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Meta-Analysis Study: The Influence of Project Based Learning Models on Creativity and Science Learning Outcomes of Elementary School Students

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Abstract. The project based learning (PjBL) model is expected to be able to change students' learning styles by increasing motivation in learning, creativity in work, generating creative ideas, and being able to think critically. The meta-analysis research aims to find out how big the effect of the PjBL model is on the creativity and science learning outcomes of elementary school students?; Does the implementation of the PjBL model affect the creativity and science learning outcomes of elementary school students? Collecting articles using the publish or perish application with the keywords PjBL model, creativity, and elementary science learning outcomes. The data obtained was analyzed by calculating the effect size of each journal. Analysis of the average effect size of 0.92 is in the large category. The PjBL model influences the creativity and learning outcomes of elementary school students with r RE = 0.925 in the high category. This shows that the PjBL model can increase student creativity and learning outcomes in elementary school science learning. The PjBL model can improve and develop creativity and high-level thinking skills based on the demands of the 4.0 era.

Keywords: Meta-analysis, PjBL, creativity, elementary School

Introduction

The concept of 21st century learning is receiving attention and is being implemented in the world of education. 21st century learning refers to an educational approach that focuses on skill development. Skills developed in The 21st century consists of *critical thinking*, *problem solving, communication* and *collaboration, creativity* and *innovatio*n (Rusadi et al., 2019; Handajani et al., 2018; Meliyana et al., 2022). 21st century learning prepares students to be able to compete in the modern world to face technological advances. Thus, 21st century learning emphasizes innovative learning processes, technology integration, and creating an interactive learning environment that is student-centered.

Science learning plays an important role in preparing students to face the competencies needed in the 21st century. Science learning is creativity that can make students think critically, logically and creatively (Fera, 2022; Iskandar, 2022). Creativity is

a person's activity in thinking for themselves or imaginatively (Hadiq et al., 2022). Creativity is a person's ability to create or produce a thought or idea or real work, whether existing or new (Lestasi et al., 2022) and has usefulness (Sari, 2018). Creativity does not have to create something new and has never existed before. Students can try to channel ideas by making something that they think is different from the others. Students can try to combine previously available data or information and make slight changes to the work they create. Sari et al. (2018); Hadiq et al. (2022) states that creativity is a person's ability to carry out an action that not only has the creative power to create a new creation, but is also able to provide various ideas (problem solving ideas) in dealing with a problem or problems. In line with Ernawati et al. (2019) student creativity has an important role in solving a problem that arises. faced.

Therefore, creativity is really needed by students in their lives. Creativity does not just come to someone's attention. In schools, teachers as facilitators must be able to guide students to creativity. Various learning models can be used to guide student creativity, one of which is the project based learning (PjBL) model. Meliyana (2022) states that this model places more emphasis on the project to be carried out. PjBL model is an innovative learning model that actively involves students to construct their knowledge independently with the mediation of their peers in groups to complete projects. In line with (Farida et al., 2018; Sulistyowati et al., 2023) that the PjBL model In an effort to increase student creativity and learning outcomes, this is learning that trains students to be able to master the material through completing projects. PjBL model is learning that facilitates students to work individually or in groups (Nurhadiyati et al., 2020). The PjBL model is a learning model that uses projects by means of teachers giving assignments to students for exploration, assessment, interpretation, synthesis and information to produce various learning outcomes. PjBL model is a contextual model because this learning model is expected to change students' learning styles by increasing motivation in learning, creativity in working, producing creative ideas, and being able to think critically in responding to and solving real problems faced (Rafik et al., 2022; Nur et al., 2023).

PjBL model can make students active, creative, innovative in solving problems. PjBL model the aim is for students to be able to compile assignments given by the teacher and produce student work products. In its implementation, students are involved in solving problems and other meaningful tasks, providing opportunities for students to work autonomously, organize their own learning, and In the end, it is able to produce a real product that is valuable and realistic (Tinenti, 2018). In line with Rizkasari (2022) that the PjBL model can increase student creativity with indicators that students have high curiosity, initiative, imagination, self-confidence, creativity and innovation, broad interests, courage, responsibility, freedom in thinking , confidence to succeed. Increasing student creativity has an impact on improving science learning outcomes at SD 02 Salak City. Apart from that, Christian (2021) stated that the results of research that had been carried out regarding the application of the PjBL model starting from basic questions, organizing, making schedules, monitoring, presenting and evaluating projects could increase student creativity.

