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Is Project-Based Learning a Guaranteed Boost for Students' Creativity? A Meta-Analytic Review

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Abstract: This study aimed to conduct a meta-analysis to examine the impact of Project-Based Learning (PjBL) on the development of creative thinking skills among junior high school students in science learning. A meta-analysis method was employed by collecting and analyzing 10 relevant articles published between 2019 and 2024 from national journals indexed at least Sinta 4 and international journals or proceedings. The results indicated that PjBL significantly improved junior high school students' creative thinking skills in science learning. The effect size obtained showed a strong influence of PBL on students' creative thinking skills. Based on the grade level, the effect size for grade 7 was 0.94, for grade 8 was 4.76, and for grade 9 was 1.06, all of which were categorized as high. The success of project-based learning hinges on the appropriate selection of materials, consideration of individual student needs, and effective teacher guidance. Each student possesses unique learning styles and abilities, necessitating individualized project assignments. Time management skills are crucial for students to achieve their learning goals and produce high-quality work. The findings of this study have important implications for the development of science curricula and teaching practices at the junior high school level, and suggest the need for further research to investigate factors that can maximize the effectiveness of PjBL in developing students' creative thinking skills.

Keywords: Creative thinking skills; Meta-analysis; Project-based learning (PjBL).

Introduction

The ability to think creatively is very important for people in the 21st century to become successful and innovative individuals. Creative thinking is about coming up with new ideas, solving problems, and finding unique solutions (Biazus & Mahtari, 2022). Other experts say that creative thinking is using your mind to respond to things or problems in many different ways (Asriadi & Istiyono, 2020). There are four main ways to measure creative thinking: fluency (thinking of many ideas), flexibility (thinking of different kinds of ideas), originality (thinking of new and unusual ideas), and elaboration (developing ideas in detail) (Faresta et al., 2020). We want students to be able to think in these creative ways in all their classes, including science.

Science learning is a systematically structured learning process aimed at understanding facts, concepts, and phenomena that are closely related to nature. To understand a concept, effective learning is needed that can help students to think, especially to think creatively, so that students can solve problems in everyday life. The choice of using learning models is one effort that can be made to improve and train students' creative thinking skills.

One of the most effective learning models to develop creative thinking skills is Project-Based Learning (PjBL). In PjBL, students are actively engaged in the learning process by working on authentic projects that are relevant to real-life situations. Through these projects, students are trained to design, implement, and evaluate their work independently or in groups. This

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allows students to develop a variety of skills, including creative thinking. Other advantages of PjBL include providing opportunities for students to develop other important skills such as problem-solving, critical thinking, teamwork, and time management. In addition, PjBL can also increase student motivation, self-confidence, and adaptability to change (Baidowi, et al., 2015; Sheu & Chen, 2014).

Several previous studies have shown that Project-Based Learning (PjBL) has a positive impact on enhancing students' creativity. Lavli (2024) explains that through classroom projects, students can be trained to think creatively. Project activities that require students to find solutions to problems will stimulate the emergence of innovative ideas. In addition, Natty, et al. (2019) revealed that the Project-Based Learning (PjBL) model has a positive impact on students' cognitive development. Through learning projects, students are trained to think critically, analyze information, and find solutions to complex problems. Project-based learning is very supportive of achieving students' science competencies. In this model, students are given the opportunity to be actively involved in all stages of the project, from planning, implementation, to presentation. This process stimulates students to think creatively in choosing tools and materials, designing the manufacturing process, and presenting their work (Ashriah, S., et.al., 2020; Birgili, 2015).

Based on the previous exposition, the researcher is interested in conducting a meta-analysis of articles from various educational journals related to the use of Project-Based Learning. The purpose of this study is to examine the effect of Project-Based Learning on improving students' creative thinking skills. The expected results can provide an insight into the use of Project-Based Learning in classroom science learning.

Method

This study employs a quantitative meta-analysis approach. Meta-analysis synthesizes findings from prior research by statistically combining data from existing studies, often utilizing scholarly articles as the primary data source. This quantitative approach necessitates the use of numerical methods to organize and analyze the data, as alternative methods are insufficient for this type of research.

This research aims to explore the influence of Project-Based Learning (PjBL) on the development of students' creative thinking skills in science education. The data for this study was sourced from peer-reviewed articles published within the last five years (2019-2024) in reputable national journals (Sinta 4 or higher) and international journals or conference proceedings. A rigorous selection process was employed to ensure that only articles meeting specific criteria were included in the analysis. Figure 1 provides a visual representation of the research methodology (Dewi et al., 2023).

