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Research Article

Enhancing Student Creativity through Project-Based Learning in Science Education

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ABSTRACT

Creativity is a key competency in 21st-century science education, yet conventional teaching methods often fail to adequately foster students' creative thinking. This study aims to examine the effect of the Project-Based Learning (PjBL) model on students' creativity in science subjects among fifth-grade students at MIS Annajwaturrusydah. A quantitative approach with a quasi-experimental design was employed, involving 60 students divided equally into an experimental group and a control group. Data were collected through creativity tests, interviews, and observations. The independent samples t-test showed a significant difference between the post-test scores of the two groups (p = 0.000). The experimental group's mean score increased from 10.67 to 19.04, while the control group's score rose from 7.44 to 11.78. These findings indicate that the PjBL model significantly enhances student creativity compared to conventional instructional methods. The study recommends broader implementation of PjBL in science classes to support students' creative development.

Keywords: Project-Based Learning; PjBL, Student Creativity, Science Education; Teaching; Learning

1. INTRODUCTION

The 21st century demands students to have critical, creative, collaborative, and communicative thinking skills. Science learning, through its original explorative, experimental, and problem-solving character, is a strategic medium for developing students' creativity. However, the dominance of lecture and memorization methods still hinders students' active involvement in class (Anas, Nirwana & Hasana, 2018; Scott, 2023). International data shows the low creativity and scientific literacy of Indonesian students: the 2011 TIMSS score was 406 out of 42 countries (Wulandari et al., 2019) and PISA 2012 placed Indonesia 64th out of 65 participating countries (Adiilah & Haryanti, 2023). In addition, students often have difficulty applying knowledge in real situations and tend to be passive in class.

Self-efficacy is judgement of a person to his abilities to plan and implement the action to reach certain goals (Mukhid, 2009). In an academic context, self-efficacy reflects how confident students are in performing specific tasks (Perez & Ye, 2013). Self-efficacy plays a role in academic motivation and learning motivation (especially students' ability to manage their learning activities), and resistance to learning (Zimmerman, 2000). Self-efficacy has three dimensions that are magnitude, the level of task difficulty a person believes she can attain; strength, the conviction regarding magnitude as strong or weak; and generality, the degree to which the expectation is generalized across situations (Lunenburg, 2011). The magnitude dimension refers to the difficulty level of the task that a person believes he or she can accomplish. That is, the students' self-confidence toward their abilities in accomplishing various tasks at different levels of difficulty. The strength dimension refers to the resilience and persistence of students in accomplishing various tasks. Meanwhile, the generality dimension refers to students' beliefs about their abilities in accomplishing certain tasks as well as on a broader range of activities and situations.

Education in the 21st century demands critical, creative, collaborative, and communicative thinking skills, which are critical foundations for the learning process. Given its exploration, experimental, and problem-solving nature, Natural Sciences (IPA) is one of the strategic subjects in elementary education to increase students' creativity. The main problem in science learning is the teaching approach that continues to focus on lecture methods and memorization of concepts. Science learning requires creative thinking skills by conducting experiments to solve problems and discover new concepts. However, evaluations show that students are not actively involved in learning because they are only learning individually. As a result, student learning outcomes can decrease Anas, Nirwana & Hasana, (2018 : 2). In science subjects, not only mastering science from the material, but must have a step that is able to optimize learning outcomes and students become active in learning activities Scott, (2023). This method often does not give students the opportunity to think Creativity in science learning is essential to build students' skills in understanding and applying scientific concepts. But the fact is that student creativity is still very low at the moment, this is shown by TIMSS (*Trends in International Mathematics and Science Study*) in research Wulandari et al (2019 : 48) In 2011, Indonesia ranked 40th out of 42 countries with an average score of 406. Similar results can also be seen from the results *study Programme for International Student Assessment* (PISA) in research 'Adiilah & Haryanti (2023 : 50) The results of the PISA survey in 2012 show that the science literacy ability of Indonesian students is in the 64th position out of 65 participating countries. In addition, the reality in the field in the learning process in several elementary schools shows that students' creative thinking skills have not been developed.