PjBL model is one of the many ways that can be used to help students face future challenges so that they are able to survive and succeed in increasingly fierce competition in the era of globalization. In line with this, Mayasari et al. (2016) stated that the PjBL model is able to equip students to prepare themselves for learning in the 21st century. PjBL is designed to be used on complex problems that require students to investigate and understand them. Considering that each student has a different learning style, PjBL provides students with the opportunity to explore content (material) using various methods that are meaningful to them, and carry out experiments collaboratively. The use of the PjBL model encourages the growth of creativity, independence, responsibility, self-confidence, as well as critical and analytical thinking in students. The application of the

PjBL model of course adapts to the learning material and students' level of development. Much research has been conducted on the use of the PjBL model in efforts to increase elementary school students' creativity. Several studies state that the use of the PjBL model in elementary school science learning has a high influence on creativity and learning outcomes (Kusmiati, 2022; Jihan, 2022; Widiastuti, 2018; Arsiya, 2022), but several studies report that the use of PjBL in science learning still has a moderate impact on student creativity and learning outcomes (Solehah, 2023; Yulaika, 2022; Rodiyah, 2021). The report shows that the influence of implementing the PjBL model in elementary school science learning is inconsistent in efforts to increase the creativity and science learning outcomes of elementary school students. In addition, the report shows the creativity and learning outcomes of elementary school students in heterogeneous science learning. It can be interpreted that there are differences in creativity and student learning outcomes. However, information regarding student creativity and learning outcomes in science learning is very important for teachers in the science learning process.

Based on the background description, the researcher wants to study the Koran through experimental research on the influence of the PjBL on creativity and student learning outcomes in existing elementary school science subjects using a meta-analysis approach. Meta analysis is a study of statistical analysis techniques that combines the results of quantitative study reviews with the accuracy of several scientific studies (Borenstein et al., 2009). According to Retnawati (2018), meta-analysis aims to determine statistical power, generalizability of results, accuracy in estimating impacts, and reducing the risk of false negative results, thereby generating new hypotheses for further research. Regarding meta-analysis research on the influence of the PjBL learning model on elementary school students' creativity and science learning outcomes that have not been exploited, researchers are interested in conducting this study. Therefore, the aim of this research is to estimate and test the effect of the PjBL learning model on creativity and elementary school science learning outcomes. The following research questions aimed at the aim of this research are: How big is the effect of the PjBL model on the creativity and science learning outcomes of elementary school students?; Does the implementation of the PjBL model affect the creativity and science learning outcomes of elementary school students?

Methods

This type of research is quantitative meta-analysis research. Meta-analysis is used to combine, review, and summarize the findings of two or more studies. By using meta-analysis, various questions can be investigated based on data collected from previous research publications (Asrizal, 2023; Borenstein et al., 2009). The meta analysis steps can be seen in Figure 1.

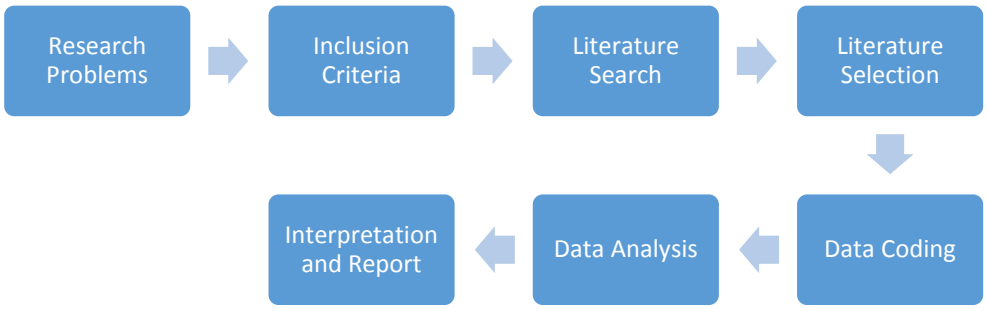

Figure 1. Meta analysis Steps (Retnawati, 2018)

This research method uses the PRISMA (*preferred reporting items for systematic reviews and meta-analyses*) (Page & Moher, 2017). Collecting articles using the *publish or perish application* with the keywords PjBL, *creativity*, and elementary science learning outcomes. Article searches carried out since November 2023 resulted in 80 scientific articles and 12 theses. Next, articles were selected to be reviewed by determining the inclusion and exclusion criteria, in Table 1. 20 articles were obtained that met the inclusion criteria to be used as samples.

