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EVALUATING THE EFFECTS OF PROJECT-BASED LEARNING IN SCIENCE EDUCATION: A SYSTEMATIC REVIEW (2023–2024)

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ABSTRACT

Natural Sciences learning in elementary schools is still dominated by conventional approaches centered on teachers, which leads to low student participation, learning outcomes, and science literacy. One of the Learning models that is considered relevant to overcome this problem is Project-Based Learning (PjBL). The objective of this research is to evaluate the efficacy and impact of the Project-Based Learning (PjBL) model on scientific instruction in primary schools. The articles are empirical in character, written in either Indonesian or English, and they are published between 2023 and 2024 with an emphasis on elementary school pupils. The method used is Systematic Literature Review (SLR). Literature searches were conducted using Scopus, ERIC, and Google Scholar databases with article selection criteria. The content of the article discusses Project Based Learning (PjBL) in elementary school science education and is published in 2023-2024. There are 11 articles that meet the inclusion category. The results of the study show that the Project-based Learning (PjBL) model has a positive influence on science learning. In elementary schools, especially to improve students' science learning outcomes, creativity, and active learning engagement. This study concludes that Project-Based Learning (PjBL) is an active learning model that involves students in meaningful activities.

Keywords: PjBL; science; elementary school; SLR

INTRODUCTION

Natural Science (IPA) learning in elementary school plays an important role in building students' knowledge, thinking skills, and scientific attitudes from an early age. Science is not only about teaching scientific concepts but also teaching students to observe events happening around them, conduct simple investigations, and show an interest in the environment. Effective science learning must be able to combine knowledge, skills and attitudes in a balanced way so that what students get is more meaningful (Krajcik *et al*., 2023). Science teaching should give students the opportunity to experience the scientific process firsthand. Students' active involvement in science learning can aid in a deeper understanding of concepts and sustainability (Kurt & Akoglu, 2023).

However, the reality on the ground shows that science learning in elementary schools often focuses on teachers (*teacher centered*) and emphasizes memorizing concepts. The lecture method and written assignments still dominate the learning process, so that students become passive and direct involvement is reduced. This situation will affect the understanding of the concept of elementary school science (Turyati *et al*., 2020). Project Based Learning (PjBL) is based on contructivism theory, which states that knowledge is actively constructed by students through meaningful learning experiences. According to (Piaget, 1952) the proses of

assimilation and accommodation occur when individuals interact with the environment and face challenging situations, thus encouraging the development of cognitive structures and higher order thinking skills. In the context of PjBL, student involvement in authentic problem solving allows for active and reflective knowledge construction. The low science literacy of elementary school students is related to the learning model that does not provide space for scientific activities (Wardah *et al*., 2022). Low learning outcomes are often due to teacher-centered learning compared to activity-based student-centered methods (Putri *et al*., 2021).

While earlier reviews have determined that student-centered methodologies enhance educational outcomes, they predominantly amalgamate studies over extensive temporal periods and fail to distinguish the most recent empirical evidence. Of publications between 2023–2024 presents novel variances in research design, outcome measurements, and implementation contexts that have yet to be fully analyzed. is uncertain whether the favorable outcomes documented in previous literature persist the latest studies, especially in elementary science education. research from 2023 to 2024 is essential to confirm effect constancy, discern developing patterns, and rectify unsolved gaps from previous synthesis.

With the demands of 21st century education and the implementation of an independent curriculum, it is hoped that science learning in elementary schools can develop critical thinking, collaboration, creativity and communication skills. The design of science learning aims to encourage students to actively build knowledge through hands-on experience and solve problems around them. Learning science with real activities is more effective in helping students build a meaningful understanding of concepts (Viro, 2020). To answer these demands, teachers are expected to implement innovative and student-centered teaching models. One useful learning model is Project-Based Learning (PjBL). PjBL is a learning model that places students at the center of the learning process using structured and contextual project activities (Markula & Aksela, 2022).