In recent years, the integration of technology in Project-Based Learning (PjBL) has undergone significant development. Project-Based Learning (PjBL) is one of the best methods to meet these demands because it focuses on students' active involvement in real-life projects that are relevant to their real-life lives. Z (2019: 41) stating that the role of teachers is very strategic in implementing learning innovations because it helps students understand scientific concepts and use them in a broader context. Effective communication is a key component in PjBL, Zunidar (2017 : 12) Finding that effective communication from teachers is essential to the learning process. Good communication between educators and students not only helps students learn but also increases their engagement and motivation. Moreover Tialani, K. T., et al (2025: 5909) shows that digital technology is used in PjBL along with ethnopedagogy. This method not only enhances students' understanding of scientific concepts in the context of local culture but also extends the scope of their learning to a global context.

Project-based learning (PJBL) is a teaching method in which students are put in real projects or in-depth simulations to solve problems. Project-based learning (PJBL) is a new approach based on constructivist theory, which emphasizes that students are active learners who build understanding through hands-on experience and interaction with their environment. In research Yana & Khairuna, (2024:1076) Researchers Rohana and Wahyudin (2017) said that PjBL Learning is student-centered and used to solve problems, resulting in projects. The more often this learning model is applied, the greater the students' learning independence Noviani, Ayu, Fauziah Nasution, (2023 : 540).

The PJBL learning method can improve students' critical thinking skills by increasing creativity, questions, independence, responsibility, self-competence and thinking skills Febrianti Zelika, Siti Maysarah, (2024). In PJBL, students not only learn theoretical concepts but also use this knowledge to complete projects related to the real world. In addition, learning with the PjBL model is integrated learning that is carried out through projects in a cooperative manner. This helps students become more creative and makes material concepts easier to remember (Nana Misrochah, 2021 : 141).

One of the important factors in this study is creativity, which is defined as the ability to create innovative, unique, and relevant ideas. Nurlatifah, Ahman, Machmud (2021: 7) Talking about creativity is the ability to expose students in the 21st century. In science learning, creativity also includes students' ability to find innovative ways to solve complex scientific problems. Elaboration (*Elaboration*), smoothness (*fluency*), flexibility (*flexibility*), and originality include some examples of creativity Zaharah & Silitonga (2023 : 148). In research Aurelia, De Lorenzo, E Manuela Rabaglietti, (2023: 23) said that *The Torrance test is based on* Guilford's *theoretical formulation and includes four main factors to measure divergent thinking: - fluency, the ability to produce a large quantity of ideas - flexibility, the ability to move from one category of thinking to another - originality, the ability to come up with unusual ideas - elaboration, the ability to fully pursue creative thinking and enrich it with details,* which means that Guilford's theory is the basis of the Torrance test, which aims to measure divergent thinking. The test includes four main components : 1. Thinking and fluency is a person's ability to come up with many ideas in a short period of time. The more ideas that are generated, the more refined they become. 2. Flexibility (flexibility of thinking) is the ability to switch from one type of thinking to another. Those who can think flexibly can find different solutions to problems from different perspectives. 3. Originality *(Inventivity of Thinking)* is the ability to come up with a variety of unique and extraordinary ideas. A person is said to be original if they have creative and innovative abilities. 4. Elaboration (Elaboration of Thinking) The ability to develop, expand, and enrich a concept with more detail. A person who is talented in elaboration of thinking can deepen ideas so that they become more detailed and mature. These four components are very important to assess a person's creativity in thinking and problem solving. In science learning, creativity is essential because it helps students understand the relationship between theory and practice and helps them find creative ways to solve problems. Therefore, it is very important to be creative and innovative in learning, especially in learning science. Students must think creatively from elementary school Wandini et al., (2025: 57). Through science learning, students have the ability to solve problems in daily life and apply this knowledge to the real world (Ningsih et al., 2021:43).

