

THE EFFECTIVENESS OF PROJECT-BASED LEARNING MODELS THROUGH A SCIENTIFIC APPROACH ON STUDENT LEARNING OUTCOMES

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Abstract

This study aims to examine the effectiveness of the PJBL model with a scientific approach that influences student learning outcomes. The method used in this study is a literature study by collecting and analyzing various previous research sources related to the implementation of PjBL in elementary schools. This literature study focuses on how PjBL can develop students' cognitive, affective, psychomotor, and social-emotional skills. The results of the study show that PjBL through a scientific approach can increase students' interest, motivation, and learning outcomes. This model encourages students to collaborate, think critically, and actively engage in real projects that are relevant to everyday life. However, there are several challenges in its implementation. The success of this model requires support from good time management, teacher guidance, and adequate facilities.

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A. INTRODUCTION

The provision of high-quality and contextually relevant educational experiences is of paramount significance in equipping students with the necessary skills and knowledge to effectively confront and navigate the myriad challenges that exist in the real world, particularly during the formative years of elementary education. A pedagogical approach that has gained considerable traction and is increasingly being adopted in contemporary educational settings is known as Project Based Learning (PBL), which facilitates a dynamic learning environment whereby students engage in practical, hands-on experiences through the completion of projects that are intrinsically linked to their everyday lives and experiences. Through the integration of scientific methodologies within this instructional framework, not only is there an enhancement in students' comprehension of the subject matter, but this model also serves to cultivate and refine their critical thinking and creative problem-solving abilities, which are essential competencies in today's complex society. An array of prior empirical studies has demonstrated that the implementation of Project Based Learning (PBL) has a statistically significant positive impact on increasing student motivation levels, as well as enhancing their capacity to tackle and resolve intricate and multifaceted problems (Fitri et al., 2018; Sukmasari & Rosana, 2017).

The implementation of the Project Based Learning (PJBL) pedagogical framework is accompanied by a plethora of advantages that can significantly enhance the educational experience; however, it is equally important to recognize that there exist numerous challenges associated with its practical application, which frequently serve as formidable barriers to successful integration into the curriculum. Among the most

prevalent challenges encountered by educators are the insufficiency of available resources, the constraints imposed by limited instructional time, and the complexities involved in effectively assessing the resultant learning outcomes of students. Empirical studies indicate that transforming the role of educators from traditional instructors to facilitators of learning necessitates substantial modifications in their teaching practices and pedagogical strategies (Gunawan et al., 2017; Jumaheni et al., 2021).

Consequently, it becomes imperative to engage in a thorough investigation of the efficacy of scientifically grounded Project Based Learning (PJBL) methodologies on the academic performance of students, with a particular emphasis on the enhancement of their understanding of course material as well as the development of higher-order thinking skills.

This comprehensive study is meticulously designed with the primary objective of identifying and elucidating the myriad challenges and obstacles that educators encounter when attempting to implement the Project Based Learning (PJBL) model effectively within their instructional practices, while concurrently seeking viable solutions that can significantly optimize the execution and efficacy of this pedagogical approach. Among the numerous issues that frequently surface are limited infrastructure resources, the inherent difficulties in meticulously designing projects that align seamlessly with the established curriculum standards, and a pervasive lack of adequate training and professional development opportunities for teachers, all of which have been highlighted in previous literature (Ismail, 2018; Lutfi et al., 2017). By thoroughly understanding and analyzing the existing challenges that hinder the successful application of PJBL, it is fervently hoped that we can develop and propose appropriate and effective strategies that will not only assist educators but also enhance the overall implementation of the Project Based Learning model within the classroom setting. Ultimately, such advancements in pedagogical practices are anticipated to foster a more engaging and enriching learning environment for students, thereby promoting deeper understanding and retention of knowledge through active and experiential learning methodologies.

Through this investigation, it is anticipated that it will yield substantial contributions to the advancement of pedagogical methodologies and the enhancement of the comprehensive educational outcomes for learners. By examining the efficacy of scientifically-informed Problem-Based Learning (PBL) and discerning the challenges encountered by educators, this inquiry seeks to develop strategies that may augment the quality of education at the elementary level. The findings of this research are projected to be beneficial not only for the evolution of educational theories but also to furnish educators with insights for the implementation of innovative and efficacious instructional models.