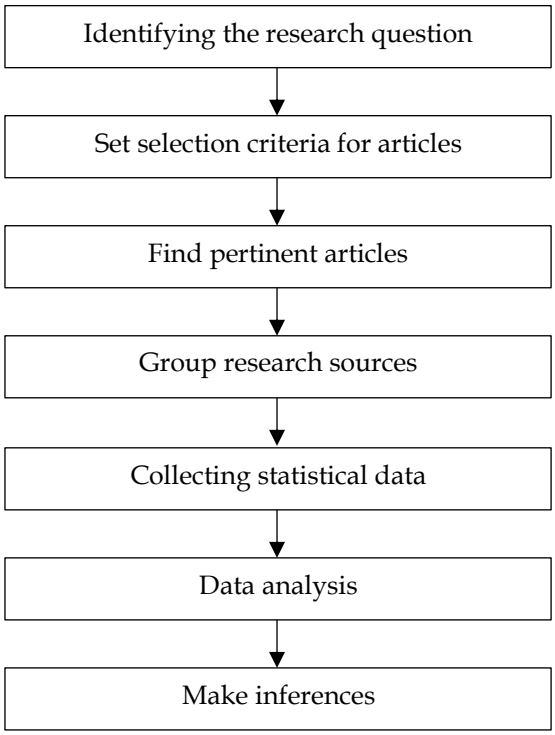

Figure 1. Procedure Of Research

Data analysis used effect size calculation techniques for each article using the formula presented in Table 2. Interpretation of effect size using interval analysis in Table 1 (Davison & Smith, 2018).

Table 1. Effect Size Category

Effect Size	Category
ES ≤ 0.15	Negligible
0.15 < ES ≤ 0.40	Low
0.40 < ES ≤ 0.75	Medium
0.75 < ES ≤ 1.10	High
ES > 1.10	Very High

Table 2. How to determine the amount of *Effect Size* (Ananda, P., N., et al: 2021)

Statistical Data	Formula	Formula
Average statistics on one group	$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}}$	Fr-1
Average statistics for each group (*two groups posttest only*)	$ES = \frac{\bar{x}_E - \bar{x}_C}{SD_C}$	Fr-2
Average statistics for each group (*two groups pre-post tests*)	$ES = \frac{(\bar{x}_{post} - \bar{x}_{pre})E - (\bar{x}_{post} - \bar{x}_{pre})C}{\frac{SD_{preC} + SD_{preE} + SD_{postC}}{3}}$	Fr-3
Statistics *Chi-Square*	$ES = \frac{2r}{\sqrt{1-r^2}}; \sqrt{\frac{x^2}{n}}$	Fr-4
T-statistics	$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$	Fr-5
P value statistics	CMA (*Comprehensive Meta Analisis Software*)	Fr-6

Notes:
ES = Effect size, X_{post} = Posttest mean, X_{pre} = Pretest mean, SD = Standard Deviation, X_E= Experimental group mean, X_C = Control group mean, $XpostE$ = Experimental group posttest mean, X_{preE} = Experimental group pretest mean, X_{postC} = Average of posttest of control group, X_{preC} = Average of pretest of control group, SD_E = Standard Deviation of experimental group, SD_C = Standard Deviation of experimental group, t = Result of t test, n_E = Number of experimental group, n_C = Number of control group, r = Correlation value.

Result and Discussion

This research aims to determine the extent to which the implementation of Project-Based Learning (PBL) influences students' creative thinking skills. After collecting 10 articles, the Effect Size of each article was calculated to determine the magnitude of the influence of the Project-Based Learning model on the creative thinking skills of junior high school students in science subjects. The analyzed articles were published from 2019 to 2024. Table 3 shows the effect size of each article, and the average effect size for each grade level (7th, 8th, and 9th grade) of junior high school is presented in Table 4. Table 5 shows the effect size of using the model for different learning materials.

Table 3. Categories of Effect Size: The Impact of Project-Based Learning on Students' Creative Thinking in Science

Title	Author	Year	Code	Grade	Formula	Effect Size	Category
The Impact of Project-Based Learning on Creative Thinking	(Efendi et al., n.d.)	2023	A1	IX	Fr-5	1.06	High
The Impact of Project-Based Learning (PBL) on Communication and Creative Thinking Skills	(Adriani et al., 2023)	2023	A2	VII	Fr-2	1.05	High
The Impact of Project-Based Learning with Poster Session Strategy on Creative Thinking Skills	(Nury et al., 2019)	2019	A3	VIII	Fr-1	3.35	Very high
The Implementation of Project-Based Learning Model on the Creative Thinking Skills of Grade 8 Students at SMP IT Nurul Hikmah Penajam Paser Utara	(Pulungan & Khairuna, 2023)	2023	A4	VIII	Fr-1	6.71	Very high
The Impact of Project-Based Learning (PBL) on Students' Communication and Creative Thinking Skills	(Andriani et al., 2023)	2023	A5	VII	Fr-2	1.12	Very high
The Implementation of Project-Based Learning (PBL) in Equipping Students with Creative Thinking Skills on the Circulatory System Material at SMP Terpadu Al Hasan Ciamis	(Milga Shari et al., 2024)	2024	A6	VIII	Fr-1	6.63	Very high
The Impact of STEM-PBL Learning Model on Creative Thinking Skills of	(Karlina et al., 2023)	2023	A7	VII	Fr-3	0.79	High