Table 1. Inclusion and Exclusion Criteria

Exclusion Criteria	1. Types of Development Research and PTK 2. Abstract is incomplete 3. Research subjects at junior and senior high school levels
Inclusion Criteria	1. Articles published 2017 – 2023 2. Research topics in elementary science 3. PjBL model type 4. Research topic in the study of creativity and elementary school science learning outcomes 5. Research subjects were elementary school students

The instrument used in this research was an observation sheet. Observation is a method of systematically collecting data through observing and recording symptoms that appear in the research object, in this case a sample article (Sugiyono, 2018). The observation sheet used in the research is in the form of a check list*,* which contains information from the articles being analyzed regarding year of publication, subject, subjects, *pretest* and *posttest scores,* number of samples. in the study used. This observation sheet is used to determine the achievement of each component that the researcher wants to carry out a meta-analysis regarding the influence of the PjBL model on creativity and elementary school science learning outcomes.

The data analysis technique used is calculating the *effect value size* of each study. *Effect size* is a measure of the quantity of a research result to determine the correlation or difference between research variables. *Effect size* statistics produce statistical standardization of research findings so that the resulting numerical values can be interpreted consistently across all variables and measures involved (Riopel et al., 2020; Hillmayr et al., 2020). The *effect size* calculation technique for each study was carried out to see the influence of the PjBL model on the creativity and science learning outcomes of elementary school students. The way to find *the effect size* used in this research uses Cohen's theory (Seftiani et al., 2021; Retnawati, 2018). Furthermore, the criteria for effect size values in this meta-analysis can be seen in table 2.

Table 2 . Effect Size Value Category

Effect Size	Categories
ES ≥ 0.80	Large
0.20 ≤ ES < 0.80	Medium
0.00 ≤ ES < 0.20	Small

Additionally, an important thing to consider when conducting a meta-analysis is checking for study bias (Smith et all., 2023; Schmid et al., 2023). In research to check study bias using funnel plots, egger's test and the rosenthal fail safe N test (Juandi et al., 2022 ; Diah et al., 2022) .

Results and Discussion

This meta-analysis method research aims to determine the effect of implementing the PjBL model on student creativity and learning outcomes in elementary school science learning. This research analyzes the effect (effect size) resulting from the PjBL model. Effect size shows the influence between two variables, namely the independent variable and the dependent variable. The independent variable is studied was the PjBL model , while the dependent variables were creativity and science learning outcomes of elementary school students. This research analyzes 20 articles that have been published in nationally accredited journals. This article was obtained with the help of publish or perish which was published from 2017-2023. The articles obtained were analyzed using JASP. Based on the inclusion criteria of the 20 articles that were analyzed, the effect size and standard error for each study were obtained which can be seen in Table 3.

Table 3 . Effect Sizes and Standard Errors of 20 studies

No.	Article Code	Publication Year	Effect Size	Standard Error
1	MA1	2022	0.62	0.19
2	MA2	2022	2.49	0.17
3	MA3	2017	2.12	0.17
4	MA4	2022	1.17	0.19
5	MA5	2017	0.45	0.12
6	MA6	2020	0.02	0.24
7	MA7	2019	1.22	0.16
8	MA8	2017	0.26	0.13
9	MA9	2023	1.59	0.23
10	MA10	2023	0.23	0.19
11	MA11	2021	0.85	0.13
12	MA12	2022	1.28	0.32
13	MA13	2020	0.65	0.22
14	MA14	2022	1.56	0.24
15	MA15	2020	0.92	0.18
16	MA16	2020	0.37	0.25
17	MA17	2017	0.23	0.24
18	MA18	2018	0.12	0.23
19	MA19	2018	1.40	0.19
20	MA20	2019	0.91	0.18
Average			0.92	0.2

It is known from Table 3 that the effect size values of the 20 articles analyzed ranged from 0.02 to 2.49, with an average effect size of 0.92. The mean standard error was found to be 0.2 with standard errors ranging from 0.12 to 0.32. Based on Cohen's effect size

category, there are eleven studies in the large category (55%) and seven studies in the medium category (35%) while two studies are in the small category (10%). Next, carry out a heterogeneity test and determine the estimation model used to calculate the average effect size of 20 articles. The results of the heterogeneity test and determination of the estimation model using random and fixed models can be seen in Table 4.

Table 4. Heterogeneous Results of Random and Fixed Models

	Q	Df	P
Omnibus test of Model Coefficients	36.575	1	< .001
Test of Residual Heterogeneity	261.420	19	< .001

Table 4 explains the results of the heterogeneity test, obtained a Q value of 261.420 which is greater than the value of 36.575 and the p value <0.001. These findings conclude that the analyzed effect sizes are heterogeneously distributed. Thus, random effect analysis indicates that there is a significant positive relationship between the PjBL model on creativity and elementary school student learning outcomes. Next, calculate the average effect size value to test the hypothesis. The results of the mean effect size test can be seen in Table 5.