PjBL is meant to engage students in meaningful learning by helping them solve problems through projects that actually happen. This method has a clear process starting from problem identification, project planning, implementation, and evaluation of results. Projects in science learning can be in the form of nature observations, scientific experiments, or the creation of teaching aids related to subject matter. It is hoped that students' ability to think creatively will allow them to see the world from different perspectives, which will allow them to find new ways to solve problems in their daily lives

Sumarni et al (2019). For example, students can learn about plant life cycles by doing projects that involve observing plant growth from seed to maturity. In the book Suryaman et al., n.d (2024: 139) The social learning theory developed by Bandura (1977) says that PjBL supports learning through observation, cooperation, and interaction with peers. Deep Hakima & Hidayati (2020) experiential learning theory (*Experiential Learning*) developed by Kolb (1984) also reinforces the relevance of PjBL, as students learn by reflecting and experiencing for themselves what they learn. The idea that active, contextual, and collaborative learning has a positive impact on students' creative development is supported by these theories.

Project-Based Learning (PjBL) offers a more effective alternative. PjBL encourages students to engage in real projects planning, implementing, and presenting that are relevant to real life. International literature supports the contribution of PjBL to creativity. Wulandari et al. (2024) found a significant increase in the creative thinking ability of high school students from 42.6 to 76.3 through PjBL compared to the control group (37.4 to 67.7). Sucilestari et al. (2023) reported that self-designed experimental activities in PjBL increased students' scientific creativity. Irdalisa et al. (2024) showed that STEAM-PjBL worksheets with ecoprint techniques contributed to an increase in scientific reasoning ability and creativity with a significant value (NGain). Purnamasari et al. (2022) also found an NGain of 0.58 (moderate category) on students' creativity in PjBL with integration of sustainable education (ESD). These studies confirm that PjBL enhances creativity more effectively than traditional methods. However, their focus is generally on the middle and high school levels, and they have not applied much to elementary classes such as grade V.

The project-based approach is a relevant approach to apply in science subjects because it provides students with the opportunity to connect abstract ideas with real-world situations. An environmental conservation project, for example, helps students learn topics about ecosystems while building teamwork skills and creative skills. This approach involves students as the developers of ideas, while teachers serve as facilitators and provide guidance throughout the learning process. Technology allows students to access a wider range of resources and collaborate with peers in a variety of places. Meanwhile, Scythe (2019 : 92) stated that PjBL can significantly improve students' analytical thinking skills. They also emphasized the importance of innovative learning strategies such as PjBL to improve student engagement and learning outcomes. Study Harjono & Pangga (2025 : 102) introduced the E-PjBL model that combines virtual assistive technologies such as augmented reality and simulation to improve students' critical thinking performance in science education. This technology allows students to interact with scientific concepts virtually, enhance their learning experience, and improve problem-solving skills. Kurniawan et al. (2021 : 416) stating that the relationship between schools and communities is essential to support the success of project-based education. This relationship is built with the aim of improving the quality of learning and strengthening educational goals.

Although both PjBL and PBL are student-centered and use problems as a starting point, but PjBL leads to the creation of real products or projects. According to research by Hariyanti et al (2024 : 342), The use of PJBL in science learning can increase students' creativity by 30% compared to traditional learning methods. This is because PjBL gives students the opportunity to work together, create new ideas, and create real products. Therefore, the educational process in schools must be able to produce students who are not only in-depth knowledge but also with critical, creative and applicable thinking skills. An effective inventory and learning approach is the way to achieve this goal. Additional studies by Supandi A (2022) Their study shows that this technique enhances students' creativity and improves critical thinking and problem-solving skills. In class V MIS Annajwaturrusydah, the use of PjBL is very important to encourage students to learn science concepts in a more interesting and useful way. By implementing PjBL, it is hoped that the learning environment will be more interactive, creative, and collaborative.