B. RESEARCH METHOD

This particular research endeavor employs a comprehensive literature review methodology in order to meticulously analyze the efficacy of the implementation of the Project-Based Learning (PBL) framework, particularly when integrated with a scientific

approach, aimed at enhancing the educational outcomes of students. The selection of a literature review as the primary methodological tool is particularly justified due to its capacity to facilitate extensive data aggregation from a multitude of prior research endeavors, which in turn produces a more expansive and nuanced understanding of the subject matter under investigation.

Engaging in literature studies within the context of scientific inquiry constitutes a pivotal component of the overarching research strategy. According to the insights provided by Cooper as cited in (Permadin & Herdi, 2021), literature studies serve multiple significant purposes, the first of which involves aiding in the establishment of connections between contemporary research initiatives and those that have been conducted previously, thereby fostering an academic dialogue across time. Moreover, literature reviews offer invaluable information to readers regarding the outcomes of research that are pertinent to the specific topic being examined, thereby enriching the contextual framework for subsequent analysis. Furthermore, a thorough literature review is instrumental in pinpointing existing gaps or deficiencies in earlier studies, which empowers researchers to contribute original insights and advancements within their respective fields of inquiry.

C. RESULTS AND DISCUSSION

Project-Based Learning (PBL) Model

A learning model is a framework of several applications of an approach, procedure, strategy, method, and learning technique that begins with planning and ends with learning. A learning model is a plan or pattern that can be used to form a learning plan so that learning and teaching activities can take place more effectively. There are various learning models, one of which is the project-based learning model, also known as PBL.

Project-based learning is a learning method that involves students in project work that produces a product or project to achieve affective, cognitive, and psychomotor competencies by involving technology and real-life problems, thereby making students more creative and motivated to study harder.

The Project-Based Learning model has advantages that are very important and beneficial for students. However, the Project Based Learning model is rarely used by teachers because, in practice, it requires considerable preparation and takes a long time to implement. This model also aims to guide students in a collaborative project that integrates various subjects (materials) from the curriculum, providing opportunities for students to explore the material using various methods that are meaningful to them and to conduct collaborative experiments.

The principle of the PJBL (Project Based Learning) learning model is learning that emphasizes that learning must be student-centered because this learning model uses problems that may be encountered in real life with predetermined themes and topics. followed by experiments or research to produce real products in accordance with the abilities of the students, so that students can solve problems with appropriate concepts, principles, and knowledge, making it more meaningful.

The Scientific Approach in Learning

The scientific approach comes from the words approach and scientific. Approach means an idea or concept used to achieve a goal. Meanwhile, scientific means something that can be repeated openly by anyone, anywhere, and anytime. Therefore, the scientific approach is an idea to achieve goals that can be implemented by anyone, anywhere, and anytime. There are also definitions of the scientific approach according to experts, namely:

1. Ministry of Education and Culture

The scientific approach is a learning model that begins with collecting data through observation, conducting experiments, asking questions, processing information or data, and communicating it in the process of applying scientific principles.

2. Rusman (2015)

The scientific approach is a learning model that provides space for students to explore and elaborate on the material being studied. In addition, this educational model also provides opportunities for students to hone their skills through learning activities designed by educators.

3. Hosnan (2014)

The scientific approach is a learning process designed so that students actively construct concepts, laws, or principles by observing, formulating problems, proposing hypotheses, collecting data using various techniques, analyzing data, drawing conclusions, and voicing them.

4. Karar and Yenice (2012)

The scientific approach is a learning process designed in such a way that learners can actively construct concepts through the steps of observing, formulating problems, making hypotheses, collecting data using several techniques, analyzing data, drawing conclusions, and presenting the concepts that have been discovered.

The scientific approach can be implemented by every teacher in all subjects to achieve learning objectives. The implementation of the scientific approach does not only focus on how to develop students' competence in conducting observations or experiments, but also how to develop students' knowledge and thinking skills so that they can support creative activities in innovation or work. Therefore, the implementation of the scientific approach in learning is centered on students so that they actively construct their knowledge through a series of scientific activities.

The implementation of the scientific approach in learning begins with the preliminary stage, followed by the core activities, and ending with the closing stage. The preliminary activities are aimed at strengthening students' understanding of the objectives and importance of the material to be delivered, thereby generating a high level of curiosity. This curiosity is a major asset in the next stage of learning, namely the core activities.

The core activity, which is a learning experience for students, is the time most used for learning with a scientific approach. In the learning implementation plan, an educator designs systematic learning activities in accordance with scientific steps. Student activities are directed at constructing concepts, knowledge, understanding, and skills with the help of educators through observing, questioning, gathering information, reasoning/associating, and communicating to help develop thinking skills and curiosity in students.

