

Analysis of the Use of Project-Based Learning (PjBL) Models on Elementary School Students' Learning Outcomes in Spatial Construction Materials

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Abstract

The Project-Based Learning (PjBL) model is an innovative, student-centered learning model. In the practice of mathematics instruction in elementary schools, issues such as teacher-centered learning still persist, resulting in students having a limited understanding of the material presented and negatively impacting their learning outcomes. Therefore, the use of three-dimensional concrete media is necessary as a learning aid. This study aims to determine the effect of the 3D concrete media-based PjBL model on improving learning outcomes in 5th-grade elementary school geometry. The research method used was a Systematic Literature Review (SLR) by analyzing 27 relevant Sinta-indexed articles from the past 10 years using the PRISMA diagram. The results of the study indicate that the use of a 3D concrete media-based PjBL model has a positive effect on students' learning outcomes in elementary school mathematics. Thus, the 3D concrete media-based PjBL model can be used as an alternative concrete learning medium to improve students' learning outcomes.

Keywords: Geometric Shapes, Learning Outcomes, Mathematics, PjBL, Elementary School

Abstrak

Model pembelajaran Project Based Learning (PjBL) merupakan model pembelajaran yang inovatif dengan berpusat kepada peserta didik. Dalam praktik pembelajaran matematika di sekolah dasar, masih di temukan masalah seperti pembelajaran yang berpusat kepada guru, sehingga siswa menjadi kurang paham terhadap materi yang dijelaskan dan berpengaruh terhadap hasil belajar mereka. Karena itu diperlukan penggunaan media konkret 3 Dimensi sebagai alat bantu pembelajaran. Penelitian ini bertujuan untuk mengetahui pengaruh model PjBL berbasis media konkret 3 Dimensi dalam meningkatkan hasil belajar bangun ruang matematika kelas V sekolah dasar. Metode penelitian yang digunakan adalah Systematic Literature Review (SLR) dengan menelaah 27 artikel relevan terindeks sinta selama 10 tahun terakhir melalui diagram PRISMA. Hasil penelitian menunjukkan bahwa penggunaan model PjBL berbasis media konkret 3D berpengaruh positif terhadap hasil belajar siswa dalam pembelajaran matematika sekolah dasar. Dengan demikian model PjBL berbasis media konkret 3D dapat digunakan sebagai alternatif media pembelajaran konkret untuk meningkatkan hasil belajar siswa.

Kata kunci: Bangun Ruang, Hasil Belajar, Matematika, PjBL, Sekolah Dasar



INTRODUCTION

Mathematics is a field of study found in schools and everyday life. Mathematics is one of the most important subjects because it challenges a person's ability to think through solving real-life problems and presents them in mathematical models. This means that mathematics is an integral part of life, as it has evolved as a human activity that shapes human thinking (Dewi et al., 2020). Mathematics is also a very important subject for children, as it helps students solve problems encountered in daily life and serves as a tool for logical and clear thinking (Khotimah & As'ad, 2024). However, students often perceive mathematics as a difficult and intimidating subject. Consequently, student motivation in mathematics learning suffers. This, of course, will affect students' learning outcomes.

Learning outcomes are the observable abilities acquired by each student through the learning process, consisting of knowledge, intellectual skills, motor skills, and attitudes (Sri Hardianti Sartika, Dadang Dahlan, 2018). The higher the learning outcomes achieved by students at school, the more it indicates that the teaching and learning activities have been effective. Learning outcomes are the results of an individual's learning that enable them to interact actively and positively with their environment. According to Bloom's Taxonomy, these learning outcomes can be achieved through three domains: the cognitive, affective, and psychomotor domains (Nurita, 2019). Thus, these learning outcomes represent the abilities students possess after participating in the learning process, encompassing cognitive, affective, and psychomotor skills. The success of an individual's learning process is influenced by several factors. Identifying these factors, which significantly impact learning success, is crucial to helping students achieve the best possible learning outcomes.

Student learning outcomes can be influenced by two factors: internal and external factors (Dewi et al., 2020). Internal factors in student learning outcomes originate from within the student themselves. These include motivation, emotional intelligence, self-confidence, independence, attitude, and many others. Meanwhile, external factors originate from outside the student and include the teacher, the teaching methods used, the learning environment, the curriculum, and the facilities and infrastructure utilized in the learning process. Other factors that can influence student learning outcomes vary widely, including individual student factors, teacher factors, media, tools, and instructional models. For a teacher, facing various problems is a challenge in itself, and teachers have a duty to seek and find appropriate solutions to address them. These factors can influence or contribute to low student learning outcomes in school (Kurniawan et al., 2023).