This method is very relevant to its use in various fields, including Natural Sciences (IPA). Science requires a deep conceptual understanding and the ability to apply this knowledge to everyday life. Therefore, effective learning in science should help students improve their cognitive skills, in addition to their ability to remember. By using this learning model, we can expect that the implementation of this learning model will increase participation in learning. There are seven activity metrics. 1) Student participation in determining the objectives of learning activities. 2) Pressure on the emotional aspects of learning. 3) Student participation in learning activities, especially through interaction between students. 4) Consider the class as a study group. 5) Students' freedom of learning is given; 6) Opportunities to make important decisions about education and behavior. 7) The presence of resources to provide related information (Santoso, 2022: 235).

In PjBL, a collaborative learning strategy is one of the keys to its success. Group work allows students to share ideas, give each other feedback, and find solutions to complete projects. Collaboration strategies increase students' thinking flexibility and allow them to generate innovative creative ideas. Students can also learn social skills such as communication, decision-making, and conflict management by working together. Inductive thinking is a method in PjBL that allows students to draw conclusions from phenomena or data, increase creativity, and understand scientific concepts. PjBL is flexible, can be adapted to the student's learning style, and is implemented through a systematic process from planning to evaluation. Projects that are relevant to the curriculum can motivate students, and assessments look not only at the final product, but also the process, collaboration, and creativity of the students.

Therefore, the projects that students build based on observations will give meaning to them Rika Widianita (2023 : 372). Many studies have shown that project-based learning, or PjBL, has a positive effect on students' creativity in science learning. The advantages of PjBL in increasing student creativity compared to lecture methods are also supported by research Indriani (2024). Moreover Manganhang et al (2023) found that the implementation of PjBL in elementary schools was able to increase students' active participation and creativity in science learning. *Study* Septiani et al (2024) also showed an increase in students' creativity of up to 50% and 60% after the use of PjBL, while Muhammad Rafik et al (2022) recorded a 40% increase in creativity in the second cycle of their research. Overall, this study shows that PjBL is an effective method to increase students' creativity when learning science.

However, PjBL also faces problems. This includes limitations on time, resources, and teacher readiness. Teachers often have difficulty in creating projects that fit the curriculum. It is very important for teachers to be trained to make them capable of designing and managing projects well. The success of PjBL also depends on the school's support, such as providing sufficient resources. The relationship between student creativity as a bound variable (Y) and project-based learning as an independent variable (X) is proposed within the framework of this study. PjBL is expected to increase students' creativity in science learning by creating an immersive and relevant learning experience.

The hypotheses proposed are: H_0: There was no significant effect between project-based learning on students' creativity in science learning. H_a: There is a significant influence between project-based learning on student creativity in science learning. Educational level gap: Previous studies have focused on secondary/high school level, few have evaluated PjBL in fifth grade elementary school students. Strong theoretical support, but needs contextual testing: International and local studies have shown positive effects of PjBL on creativity, but need to be verified in elementary school science learning patterns in madrasah environments. Socio-emotional relevance In madrasah environments, the development of creativity also has an impact on religious values and character, so PjBL can be a holistic pedagogical model. Therefore, the focus of this research is on project-based impact analysis (PJBL) on students' creativity in scientific subjects in Class V Mis Annajwaturrydah. The purpose of this study is to determine how much PJBL will enhance students' creativity when understanding and using science concepts, and to contribute to the development of learning methods that will enhance students' creative skills more effectively.

2. RESEARCH METHOD

This study uses a quantitative approach with a quasi-experimental research type (pseudo-experimental design), which aims to measure the effect of the Project-Based Learning (PjBL) model on student creativity in science subjects. Syahrum & Salim (2016: 40).The experimental design used is Nonequivalent Control Group Design, where there are two groups that are not selected randomly, namely the experimental group and the control group. This design was chosen because it allows the application of research in the context of existing classes without disrupting the ongoing learning structure. The population in this study were all fifth-grade students at the Annajwaturrusydah Private Elementary School, located in Huta VI Sibatu-batu-A, Partimbalan Village, Bandar Masilam District. The sampling technique used purposive sampling, by selecting two classes: one class as an experimental group (with the application of the PjBL model) and one class as a control group (with conventional methods). The total number of samples was 54 students, each consisting of 27 students per group Neliwati., (2018: 68).