Project-based learning provides opportunities for students to engage in investigative learning activities to produce a product or solve real problems. Through PjBL, students not only gain knowledge, but also grow critical thinking skills and scientific attitudes. PjBl is very suitable to be carried out in science learning because it is in line with the characteristics of process-oriented science learning. Students who learn using PjBL get a more effective experience of science concepts when compared to students who study using the traditional model. Project-based science learning is able to quickly increase student motivation, learning outcomes, and engagement. Project-based learning has a positive influence on students' thinking skills because students are trained to identify problems, design solutions, and evaluate the results of work correctly. Student involvement in project activities encourages the improvement of observation skills, data collection, and objective conclusion drawn. There is a positive influence on science process skills and science learning outcomes using PjBL (Kurt & Akoglu, 2023).

Compared to students taught using traditional instructional approaches, those who participate in Project Based Learning

(PjBL) have more meaningful experiences comprehending scientific concepts (Turyati *et al*., 2020). It has been demonstrated that PjBL in science instruction successfully raises student involvement, motivations and learning results (Pangestu *et al*., 2024). Additionally, using STEM-based PjBL encourages students to think creatively and critically (Kartikasari *et al*., 2024). By involving students in problem identification, solution design, and evaluation of their work PjBL Enhances their critical thinking abilities (Aswan *et al*., 2024). Engaging in project activities actively also fosters the growth of observational skills, data collection abilities, and the ability to make unbiased judgments (Setiyadi *et al*., 2024). PjBL significantly improves student science learning outcomes and science process skills overall (Surya, 2023).

Based on the description above, this literature review is important for the combination of research findings in the use of project-based learning models for science learning in elementary schools. The purpose of this study is to analyze the effectiveness and contribution of the PjBL model to elementary school science learning based on research results from national and international journals in 2023-2024. The results of this study are expected to be a guide for teachers, researchers, and policymakers in developing science learning that is student-centered and in accordance with the times.

RESEARCH METHODS

This research is a literature research using the *Systematic Literature Review* (SLR) method. Systematic Literature Review is a research method that is conducted in an orderly, transparent, and objective manner to identify, evaluate, and consolidate previous findings relevant to a particular subject. This study systematically applied inclusion and exclusion criteria to ensure transparency and quality of study selection, in accordance with the 2020 PRISMA guidelines (Page *et al*., 2021). Included articles were empirical studies conducted during the 2023–2024 period with quantitative or experimental designs that examined student-centered learning approaches, pecifically PjBL in elementary school science learning and reported measurable learning outcomes. Studies with a sample size of at least 20 students and published in peer-reviewed journals were included. Articles published before 2023, non-empirical publications, studies outside the elementary school level, articles without clear learning outcome data, duplicates, and articles without full text were excluded from the analysis.

This SLR method is widely used in education research because it can provide a complete picture of the development of certain subjects based on published empirical evidence. In this study, SLR was used to examine the application and role of (Snyder, 2019), (Xiao & Watson, 2019), *Project-Based Learning* (PjBL) to Natural Sciences (IPA) learning in elementary schools. There are three main stages in systematic literature review, namely planning, implementation and reporting, as recommended in the Education research review (Xiao & Watson, 2019).

The planning stage is the initial planning stage. At this stage, the researcher determines the focus and purpose of the research, which is to analyze *the Project Based Learning* model for science learning in elementary schools. In SLR, a clear determination of the research focus is essential because it can affect the relevance and depth of the results of the literature

synthesis (Snyder, 2019). In this study, the article studied is in the 2023-2024 publication, the goal is to ensure that the results of the study are up-to-date and relevant to the current development of science learning. Publication year restriction selection is a common practice in SLR to keep research findings up to date (Xiao & Watson, 2019).

The next stage is the conducting stage which is the stage of conducting article search and selection. Systematic searches are used to search for literature, by utilizing scientific databases such as Scopus, ERIC (Education Resources Information Center), and Google Scholar, all of which are widely recognized as reputable sources of scientific publications in the field of Science Education and learning (Snyder, 2019).