This is consistent with research conducted by Widiawati & Kristin (2025) at SD Negeri Tingkir Lor 02 among fifth-grade students, which showed that, based on observational findings, teachers still employ a teacher-centered learning process; consequently, students are unable to pay close and effective attention, and they become passive in the learning process. This issue also inevitably impacts student learning outcomes, as evidenced by the persistently low mid-semester test scores in mathematics. From these observations, it is evident that the low learning outcomes stem from the limited variety of instructional models and methods used, which in turn lead to students being less active in the learning process. Based on these root causes, a solution is needed to improve student learning outcomes. This solution involves changing the learning model used by teachers, shifting from a teacher-centered approach to a student-centered one. Additionally, the limited use of learning media can be leveraged to enhance students' understanding and improve their learning outcomes. Student learning outcomes are influenced by the methods and media used in the learning process, as these outcomes serve as a measure of the effectiveness of the learning assessment that has been conducted (Lubis & Nuriadin, 2022).

The learning method is designed so that students are actively involved in solving various problems. This encourages each student to develop the ability to identify problems and provides opportunities to explore them. By giving students the opportunity to propose a wide variety of alternative solutions through the presentation of discoveries, ideas, and opinions used to resolve various problems, this approach creates space for more students to express themselves during learning activities (Firman et al., 2022). To ensure students can effectively receive and understand the material presented by the teacher, it is essential to employ a learning model that fosters student engagement, imagination, creativity, and enjoyment throughout the learning process. One learning model capable of addressing the issues mentioned above is the use of the Project-Based Learning (PjBL) model. Project-Based Learning, commonly referred to as PjBL, is a learning model that uses projects or activities as the core of learning; students engage in exploration, evaluation, interpretation, and synthesis of information to produce various forms of learning outcomes (Rani et al., 2021).

In Project-Based Learning, students learn through real-world problem-solving situations, which can foster lasting knowledge and organize learning projects. The Project-Based Learning model encourages students to become more active, independent, and creative in solving problems. In the context of PjBL, collaborative tasks provide a platform for students to engage in meaningful communication, negotiate meaning, and provide mutual support within their Zone of Proximal Development (ZPD), thereby promoting deeper language learning and cognitive development (Hsu, 2025). Therefore, the project-based learning model can foster students' character traits, particularly creativity and curiosity (Rani et al., 2021). Learning activities must be designed to challenge students in problem-solving and provide them with opportunities to explore their informal knowledge in response to contextual situations as mathematicians (Fajri et al., 2025). Thus, the implementation of the Project-Based Learning model serves as an approach to problem-solving, incorporating various strategies used to address challenges.

Although the Project-Based Learning (PjBL) model has been widely used in previous studies, most of these studies have focused on enhancing creativity and student engagement in the learning process, as this model encourages students to actively ask questions, investigate, explain, and engage with problems (Siti Dwi Amriani et al., 2024). Consequently, prior research has tended to utilize effective learning media in the learning process, indicating that such studies primarily focused on examining the effectiveness of the PjBL model without incorporating the use of concrete 3D-based media in spatial geometry instruction. Furthermore, this study specifically emphasizes analyzing the impact of implementing the PjBL model using 3D concrete media on student learning outcomes in the limited scope of three-dimensional geometry. In previous studies, students were generally only positioned as users of media provided by teachers, whereas in this study, students are directly involved in the process of creating the 3D concrete media. It is this involvement that is expected to provide students with a more meaningful learning experience because students not only understand concepts theoretically but are also able to construct three-dimensional shapes in reality.

Therefore, research is needed to examine how the implementation of a 3D concrete media-based Project-Based Learning model can improve student learning outcomes in solid geometry at the elementary school level. Of course, teachers need to use problem-solving strategies tailored to the specific situations and conditions of the problems presented. To maximize student learning outcomes, the implementation of a Project-Based Learning model using learning media is necessary. Learning media can be used to maximize the implementation of the concrete media-based Project-Based Learning model. Concrete media are learning media derived from real objects commonly found in the surrounding environment, as well as media in the form of actual objects

related to the subject matter being studied, which are used to convey messages to students (Mahmudi Ali, 2023).