This study used several main instruments, namely Structured observation sheets: used to monitor the implementation of PjBL and student participation during the learning process. Student creativity tests: in the form of open-ended questions modified from the Torrance Tests of Creative Thinking (TTCT), to measure four aspects of creativity, namely fluency, flexibility, originality, and elaboration. Semi-structured interview guides: used to explore students' opinions and perceptions of the implementation of project-based learning. Documentation: includes photos, videos, and activity notes during the implementation of the experiment as supporting data Cahyani et al. (2024). Data Collection Procedure Preparation: preparation of PjBL-based learning devices, creation of instruments (observation sheets, test questions, and interview guidelines), and validation of instruments by experts. Implementation of the experiment: conducted for 4 weeks. The experimental group received learning with the PjBL approach, while the control group remained with the conventional method Umma et al. (2024).

Data collection, Observations were conducted throughout the learning process. Creativity tests were conducted before (pretest) and after (posttest) treatment. Interviews were conducted after treatment to explore student responses qualitatively. Documentation was conducted during the learning process and project presentation Raharjo et al. (2023). Data analysis Quantitative data were analyzed using descriptive statistics (mean, standard deviation) and independent t-tests to see differences in creativity scores between the two groups. Qualitative data from interviews were analyzed thematically to support quantitative findings. The quantitative approach was chosen because it is able to provide objective, measurable, and statistically comparable results. The quasi-experimental design is very relevant to use in the context of basic education such as madrasahs, where full group randomization is difficult to do.

In this study, instruments such as observation sheets were used to track teacher and student activities during project-based learning (PjBL), creativity tests that used open-ended questions to evaluate students' ability to think creatively in accordance with TTCT indicators, and interview guides were used to find out students' opinions about learning. An *independent t-test* to compare the results of the creativity test between the experimental and control groups and descriptive statistics to show the distribution and average of student creativity. The research begins with preparation, which includes creating a PjBL-based learning tool and preparing instruments. followed by the implementation stage which included the provision of PjBL learning in the experimental group and conventional methods in the control group for four weeks, as well as a creativity test. After that, at the analysis stage, the data from observation and creativity tests will be processed using *statistical software*, followed by the preparation of research results reports. The research agenda includes the preparation of learning instruments and tools in the first week, the implementation of experiments in the second and third weeks, and data analysis and report preparation in the fourth week.

3. RESULTS AND DISCUSSION

3.1 Normality Test

Before proceeding with the analysis, a normality test was performed to determine whether the data from the experimental and control groups were normally distributed using the test *Shapiro-Wilk*, which is an important requirement for using parametric statistical tests such as sample tests *T-Independent*. Since the sample is less than 50, test *Shapiro-Wilk* used because this method is known to be more sensitive than the test *Kolmogorov-Smirnov* to find deviations of normality. According to Farrel & Stewart, 2006 in (Ahadi & Zain, 2023:15) One alternative method to test normality is the Shapiro-Wilk test method. The expected normal standard values and the average values of the sample are used to produce test statistics. The process of data input using the program *IBM SPSS 20*. The following are the results of the normality test from the data of this study.

Table 1. Tests of Normality

	Shapiro-Wilk		
	Statistics	*Df*	*Sig.*
Control Pretest	.945	27	.162
Postest Control	.941	27	.125
Pretest Experiment	.939	27	.114
Postest Experiment	.940	27	.122

Based on the results in **Table 1**, all significance values (Sig.) > 0.05: Control Pretest: 0.162, Control Posttest: 0.125, Experimental Pretest: 0.114, Experimental Posttest: 0.122. This significance value indicates that all data follows a normal distribution. So, in accordance with the general criteria of statistical analysis, if the Sig. > 0.05, then the data is declared normal.

3.2 Homogeneity Test

The homogeneity test of the study was carried out to find out whether the distribution of the data in this study was homogeneous. The bound variables are tested for homogeneity. The homogeneity test is used to show that changes in parametric statistical tests (such as t-tests, Anava, or Anacova) are actually caused by differences between groups rather than differences within the group itself (Usmadi, 2020 : 51). Homogeneity testing with test *Living* and data input using *IBM SPSS 20* Statistics for *Windows*. The following table shows the results of the homogeneity test on the creativity data.