The articles obtained were then selected through several stages, namely the removal of duplicate articles, filtering by title and abstract and reviewing the complete text. This gradual selection procedure is in accordance with the PRISMA flow which aims to guarantee only relevant and quality articles are further analyzed (Page *et al*., 2021). Although a meta-analysis was considered, it was not performed due to substantial methodological and statistical heterogeneity among the included studies. Variations in study design, sample characteristics, intervention duration, outcome measures, and incomplete reporting of standardized effect sizes or necessary statistical data limited the feasibility of a quantitative synthesis. Therefore, this study employed a qualitative systematic review approach to provide a rigorous and context-sensitive interpretation of the findings. This study uses 11 articles as the main material in the review process. The determination of the number of articles in the SLR is adjusted to the research objectives and the desired depth of analysis, not just the number of initial search results (Snyder, 2019).

The last stage of SLR is the reporting stage. This stage is the stage of analysis, synthesis, and reporting of results. Critical apparaisal practices in SLR are highly recommended to be able to increase the credibility and validity of research synthesis results (Kerres & Bedenlier, 2020).

RESULTS AND DISCUSSION

The results of *the Systematic Literature Review* of 11 articles published in the 2023-2024 range obtained various findings related to the application of the Project Based Learning (PjBL) model in science learning in elementary schools. The results of the SLR can be seen in the following table.

Table 1. Mapping Based on Research Result Categories

Researcher Name	Categories of Research Results
Tria Nency, 2023	Science learning outcomes & Student learning activity
Mirva Faudati *et al*., 2024	Science Learning Outcomes & Student Creativity
Dewi, 2023	Science learning outcomes & Student learning activity
Pangestu, 2024	Science Learning Outcomes, Collaboration & Independence
Setiyadi *et al*., 2024	Science Process Skills & Effectiveness of the PjBL model
Atmojo, 2023	Science process skills

Suryanti *et al*., 2024	Science Literacy & Effectiveness of the PjBL model
Sugiartini, 2024	Science literacy
Zauni & Purwowidodo, 2024	Student Creativity, Collaboration & Independence
Apriansyah, 2024	Student creativity
Siti Fatimah, 2023	Shiva's learning activity

Table 1 shows that the science learning outcome category is a finding that is often researched. Some studies such as (Nency, 2023), (Andriani *et al*., 2023), (Faudati *et al*., 2024) and (Pangestu *et al*., 2024) have consistently shown an increase in students' average scores and learning completeness after the implementation of project-based learning (PjBL). Active involvement in project planning and implementation allows students to build a more meaningful understanding of science concepts.

In addition to the cognitive aspect, the findings in the student learning activity category show that PjBL is able to encourage students to actively discuss, collaborate, and present their projects. This indicates a change in learning from (Nency, 2023), (Andriani *et al*., 2023), and (Fatimah *et al*., 2024) The heterogeneity of findings across the analyzed studies appears to be influenced by variations in project duration, intensity of teacher facilitation, availability of learning resources, and the integration of STEM elements into the implementation of PjBL. Studies that employ longer project cycles and structured teacher mentoring tend to show more significant improvements in learning outcomes than those with shorter-term implementations. Furthermore, differences in classroom context, student characteristics, and school facilities can also contribute to variations in reported effectiveness. This suggests that the impact of PjBL is contextual, and its success depends heavily on the quality of its implementation, not simply on the model itself.

The aspect of student creativity is also an important finding in several studies. The Project Based Learning model provides space for students to develop ideas, produce products, and solve problems creatively through science project activities, (Faudati *et al*., 2024),(Apriansyah *et al*., 2024), and (Zuani dan Purwowidodo, 2024).

On the aspect of science process skills, research by (Setiyadi *et al*., 2024) and (Atmojo *et al*., 2023) shows that the PjBL model is effective in practicing the ability to observe, clarify, interpret data, and communicate learning outcomes. Although the number of research on this aspect is still limited, the friend shows the great potential of PjBL in supporting the characteristics of science learning.

Findings related to science literacy were examined by(Suryanti *et al*., 2024) and (Ni Nyoman Ayu Sugiartini et al., 2024). Which showed that PjBL helps students understand science concepts contextually and apply them in daily activities. Furthermore, aspects of student collaboration and independence in research finding by (Pangestu *et al*., 2024) and (Zuani and Purwowidodo, 2024). In addition, show that PjBL can contribute to the development of students' social skills and responsibility.