1. Observing is an activity of identifying an object through the senses, through sight (reading, listening), smell, hearing, taste, and touch when observing an object with or without the use of tools so that students can identify a problem.
2. Questioning is the activity of expressing something that one wants to know, whether it is related to an object, an event, or a particular process. Questions can be asked orally or in writing and can be in the form of questions or hypotheses so that students can formulate problems and hypotheses. These questions should be related to why and how, requiring answers through experimentation.
3. Collecting data is the activity of seeking information as material for analysis and conclusion. This activity can be done by reading books, field observations, trials, interviews, distributing questionnaires, and so on, so that students can test the hypotheses they have made previously.
4. Associating is processing data in a series of physical and mental activities with the help of certain tools. Data processing can be in the form of tables, graphs, charts, concept maps, calculations, and modeling. Next, students analyze the data to compare or determine the relationship between the data they have processed and the existing data so that conclusions can be drawn.
5. Communicating is an activity in which students describe and convey their findings from observing, questioning, collecting and processing data, and associating, to others either verbally or in writing in the form of diagrams, charts, pictures, and the like with the help of simple technological devices and/or information and communication technology.

The five steps in the scientific approach can be carried out sequentially or non-sequentially, especially in the first and second steps. Meanwhile, the third step and so on should be carried out sequentially. These scientific steps are applied to provide more space for students to build independent learning and optimize their intellectual potential. Students are asked to build their own knowledge, understanding, and skills from the learning process, while educators guide and provide reinforcement and enrichment of what students are learning. Through a learning model that is relevant to the scientific approach, the output (students) will have good intellectual abilities and character.

Implementation of PJBL Through a Scientific Approach

The scientific approach is an approach that encourages students to be active in the learning process. As mentioned earlier, in this approach, students are encouraged to

go through five main steps, namely: observing, questioning, gathering information/data, associating/analyzing, and communicating. These five scientific steps enable students to build their skills and creativity in the learning process.

To encourage student activity in the learning process, a learning model that suits the characteristics of students with a scientific approach is needed. One model that can be applied to achieve this is the project-based learning (PBL) model.

The following are the steps and strategies for implementing PJBL with a scientific approach in:

1. Fundamental Questions

Educators can present topics and ask questions about how to solve problems. Social studies topics or materials that can be used include ways to overcome environmental problems. At this stage, the scientific approach is for students to listen to and observe the information provided by the educator, after which they are invited to ask fundamental questions about what should be done regarding the topic/problem solving.

2. Designing product planning

At this stage, educators ensure that each student in the group selects and understands the procedures for creating the project/product to be produced. The scientific approach is for students to collect information from various sources and develop hypotheses or estimates of the results of the project to be carried out.

3. Preparing a Production Schedule

At this stage, educators and students agree on a project schedule (stages and collection). The scientific approach that can be applied is for students to collect data/information in a more scheduled and systematic manner.

4. Monitoring project activity and progress

The role of the educator is to monitor student activity during the project, monitor progress, and provide guidance if students encounter difficulties. At this stage, students can apply process learning by associating or processing data, then analyzing whether the data is appropriate so that conclusions can be drawn.

5. Testing the results

Educators assess students, their projects, their activity, their involvement in the creation, and measure the achievement of standards. At this stage, students need to communicate by discussing the feasibility of the projects they have created and produce product/work reports to be presented to others.

The Application of the PJBL Model through a Scientific Approach Affects Student Learning Outcomes in Elementary Schools

A learning model is a structure for applying various approaches, procedures, strategies, methods, and learning techniques that are designed from the planning stage to the implementation of learning activities (Asyafah, 2019:22). In addition, a learning model can also be understood as a pattern or design used to develop a learning plan

so that the teaching and learning process can take place optimally (Khoerunnisa & Aqwal, 2020:27). One type of learning model that is well known is Project-Based Learning (PJBL).

According to Isriani Hardini and Dewi Puspitasari (2012:122), Project-Based Learning (PBL) is a learning model that provides opportunities for educators to organize the learning process in the classroom by involving students in project activities. Meanwhile, Warsono and Hariyanto (2012:152) explain that PJBL is a teaching method that connects the use of technology with everyday problems that are familiar to students or projects carried out at school. According to Umi Faizah (2015:29), PJBL is a learning strategy that encourages students to gain new knowledge and understanding through project activities.