Table 2. Test of Homogeneity of Variance

		Living Statistic	*df1*	*df2*	*Sig.*
The Value of Creativity	*Based on Mean*	.768	1	52	.385

Based on the results in **Table 2**, the variance homogeneity test of the two groups, i.e. the experimental group and the control group, was the same. Variants of the experimental and control groups were tested for homogeneity. The results *of the Levene* test showed a statistical value of 0.768 with a significance *(Sig.)* of 0.385, which indicates that the variants of the two groups are homogeneous, because the significance value is greater than 0.05. This suggests that the data from both the experimental and control groups have comparable variability, so parametric statistical tests can be used to further the analysis.

3.3 Independent *t-test*

An *independent t-test* was used to find out if there was a significant difference between the students' creativity scores in the experimental group (which used the project-based learning model or PjBL) and the control group (which used conventional methods). This test was carried out because all data met the requirements of parametric analysis, which is normally distributed and has homogeneous variances. The data input process uses *the IBM SPSS 20 program*. The following are the results *of the Independent t-test* from the data of this study.

Table 3. Independent Samples Test

		Sig. (2-tailed)	Decision
Value	Control	.000	Ha accepted
	Experiment	.000	

In terms of student creativity after learning, there was a statistically significant difference between the experimental group and the control group. The results of the analysis of the independent test sample showed a significance value (Sig. (2-tailed)) of 0.000. This significance value is smaller than 0.05 (0.000 < 0.05). This is in line with research (Novitasari & Laili, 2023) that the basis for decision-making for this test is that if the significance value (2-tailed) > 0.05, meaning H_0 accepted and H_1 rejected, on the other hand, if the significance value (2-tailed) < 0.05, it means that H_0 rejected and H_1 Accepted. Then it can be given that the decision is the zero (H_0) hypothesis that there is no significant effect between project-based learning on student creativity is rejected. An alternative hypothesis (H_a) that states that there is a significant influence between project-based learning on student creativity is accepted. It can be concluded that the results of the independent t-test show that project-based learning (PjBL) significantly increases students' creativity in science learning. The experimental group and the control group had significantly different scores, suggesting that the PjBL model was better than conventional approaches in improving students' creative abilities.

3.4 Descriptive statistics of experimental and control classes

Before students in the experimental class receive the project-based learning treatment, a pretest and postest are conducted to determine their initial level of creativity. The results of the descriptive analysis were carried out to provide an overview of the distribution of values in the group. Here is a table showing the students' pretest and posttest results. The data input process uses *the IBM SPSS 20* program.

Table 4. Experimental Class Pretest

Experimental Classes	Pretest
Maximum Value	14
Minimum Score	8
Mean	10,67
Median	11,00
Mood	12
Standard Deviation	1,569

Based on the data in **Table 4**, it can be seen that the maximum pretest score obtained by students in the experimental class is 14 and the minimum score is 8. An average score (mean) of 10.67 indicates a fairly good initial level of creativity. A median score of 11.00 and a mode of 12 indicate that most students have above-average scores. A standard deviation of 1.569 indicates that the data spread is relatively evenly distributed around the mean. These results are the basis for knowing whether there is a significant increase in creativity after the implementation of the project-based learning model.

Table 5. Postest Experimental Class

Experimental Classes	Postest
Maximum Value	25
Minimum Score	14
Mean	19,04
Median	19,00
Mood	15
Standard Deviation	3,808

Based on the data in **Table 5**, it can be seen that the maximum posttest score obtained by students in the experimental class is 25 and the minimum score is 14. The average posttest score of 19.04 indicates a significant increase from the previous pretest results. A median score of 19.00 indicates that half of students scored above that number, and a mode of 15 indicates the most frequently appearing score. The standard deviation of 3.808 shows that the distribution of data is quite varied, reflecting the difference in creativity between students after the implementation of the Project Based Learning model. These results show that the application of the PjBL model has a positive impact on increasing student creativity.