Grade 8 Students at SMP Negeri 1 Slogohimo Wonogiri During the Pandemic on the Hydrosphere Material							
The Impact of Project-Based Learning on Students' Creative Thinking in Science Learning	(Ningsih et al., 2021)	2021	A8	VIII	Fr-2	1.51	Very high
The Impact of Project-Based Learning Integrated with Ethnoscience on Students' Creative Thinking Skills in Seventh Grade Science at SMPN 2 Pujut	(Wanggi et al., 2023)	2023	A9	VII	Fr-5	0.80	High
The Impact of Project-Based Learning on Students' Creative Thinking Skills at SMP Negeri 6 Tondano	(Pontoh et al., 2024)	2024	A10	VIII	Fr-5	0.79	High

These results show the effect size on the effects of Project Based Learning on science learning and students' creative thinking skills in Table 3 shows that five articles (A3, A4, A5, A6, A8) had very high value and five articles (A1, A2, A7, A9, A10) had high value. The distribution of the data varies from high to very high categories, and the mean of effect size is 2.38.

From this distribution, it can be seen that almost all articles are in the high to very high category effect size. For the very high category, there are 5 articles in that category. The very high category is the most article effect size category with a percentage of 50%. The high categories are the second most article categories with a percentage of 50% or the number of articles each, namely 5 articles.

The number of articles in the high to very high category indicates the impact of the Project Based Learning on science learning and students' creative thinking skills. The overall effect size cannot be accurately determined by simply averaging the results from all articles. This is because it is crucial to assess the homogeneity, or the degree of variability, within the overall population of articles.

Table 4. Effects of Project-Based Learning on Creativity by Grade Level

Grade Level	Article Code	Effect Size	Average Effect Size	Description
VII	A2	1.05	0.94	High
	A5	1.12		
	A7	0.79		
	A9	0.81		
VIII	A3	3.35	4.76	Very high
	A4	6.71		
	A6	6.63		
	A8	1.51		
	A10	0.79		
IX	A1	1.06	1.06	High

Table 4 shows that Project-Based Learning has a positive impact on science learning in all junior high school grades. The effect size was consistently high across all grades, with the highest average found in grade 8. Grade 7, based on four studies, had an average effect size of 0.94, which is considered high. In grade 8, five studies showed an average effect size of 4.76, also considered high. Even though only one study looked at grade 9, it found a high effect size of 1.06.

Using Project-Based Learning (PBL) in all junior high school grades has a very positive effect on students' creativity in science class. This is shown by the consistently high results from all the studies. There were more studies done in grade eight, which makes us more confident about the results for that grade.

Table 5. Results of Effect Size by Topic

Topic	Article Code	Effect Size (Mean)	Description
Biotechnology	A1	1.06	High
Pollution	A2, A5	1.09	High
Global Warming	A3	3.35	Very high
Sound and Waves	A4, A8	4.11	Very high
Blood System	A6	6.63	Very high
Ecosystem	A9	0.81	High
Water Cycle	A7	0.79	High
Excretion System	A10	0.79	High

Next, looked at how much Project-Based Learning helped students learn different science topics. Eight different topics were studied, and all of them showed a big improvement when using Project-Based Learning. The biggest improvement was seen in the topic of the circulatory system, with a score of 6.63. This is probably because the students in these studies were very motivated, which helped them improve their creative thinking skills. This is similar to what Rahmawati et al. (2021) found, which is that students who are more motivated are also better at creative thinking.

Based on the findings that have been presented, it can be said that the PjBL model is one of the recommended models in current learning, namely 21st century learning to improve students' creative thinking skills as expressed by (Nursamsu & Rachmatsyah, 2021; Rahayu et al., 2023; Wulandari et al., 2024), and its implementation is adjusted to the student's education level (Hikmah et al., 2023). Through PjBL students will be involved in problem-solving and analyzing activities, designing, completing projects, and producing new products that will encourage students' creative thinking skills (Anwar et al., 2024; Sucilestari et al., 2023; Yanti et al., 2023).

The success of the PjBL model to improve students' creative thinking skills is influenced by the teacher's skills to design and assist students during the learning process. Teachers need to understand students well in terms of cognitive, affective, and psychomotor skills (Leasa et al., 2023). In addition, it is necessary to use worksheets or ebook that are in accordance with the PjBL learning steps (Dwiningsih & Aisy, 2024; Hasibuan et al., 2023; Kusumaningtyas et al., 2023; Setyani et al., 2024), as well as conduct appropriate assessments during the learning process (Eliaumra et al., 2024; Rosidin et al., 2023). The implementation of project-based learning model needs to be adapted to teaching materials that allow students to explore creative ideas. The diversity of students' abilities and learning experiences needs to be considered to ensure the success of the project. Poor time management can hinder the learning process and produce suboptimal results (Nasution et al., 2021).

Conclusion

Overall, this research provides strong evidence of the effectiveness of the Project-Based Learning model in enhancing students' creative thinking skills in science learning at the junior high school level. Based on the results of the study, it can be concluded that the effect of the PjBL model on students' creative thinking skills as a whole is 2.38 with a very high category. The effect of the PjBL model on students' creative thinking skills based on grade level gives the greatest influence on grade VIII of 4.76 with a very high category, and the smallest in grade VII of 0.94 with a high category.

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