The use of concrete media can provide students with hands-on experiences. Consequently, learning becomes more engaging because it optimally utilizes the students' surrounding environment as a learning medium (Narayani, 2019). The use of learning media in teaching three-dimensional shapes is considered highly appropriate. Three-dimensional shapes refer to a category of figures that are three-dimensional or have space bounded by their sides. Solid figures are three-dimensional shapes that have space, volume, and sides that bound them (Pangestu & Ruqoyyah, 2023). Therefore, it is highly appropriate to apply Project-Based Learning (PBL) using concrete learning materials when teaching solid figures in mathematics.

The novelty of this study lies in the integration of the Project-Based Learning (PjBL) model with the use of 3D concrete media created independently by students in the study of three-dimensional shapes in elementary school. This study emphasizes not only the use of project-based learning but also the process of constructing concrete media as part of students' learning activities. Thus, it differs from previous research conducted by (Padji et al., 2024), which employed an observational approach and utilized pre-prepared media. In contrast, this study provides students with the opportunity to design, create, and present these spatial geometry models directly. Through these activities, students are able to gain active, contextual, and meaningful learning experiences. The hope is that this will improve students' understanding of spatial concepts, creativity, and learning outcomes. Therefore, this study presents an innovation in mathematics learning that combines project-based activities, 3D concrete media, and actively involves students in the learning process.

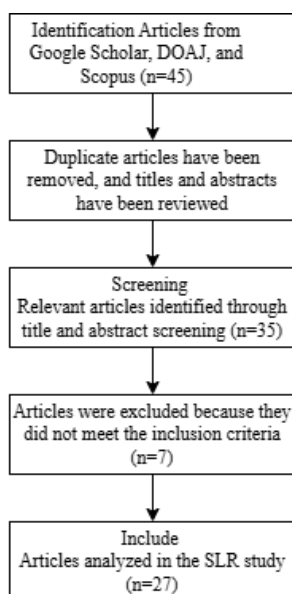
This study is necessary because elementary school students' learning outcomes in mathematics, particularly regarding three-dimensional shapes, are still relatively low. Students often find three-dimensional shapes difficult because they are abstract and require strong visualization skills. Meanwhile, the current teaching approach remains largely traditional, and the use of models and methods that are insufficiently effective prevents students from gaining a deep understanding of the concepts. Therefore, there is a need for innovative teaching models that can provide students with concrete learning experiences. Thus, the urgency of this research lies in the need for teachers to apply models and methods, as well as additional mathematics learning media that are effective, engaging, and appropriate for the characteristics of elementary school-aged students. The implementation of project-based learning (PjBL) using 3D concrete media can serve as a relevant solution because it helps students understand spatial concepts by providing them with opportunities for direct experience through meaningful project activities. Consequently, the results of this study are expected to serve as a reference for teachers in developing innovative mathematics learning processes and to form the basis for future research on the application of PjBL using concrete media to improve student learning outcomes.

METHOD

This study employs a Systematic Literature Review (SLR) approach to comprehensively examine the impact of the Project-Based Learning model on student learning outcomes in the subject of three-dimensional shapes. This literature review process follows the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure that the review is conducted systematically, transparently, replicably, and scientifically valid (Irvansyah et al., 2025). The literature search was conducted through three primary databases: Google Scholar, DOAJ, and Scopus. Based on this identification process, 40 articles were identified; these articles were then screened by removing duplicates and reviewing the titles and abstracts. After the selection, there were 30 relevant articles, and those meeting the criteria were further

analyzed through a feasibility stage until relevant articles were obtained to serve as sources for this study. Consequently, the data used consisted of 27 relevant articles based on the content of the discussion.

The keywords used include: project-based learning, three-dimensional shapes, mathematics, concrete materials, and learning outcomes. The inclusion criteria for selecting journal articles are as follows: (a) Articles written in English or Indonesian and published between 2020 and 2025; (b) Articles discussing the impact of protectionist policies on international trade flows, both at the macro and micro levels; (c) Articles that have undergone a peer-review process and are indexed in academic databases, whether in the form of relevant empirical or conceptual studies. This study employs data analysis using a content analysis approach, which involves systematically reviewing the content of each journal article to gain a deep understanding of the influence of the Project-Based Learning model on student learning outcomes in solid geometry.



