Research 2024

It can be seen in the data in **Table 5** above that the average questionnaire of student creativity in the experimental class and the control class is different. From the results of the data description, it can be seen that the average questionnaire of creativity of experimental class students is 89.17, with a very creative category, and the control class is 87.54, with a very creative category. This means that the average creativity skills of experimental class students are higher than those of control class students. The average creativity of students based on initial ability can be understood in **Table 6** below.

Table 6. Average Student Creativity

Category	Statistics	Class	
		Experiment	Control
High	N	10	11
	\bar{x}	98,99	91,8
	S	0,99	4,00
	N	14	13

Category	Statistics	Class	
		Experiment	Control
Low	\bar{x}	83,9	82,5
	S	3,82	5,08

Source: Research 2024

From **Table 6** above, it can be understood that the mean and standard deviation of the creativity of experimental class students in the high initial ability group are 98.99 with very creative criteria using project-based learning and 0.99 in the experimental class, and 91.8 with very creative criteria and 4.00 in the control class using direct interaction. Meanwhile, the low-group experimental class students' mean and standard deviation were 83.9 and 3.82, and 82.5 and 5.08.

Hypothesis Testing

Hypothesis testing with the two-way ANOVA test is carried out after fulfilling the requirements for normally distributed data and homogeneous data group variances (Miari, 2022). This research test uses a two-way ANOVA with a 2x2 factorial design with SPSS version 26. The hypothesis testing data can be seen in **Table 7** below.

Table 7. Two-Way Variance Analysis

Tests of Between-Subjects Effects					
Dependent Variable: Berpikir Kritis					
Source	Type Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1096.435 ^a	3	365.478	10.604	.000
Intercept	392859.535	1	392859.535	11398.005	.000
Learning Model	239.173	1	239.173	6.939	.012
Creativity	869.655	1	869.655	25.231	.000
Model Pembelajaran * Creativity	29.855	1	29.855	8.807	.014
Error	1516.565	44	34.467		
Total	397920.000	48			
Corrected Total	2613.000	47			

a. R Squared = .420 (Adjusted R Squared = .380)

Source: Research 2024

Hypothesis Testing 1

$$H_0: \mu A1 \leq \mu A2$$

$$H_a: \mu A1 > \mu A2$$

Description :

$\mu A1$: The average science critical thinking of students who get learning with the PJBL model

$\mu A2$: Average critical thinking of science students who get learning with direct interaction models

SPSS output of ANOVA calculation results in table 13 obtained a value of $F_{count} = 6.93$, the probability value or significance value in the learning model is $0.012 < 0.05$, so there is a significant difference between the average learning outcomes of the project-based learning model of 93.82 compared to the direct interaction model of 89.01. This shows that the average learning outcomes of the project-based learning model are higher than the direct interaction model, so the hypothesis testing rejects H_0 and accepts H_a .

Thus, the critical thinking of the project-based learning model is higher than that of the direct interaction model.

Hypothesis Two

$$H_0: \mu_{B1} \leq \mu_{B2}$$

$$H_a: \mu_{B1} > \mu_{B2}$$

Description :

μ_{B1} : Average critical thinking with high creativity

μ_{B2} : Average critical thinking with low creativity

The SPSS output of the ANOVA calculation results in Table 13 above, obtained the value of Fhitung = 25.23, the significance value of the learning model is $0.00 < 0.05$. There is a significant difference, so the hypothesis testing rejects H_0 and accepts H_a . Thus, critical thinking has higher creativity than those with low creativity.

Hypothesis Three

$$H_0: \mu_{AB} = 0$$

$$H_a: \mu_{AB} \neq 0$$

Description :

μ_{AB} : The average critical thinking of students who are given a learning model and have creativity

SPSS output of ANOVA calculation results in table 13 obtained a value of Fcount 8.81, significant value of 0.014 with $\alpha = 0.05$, then the sig value of 0.014 < 0.05 . This shows that the hypothesis is rejected, H_0 , and accepts H_a . Thus, there is an interaction between learning models and creativity in influencing students' critical thinking.

Discussion

Based on the research, it was found that there was an effect of the project-based learning model on critical thinking. Project-based learning can improve students' critical thinking skills by providing problems that students will later study for solutions to these problems (Eliyasni et al., 2019). In addition, project-based learning also allows students to share information and knowledge they have in a discussion with other students (Almulla, 2020). In science learning, students are usually asked to make Biology projects by utilizing sources around them, so in working on them, students are required to think critically, creatively, and collaborate with their group friends (Owens et al., 2020). For teachers themselves, project-based learning also requires teachers always to think creatively and is considered more effective than conventional teaching (Yustina et al., 2020). In addition, project-based learning is a learning model that provides opportunities for teachers to manage classroom learning by involving various kinds of projects in the learning process. However, the teacher must consider many rights in more detail in their implementation. Some of these include discussion starter questions for learners, learning objectives for learners, the integrity of the project, and ensuring that the content of the learning project is central to the learning is a challenge for teachers (Markula & Aksela, 2022). The creativity and motivation of learners to increase learning is supported by constructivist theory, which rests on the idea that learners construct their knowledge in the context of their own experiences. When project-based learning is carried out in a collaborative learning model in small groups, there are opportunities to convey ideas, listen to other

people's ideas, reflect on their ideas to others, and reflect on their ideas to people, which is a form of individual learning (Febrita, 2020).

The results also show an interaction between the project-based learning model and students' creativity in critical thinking in science. Based on research in line with the research carried out, it proves that there is an interaction between students' critical thinking ability and creativity by applying project-based learning. In project-based learning, students solve problems by combining various information or content from daily experiences. Students' creativity is higher, and the level of thinking in finding information or sources increases, resulting in an increase in the students' skills, based on questionnaire data on student creativity (Noviyanto, 2020). In addition, students' creativity also increases in line with the assumption that project-based learning is one of the learning models used in the learning process (Chen et al., 2022). Thus, the ability of learners to carry out teamwork in groups, to think, provide suggestions, give opinions, and respond with the group, shows the creativity of learners in the team or group. Thus, project-based learning interaction occurs in fifth-grade science students' critical thinking ability and creativity on the Ecosystem material.

CONCLUSION

The project-based learning model affects students' critical thinking by obtaining an average score of 93.52, and students who are taught using the direct interaction learning model obtain an average score of 89.01. The results of the variance analysis of both learning models show that the learning outcomes of students using the project-based learning model are higher than those of students taught using the direct interaction learning model. Based on the results of data calculations, it can be seen that the learning outcomes of students who learn using the project-based learning model and have high creativity obtain an average value of 95.55, and students who have low creativity obtain an average of 86.97. The results of the variance analysis of the two learning models show that the group of students with creativity obtains a higher critical thinking score than those with low creativity. There is an interaction between project-based learning models on students' creativity and critical thinking skills, as evidenced by the interaction graph of learning models and students' creativity on critical thinking skills between project-based learning models and students' creativity and science critical thinking skills of fifth-grade students of SD Negeri Kaloy Tamiang Hulu. Suggestions for further researchers, when implementing learning in group division, can make students in the group actively participate in group activities, which can positively impact the research results.

AUTHOR'S NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirm that the research data is free from plagiarism.

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