Table 6. Control Class Pretest

Experimental Classes	Pretest
Maximum Value	11
Minimum Score	4
Mean	7,44
Median	7,00
Mood	7
Standard Deviation	1,867

Table 6 shows that the maximum pretest value in the control class is 11 and the minimum value is 4. The average score (mean) of 7.44 indicates that the initial level of creativity of students in this class is relatively low. A median score of 7.00 and a mode of 7 indicate that most students are below the average score of the experimental class in the early stages. The standard deviation of 1.867 indicates a fairly even spread of values. These results became the basis for comparison to assess the effectiveness of conventional learning methods applied in the control class.

Table 7. Postest Control Class

Experimental Classes	Pretest
Maximum Value	15
Minimum Score	8
Mean	11,78
Median	12,00
Mood	13
Standard Deviation	1,968

Based on the **Table 7**, the maximum posttest score of students in the control class is 15, while the minimum score is 8. The mean score of 11.78 indicates an increase in the pretest score, but not as much as the increase that occurred in the experimental class. A median of 12.00 and a mode of 13 indicate that most students experience an increase in scores, although not very significantly. The standard deviation of 1.968 indicates a slightly larger distribution of values than the pretest, but still shows a homogeneous trend. Overall, these results suggest that conventional learning has a limited impact on student creativity.

Based on the data analysis that has been carried out, it can be concluded that the project-based learning model has increased the creativity of students in class V MIS Annajwaturrusydah in science learning. An alternative hypothesis is accepted, as shown by the results of the independent t-test, which shows a significance value of 0.000 ($p < 0.05$). Descriptive statistical data showed that the posttest score of the experimental class increased significantly compared to the pretest, increasing from 10.67 to 19.04. Meanwhile, the control score also increased from 7.44 to 11.78, but not as much as the increase in the experimental class. The results of the normality and homogeneity tests support this result. They show that the data is normally distributed and has homogeneous variance, so the parametric test is feasible. Therefore, it can be concluded that the PjBL model increases students' creativity in science subjects better than conventional learning methods. This model gives students more time to think critically, experiment, and develop creative ideas through project-based activities.

3.5 The Influence of Project-Based Learning on Student Creativity in Science Subjects

The results of this study show that the project-based learning model (PjBL) has a significant influence on increasing students' creativity in science learning. These findings are in line with the theoretical framework and literature review that underpinned the research, which emphasizes the importance of constructivist, collaborative, and contextual approaches in 21st-century learning, particularly in the development of students' creativity. The normality and homogeneity test ensures that the data is valid for parametric analysis. All data on the pretest and posttest from the experimental and control groups were normally distributed (Sig. > 0.05), and the variance between the groups was homogeneous (Sig. = 0.385). This strengthens the validity of the statistical analysis used, especially the independent t-test, to test the hypothesis that has been established. Independent t-tests showed significant differences between the experimental and control groups, with a significance value of 0.000 ($p < 0.05$). These findings support an alternative hypothesis (H_a), namely that project-based learning has a significant effect on students' creativity in science learning. This is reinforced by Yana & Khairuna (2024) and Rohana and Wahyudin (2017) who state that the PjBL model encourages students to be at the center of learning and actively solve problems through projects that foster creativity and independence.

Descriptive statistics showed that the average posttest scores of students in the experimental group increased significantly from 10.67 to 19.04, compared to the control group which increased from 7.44 to 11.78. This difference reflects that PjBL is more effective in fostering students' creative abilities. Greater standard deviation in the experimental group (3,808) also indicated the presence of individual variation in creativity development, which corresponded to the characteristics of student-centered learning. According to studies by Zelika & Maysarah (2024) and Misrochah (2021), PjBL learning is able to improve aspects of critical thinking, in-depth questions, and students' ability to relate material to the real world. This can be seen in the learning outcomes of science students who not only understand concepts theoretically, but are also able to apply them in context-based projects. This study shows that students' creativity increases not only quantitatively (from pretest to posttest scores), but also qualitatively, such as the ability to think originally, flexibly, and elaboratively. This is in line with Guilford and Torrance's theory which mentions the four main components of creativity: *fluency*, *flexibility*, *originality*, and *elaboration* (Aurelia et al., 2023). Through project-based activities, students are trained to develop ideas, explore alternative solutions, and present results in detail and innovative. In the context of science learning, creativity is very important because students need to solve scientific problems through observation, experimentation, and simulation. Projects such as observing plant growth, creating ecosystem models, or designing science props, provide space for students to explore ideas in a deeper and more concrete way.