RESULT AND DISCUSSION

To answer the research question namely, the effect of the Project-Based Learning (PjBL) model on elementary school students' learning outcomes in the topic of three dimensional shapes please refer to the following table

Table 1. Relevant Research

Number	Year and Author	Title	Research Content
1.	(Prastiyo et al., 2023)	Improving Mathematics Learning Outcomes Through the Project-Based Learning (PBL) Model in the Topic of Net Diagrams of Three-Dimensional Shapes for Fifth-Grade Students at SDN 6 Wirosari	Based on the research findings, it can be concluded that the implementation of the Project-Based Learning model, supported by 3D net models, can improve learning outcomes in mathematics for the topic of nets of three-dimensional shapes in the second semester of fifth grade. This is evidenced by the average score in Cycle 1, which reached 74, and in Cycle II, which

			reached 84, with a minimum passing score of 75.
2.	(Hidayati et al., 2025)	The Implementation of the Project-Based Learning (PjBL) Model Using Concrete Materials to Improve Motivation and Learning Outcomes in Mathematics (Solid Shapes) Among Fifth-Grade Students	Based on the research discussion, it can be concluded that the implementation of the Project-Based Learning (PjBL) model using concrete materials is carried out through six main steps. The implementation of this model has proven effective in increasing students' motivation to learn, as evidenced by the results of observations in each cycle, which showed improvement, as well as in enhancing learning outcomes.
3.	(Rokhmah & Aini, 2025)	The Effect of Implementing a Project-Based Learning Model in Mathematics on the Learning Outcomes of Fifth-Grade Students at SDN Kedensari 1	The implementation of the project-based learning (PjBL) model significantly improved student learning outcomes in the topic of three-dimensional shapes in the fifth grade at SDN Kedensari 1. This model not only encourages active student engagement but also deepens students' understanding of mathematical concepts.
4.	(Astria Ayu Ramadanti, 2021)	The Effectiveness of the Project-Based Learning Model on Mathematics Learning Outcomes in Elementary School	The Project-Based Learning model is effective in improving elementary school students' mathematics achievement. Student achievement ranged from a low of 11.30% to a high of 37.48%, with an average of 24.72%.
5.	(Fatimah et al., 2023)	The Effect of the Project-Based Learning (PjBL) Model on Mathematics Learning Outcomes	The learning outcomes of the experimental class, which used the project-based learning (PjBL) model, were better than those of the control class, which did not implement the project-based learning model. This indicates that the implementation of the project-based learning model had an impact on the mathematics learning outcomes of fifth-grade students at SDN 19 Cakranegara in Mataram City during the 2022/2023 school year.
6.	(Azizah & Wardani, 2021)	Efforts to Improve Mathematics Learning Outcomes Through a Project-Based Learning Model for Fifth-Grade	Based on the results of the research and discussion conducted on improving mathematics learning outcomes through the implementation of the Project-Based Learning model, it can be concluded that the Project-Based Learning

		Elementary School Students	model used in the learning process can improve students' learning outcomes in the cognitive and psychomotor domains.
7.	(Erviana & Mahmudah, 2023)	Analysis of the Implementation of Project-Based Learning to Improve Mathematics Learning Outcomes in Elementary Madrasahs in Palangkaraya City	The students' learning outcomes following the implementation of this project-based learning model were demonstrated by their grades after the evaluation, which were highly satisfactory.

Based on the results of an analysis of several previous research articles, it can be concluded that the use of the Project-Based Learning (PjBL) model in mathematics instruction—particularly regarding three-dimensional shapes in elementary school has a positive impact on student learning outcomes. The implementation of the PjBL model creates a learning environment that is more active, meaningful, and student-centered, thereby making it easier for students to understand abstract mathematical concepts. This aligns with the research conducted by (Prastiyo et al., 2023), which demonstrated that the implementation of the PjBL model, supported by 3D mesh teaching media, was effective in capturing students' attention and improving their mathematics learning outcomes, particularly among fifth-grade students at SDN 6 Wirosari. This improvement is evident from the average student scores, which rose from 74 to 84, and the learning achievement rate, which increased from 61% to 86%. This indicates that the use of concrete media helps students understand the concepts of three-dimensional nets in a more tangible and in-depth manner.