Table 5 . Correlation coefficient

					95% Confidence Interval	
	Estimate	Standard Error	z	p	Lower	Upper
intercept	0.925	0.153	6,048	< .001	0.625	1,224

Based on table 5, it is known that the effect size value with the random effect model was obtained (r RE = 0.925; SE = 0.153; z = 6.048; p < 0.001). This shows that the application of the PjBL model has a significant effect on the creativity and learning outcomes of elementary school students. At a 95% confidence level with a lower limit value of 0.625 and an upper limit of 1.224. The influence of the PjBL model on the creativity and learning outcomes of elementary school students is in the high category (r RE = 0.925). Therefore, the application of the PjBL model influences the creativity and learning outcomes of elementary school students.

This meta analysis was carried out to see the effect of using the PjBL model on student creativity in elementary school science learning obtained from 20 articles in the database for the last 7 years. Based on the results of the analysis, the average *effect size was* 0.92, which is in the large category. This shows that the PjBL model can increase student creativity in elementary school science learning. This is in line with Christian (2021) opinion that the PjBL learning model has a very big influence in increasing the creativity and learning outcomes of students in elementary schools. Supported by research Kusmiati (2022) that the PjBL model has a significant influence on student learning creativity. Models PjBL is creative and interesting learning that inspires students to express their creativity (Gunawan et al., 2018). The PjBL model encourages students to have a more disciplined learning attitude, enabling them to learn more actively and creatively. Model PjBl encourages students to choose learning experiences that are fun and more meaningful. Besides that, This learning encourages students to explore, solve problems, that is student-centered *,* as well as producing products . real . in the form of .project results (Erisa, 2021). As for The advantages of the PjBL learning model include (1) increasing student learning motivation, (2) increase activity and ability to solve complex problems (3) train students in the use of media, art and technology, with the principles of ergonomics, hygienic, precise

– nimble – fast, ecosystemic and metacognitive (4) Producing finished works that are ready to be utilized and used in life.

Checking publication bias in meta-analysis with funnel plot, egger's test and the rosenthal fail safe N test (Bernard et al., 2014; Suryono et al., 2023; Li & Wang, 2023; Juandi et al., 2021). The results of the study bias can be seen in Figure 2.

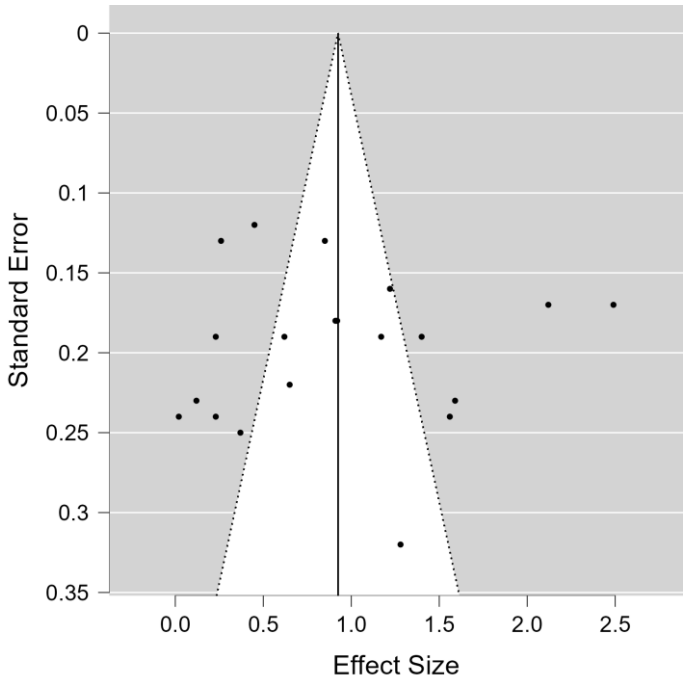

Figure 2. Funnel Plot Standard Error

Based on Figure 2, the results of the analysis of the 20 effect sizes with funnel plots form a symmetrical pattern. This is supported by the results of the Egger test where z = -0.238 and P = 0.812 which states that the funnel plot formed is symmetrical. According to Bernard (2014) when the fail-safe N value is higher than 5 K + 10 (K = number of individual studies), there is no publication bias in the meta-analysis. In this study, K = 20 so that 5(20) + 10 = 110. Furthermore, the fail safe N value obtained in this study was 3574 with a sig value. 0.50 and $p < 0.001$. These results also confirmed that there was no issue of publication bias in the meta-analysis study. Therefore, publication bias in this study was not found.