The effectiveness of the PjBL model when compared to conventional learning further strengthens the evidence that PjBL is a relevant and potential learning model to improve the quality of science learning in elementary schools (Setiyadi *et al*., 2024) and (Suryanti *et al*., 2024)

The grouping of research findings based on the research results in table 1 is presented visually in the following table.

Figure 1. Distribution Bar Diagram of Research Findings of PjBL Science Elementary School

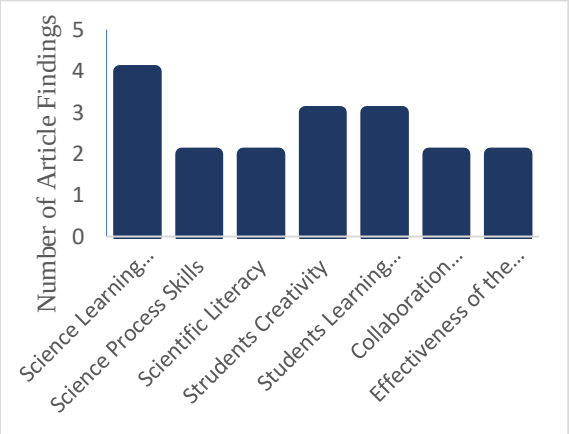


Figure 1 shows that the science learning outcome category has the highest number of findings, which is as many as four article findings. Furthermore, the categories of student creativity and student learning activity each have three article findings. Then, the categories of science process skills, science literacy, collaboration and independence as well as the effectiveness of the PjBL model were obtained in two articles each.

In qualitative content analysis and thematic synthesis, one unit of analysis (article) can be encoded as more than one aspect or category because the research findings are multidimensional and interrelated (Bohm & Sundqvist, 2025). The number of findings of each aspect can exceed the number of articles analyzed (N = 11). Thus, the number of aspects of each aspect describes the frequency of occurrence of aspects of research results, not the number of unique articles (Krippendrorff, 2018).

The distribution of research findings in the 2023-2024 period shows that the main focus of the Project Based Learning (PjBL) model in elementary school science learning is still dominated by the aspect of student learning, which can be seen from the highest number of findings in this category. However, limited attention has been paid to implementation fidelity. Most studies did not clearly report teacher training, adherence to PjBL phases, or variations in implementation, which may contribute to differences in reported outcomes. Therefore, clearer reporting of implementation fidelity is needed to better interpret the effectiveness of PjBL.

This indicates that the analysis of PjBL is still largely measured through cognitive achievement as an indicator of the success of science learning. On the other hand, findings of student creativity and learning activity also appear with relatively high frequency, confirming the role of PjBL in encouraging active engagement and 21st century skill development. Meanwhile, science process skills, science literacy, and student collaboration and independence were obtained in lower numbers, suggesting that these aspects have not been the main focus in most studies. Findings regarding the effectiveness of the PjBL model compared to conventional learning are also obtained in two articles, proving that PjBL has the potential as an effective learning model.

CONCLUSION

Based on the analysis of 11 research articles from 2023 to 2024, it can be concluded that the implementation of Project-Based Learning (PjBL) in science education for elementary schools has a positive impact on student learning processes and outcomes. The findings of the study show that the impact of PjBL is most significant on the aspect of science

learning outcomes, which is the main focus of most of the research. In addition, PjBL has also been proven to increase students' creativity and learning activity, which reflects the role of this model in encouraging students' active involvement during learning. Other impacts obtained from the results of the research, albeit in a more limited amount, are science process skills, science literacy, collaboration and student independence. Findings on the effectiveness of the PjBL model compared to conventional learning further suggest that PjBL is better. It is a relevant and promising learning model that can be applied in elementary school Science Education. Therefore, the application of the PjBL model is recommended not only to focus on the cognitive aspect, but also to optimize to help students develop their scientific skills and learning attitudes.

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