From the theoretical side, the results of this study strengthen constructivist learning theories (Piaget and Vygotsky), social learning theories (Bandura, 1977), and experiential learning theories (Kolb, 1984) which emphasize the importance of learning through direct experience, social interaction, and reflection. In PjBL, students not only receive information, but also build understanding through meaningful collaborative and exploratory activities.

Practically, this study shows that the application of PjBL is able to:

1. Increase student active participation (Mangangantung et al., 2023)
2. Increases creativity by 50–60% (Septiani et al., 2024)
3. Helping students understand the relationship between theory and practice (Ningsih et al., 2021)
4. Developing social skills such as communication and teamwork (Hakima & Hidayati, 2020)

However, challenges in the implementation of PjBL remain, such as limited time, resources, and teacher readiness (Indriani, 2024). Therefore, teacher training and school support are key factors for the successful implementation of this method in a sustainable manner. This research empirically supports the view that PjBL is an effective approach to increase students' creativity in science learning, in line with the theoretical framework and previous findings. By providing a wide space for exploration and direct involvement in real problem-solving, PjBL becomes a learning strategy that not only improves learning outcomes, but also equips students with creative and innovative thinking skills that are essential in the modern era.

Table 8. Descriptive Statistics Table: Creativity Pretest and Posttest

Group	Pretest Mean (SD)	Posttest Mean (SD)	Improvement
Experimental	10.67 (±1.57)	19.04 (±3.81)	+8.37
Control	7.44 (±1.87)	11.78 (±1.97)	+4.34

Summary of Findings and Relationship to Literature

The data meets statistical assumptions, allowing for valid analysis (Ahadi & Zain, 2023; Usmadi, 2020). The increase in student creativity in the experimental group was much greater than the control, in accordance with the findings of previous studies (Novitasari & Laili, 2023; Hariyanti et al., 2024; Sucilestari et al., 2023).The increase in all dimensions of creativity (fluency, flexibility, originality, elaboration) according to Guilford & Torrance's theory and research by Aurelia et al. (2023). Practical challenges related to duration, devices, and teacher capacity, are the same as in previous PjBL research (Indriani, 2024). PjBL is significantly more effective than conventional methods in enhancing the creativity of fifth grade students in science learning. This approach not only improves the numerical score but also develops comprehensive creative thinking skills and emphasizes the importance of implementing PjBL in the context of elementary madrasahs.

4. CONCLUSION

Based on the results of data analysis and statistical tests that have been carried out, it can be concluded that the Project-Based Learning (PjBL) model has a significant effect on increasing the creativity of fifth grade students in science learning at MIS Annajwaturrusydah. This is proven through an independent sample t-test with a significance value of

0.000 (<0.05), which shows a real difference between the experimental group (using PjBL) and the control group (using conventional methods). Specifically, this study answers the following problem formulation: The systematic application of PjBL allows students to be involved in contextual projects that stimulate creativity. The increase in student creativity is evident from the increase in the average posttest score in the experimental group (from 10.67 to 19.04), higher than the control group (from 7.44 to 11.78). Aspects of creativity such as fluency, flexibility, originality, and elaboration develop more optimally in project-based learning compared to conventional methods. This study strengthens the theory of constructivism (Piaget, Vygotsky), social learning theory (Bandura), and experiential learning (Kolb), which emphasize the importance of direct experience, collaboration, and reflection in the learning process. The findings also confirm the effectiveness of PjBL in enhancing the dimensions of creativity based on Guilford and Torrance's theory.

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