The application of PjBL in science learning in elementary schools provides students with a meaningful learning experience, because in developing their potential students are given direct experience with nature systematically. Science learning aims to develop students' skills in scientific thinking. In learning, students are invited to ask questions, design, collect, analyze data and draw conclusions based on existing evidence. Therefore, elementary science learning is learning that can make students think critically, logically and creatively. This is in line with the results of research conducted by Wulandari et al., (2019) which said that efforts to create something new in the form of ideas or thoughts are part of thinking. Students need to have this creative thinking ability , especially starting at the elementary school level, so that students' understanding of the material and learning outcomes improves. The ability to think creatively is very important in life, when students have the ability to think creatively, they will get used to thinking creatively at the next level (Surya et al., 2018). The capacity to consider many potential solutions to a problem

is creativity. According to Isti (2013) the three components of creative thinking are *fluency*, namely. earning ability. Lots . ideas and . answers when solving problems or questions (2) *originality* is the ability to create original ideas from one's own thoughts and provide answers that are different from other people's answers, and rare given . by . most . people; (3) *elaboration* (decomposition) is the ability to add, elaborate, and expand ideas or opinions.

The results of analysis using the Random Effect model show that the application of the PjBL model has a significant effect on the creativity and learning outcomes of elementary school students ($z = 6.048$; $p < 0.001$; 95% CI [0.625; 0.224]). The influence of the PjBL model on the creativity and learning outcomes of elementary school students is in the high category ($r_{RE} = 0.925$). Therefore, the application of the PjBL model influences the creativity and learning outcomes of elementary school students . This shows that the PjBL model can develop student creativity. Creativity is a person's ability to give birth to something different new, both in the form of ideas and real work, both in the form of aptitude characteristics or non aptitude, both in the form of work and in combination with other things existing ones, all of which are relatively different from what already exists previously. Sari (2018) states that creativity is students' ability to create new things in learning, both in the form of the abilities and talents that a person has develop information obtained from teachers in the teaching and learning process . The teaching and learning process has a major contribution in developing student creativity. Creativity in learning can be considered important because it can develop self-confidence, improve students' skills, understanding and ability to think critically. One model that can develop student creativity in the learning process is the PjBL model.

Creativity in elementary science learning can be increased through various innovative and creative learning models. Kusmiati (2022) stated that PjBL is effective and has positive value applied to elementary school students in increasing student creativity. PjBL is an active, student-centered teaching approach, involving students to work on real-life problems, collect and analyze data, and generate solutions to problems encountered. PjBL focuses on individual differences and supports students' socialization, thinking, and self-regulation skills. It is characterized by student activity, constructive investigation, goal setting, collaboration, and communication. PjBL allows students to apply and develop theory, skills, and techniques to solve real-world problems. Tatiana (2022) stated the results of her research that the project model was found to be effective in developing communicative competence, self-confidence in planning and reporting projects. PjBL enriches students' learning experiences and knowledge, providing more meaningful education based on innovative learning. Overall, project-based learning is a student-centered pedagogical approach that promotes active learning, critical thinking, and the development of practical skills.

The PjBL model is not only required to express opinions but in PjBL students are required to solve problems through giving assignments in making projects so that students' creativity and creative thinking abilities increase. This is in line with (Salsa 2023; Yulaika, 2022; Widiastuti, 2018) that implementing PjBL in science education leads to a significant increase in student creativity and conceptual understanding. Apart from that, Rafik (2022) PjBL model provides opportunities for students to develop creativity and high-level thinking skills based on the demands of the 4.0 era. By involving students in hands-on projects and problem-solving activities, PjBL can stimulate students' creative thinking and problem-solving abilities. The effectiveness of PjBL in increasing creativity and science learning outcomes in elementary schools has been observed in various elementary schools (Christian, 2021; Radiansyah, 2022; Sri, 2023). Therefore, implementing PJBL in science lessons can be an effective approach to foster creativity among elementary school students.

Conclusion

The application of PjBL in science learning can be an effective approach to foster creativity, independence, responsibility, self-confidence, and critical and analytical thinking in elementary school students. This meta-analysis was conducted to estimate and test the effect of the PjBL learning model on creativity and learning outcomes of elementary science, in 20 articles that have been published in nationally accredited journals. Based on the results of the analysis, the average effect size of 0.92 is included in the large category. The PjBL model affects the creativity and learning outcomes of elementary school students with r RE = 0.925 in the high category. This shows that the PjBL model can improve student creativity and learning outcomes in elementary school science learning. The PjBL model can improve and develop creativity and high-level thinking skills based on the demands of era 4.0.

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