This is consistent with research (Hidayati et al., 2025) stating that the implementation of the PjBL model using concrete media is capable of increasing students' motivation to learn, which consequently influences their learning outcomes, particularly regarding 5th-grade elementary school solid geometry material. The improvement in learning outcomes occurs because the learning process conducted by teachers involves several stages, such as project design, planning work steps, project implementation, presenting results, and evaluating the project. Through these stages, it is hoped that students will become more active and can be directly involved in the learning process. Additionally, it is expected that using the PjBL model will enhance students' self-confidence in expressing their opinions and collaborating in groups.

The implementation of the Project-Based Learning model has clearly had a significant impact on student learning outcomes, as demonstrated by a study conducted by (Rokhmah & Aini, 2025) on fifth-grade students at SDN Kedensari 1. In this study, all students showed significant improvement without any decline in learning outcomes. This clearly indicates that the implementation of the PjBL learning model in the mathematics spatial geometry curriculum not only enhances conceptual understanding but also increases student participation, thereby making it easier for students to grasp abstract mathematical concepts.

This engagement certainly keeps students active throughout the learning process. This is further supported by (Astria Ayu Ramadanti, 2021) research conducted by which states that the implementation of the PjBL model in the learning process can be an effective way to improve mathematics learning outcomes. This is evidenced by an average increase in learning outcomes of 24.72%. The percentage of student learning outcomes, ranging from 11.30% to 37.48%, demonstrates that the consistent

implementation of PjBL has a positive impact on student learning outcomes in elementary school.

Prospective educators should be aware that the use of the Project-Based Learning (PjBL) model leads to improved learning outcomes. This is consistent with research conducted by (Fatimah et al., 2023) which showed that students who used the PjBL model achieved better learning outcomes compared to those who did not. This is consistent with the hypothesis test, which showed that the calculated t-value was greater than or equal to the critical t-value ($2.353 \geq 1.671$) at a 5% significance level. Therefore, it can be concluded that the implementation of the Project-Based Learning model has a positive impact on the mathematics learning outcomes of fifth-grade students at SDN 19 Cakranegara in Mataram City.

This indicates that project-based learning is more effective when applied to classroom instruction than teacher-centered learning, as the PjBL model directly engages students in the learning process. Improvements in student learning outcomes using the Project-Based Learning model were found not only in the cognitive domain but also in the psychomotor domain. This aligns with research conducted by (Azizah & Wardani, 2021) which found that all learning achievement indicators were met effectively following the implementation of the PjBL model in the learning process.

In addition, research conducted by (Erwana & Mahmudah, 2023) indicates that implementing this project-based learning model can effectively improve student learning outcomes, particularly in mathematics at elementary schools in Palangkaraya City. In this study, students became more active and engaged in the learning process, so none of them felt bored during class because they were able to participate directly in the learning process.

Based on the overall results of this study, it can be concluded that the use of the Project-Based Learning (PjBL) model can be considered highly effective for application in the mathematics learning process, particularly regarding three-dimensional shapes in elementary school. The implementation of this learning model has a positive impact on improving student learning outcomes, as in this project-based learning, students are able to gain direct learning experiences through project activities and the use of concrete materials. The use of these 3-dimensional concrete media helps students understand mathematical concepts particularly abstract geometric shapes by making them tangible and easier to grasp. Additionally, the implementation of the PjBL model enhances students' motivation, creativity, and critical thinking skills, as well as fosters collaboration and active engagement among peers during the learning process. Consequently, learning becomes more enjoyable and meaningful.

CONCLUSION

It was concluded that the use of the Project-Based Learning (PjBL) model with 3D concrete media is effective in influencing students' learning outcomes in elementary school mathematics spatial geometry. The implementation of this model makes students more active and creative, enhances their critical thinking skills, and fosters a spirit of cooperation and responsibility. This, in turn, helps students better understand abstract spatial geometry concepts, making them more tangible and meaningful. The implications of this study indicate that the 3D concrete media-based PjBL model can serve as an alternative approach for teachers to employ in innovative learning processes at the elementary school level. Therefore, teachers are encouraged to effectively utilize and implement this Project-Based Learning model optimally, supported by adequate learning resources. However, this study certainly has limitations because it only used a Systematic Literature Review (SLR) approach based on previous research articles; thus, future research is expected to conduct direct field studies with a broader scope of material and subjects.

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