From these opinions, it can be concluded that Project Based Learning (PBL) is a learning method that involves students in project activities to produce a product or work. This model aims to develop students' affective, cognitive, and psychomotor competencies by connecting technology and real problems in everyday life. This approach encourages students to be more creative and motivated to learn more actively.

The Project-Based Learning (PBL) model has many advantages that are very beneficial for students. However, this model is rarely implemented by teachers because it requires careful preparation and a considerable amount of time to implement. According to Mulyasa (2014:145), PJBL is a learning model that focuses on solving complex problems through an investigative process. This model is also designed to help students carry out collaborative projects that combine various subjects in the curriculum. In addition, PJBL provides opportunities for students to explore learning materials in a meaningful way and conduct experiments together.

The principle of the PJBL (Project Based Learning) learning model is that learning must be student-centered because this learning model uses problems that may be encountered in real life. Themes and topics are predetermined, then experiments or research are conducted to produce real products that are in line with the students' abilities. This aims to enable students to solve problems using the right concepts, thereby making learning more meaningful.

The main principle in the Project Based Learning (PBL) model is learner-centered learning. This model utilizes problems relevant to real life as the basis for learning, with predetermined themes and topics. Students then conduct experiments or research to produce real products according to their abilities. The goal is for students to be able to solve problems by applying the appropriate concepts, principles, and knowledge so that the learning process becomes more meaningful.

Challenges and Obstacles Faced by Educators in Implementing the PJBL Learning Model with a Scientific Approach

Project-based learning, as a learning model that encourages students to be active, certainly has challenges and obstacles in its implementation. These obstacles do not only come from students, but teachers as facilitators also face obstacles in

implementing it. A common obstacle faced by teachers is insufficient time in the learning process. Because this project-based model requires students to produce a product, its implementation requires a considerable amount of time. In this process, the role of the teacher as a facilitator is also very much needed in managing and supervising the class so that learning can run effectively.

Another obstacle in the implementation of the project-based learning model is the lack of student activity in working on a project. Students, with their diversity, have different learning styles with varying levels of understanding. Therefore, not all students can be actively involved in the learning process, which has an impact on the implementation of the learning model that cannot run optimally. This is in line with the explanation provided by Mislinawati and Nurmasyitah (2018), who stated that it is difficult to direct students to be actively involved in the learning process. Students who are less intelligent tend to be passive in the discussion process, i.e., they are more silent and listen. Teachers are less able to work around time constraints, so that classroom management and supervision are not optimal.

A similar opinion is mentioned by Cintang (2018), who states that the obstacles or barriers faced by teachers in implementing the Project-Based Learning (PjBL) model are in terms of time management, technical difficulties in implementing projects because students are not disciplined in following the established work procedures, projects are not optimal, especially for projects that produce tangible products, and disparities in student abilities that result in inequality among students.

From the above obstacles, there are solutions that can be implemented to overcome them, such as: (1) adjusting the time according to the duration of the project or assigning students to work on the project at home, (2) for student involvement, teachers need to supervise, remind, and motivate students.

Mislinawati and Nurmasyitah (2018) and Nyai Cintang (2018) highlight the importance of time management and teacher supervision in overcoming obstacles to project implementation in the classroom. To overcome time constraints, teachers can adjust the duration of the project to the time available, divide the time into each phase of the project, or even combine several lessons. In addition, effective supervision of student activities during the project process is very important to ensure that all students are actively involved. To overcome student discipline problems, teachers need to act as supervisors and divide students into heterogeneous groups so that they can complement each other.

Furthermore, based on the results of previous studies, there are obstacles faced by teachers in applying the scientific approach, namely: 1) at the observation stage, many students did not listen to the teacher's instructions; some of them were quiet, lacked focus, or even talked to their friends instead of observing the objects provided by the teacher. 2) at the questioning stage, teachers experienced difficulties because students were still not active in asking questions. This may be due to students' lack of curiosity about the material provided by the teacher. In addition, when the teacher gives students the opportunity to ask questions, they become confused about what to ask, so the teacher's guidance is very much needed. 3) In the information gathering

stage, the difficulty faced by teachers is that the source of information that elementary school students trust comes only from the teacher. 4) In the association or reasoning stage, the problem faced by teachers is that students lack/are not yet capable of thinking critically about something, so students really need guidance from teachers. 5) In the communication stage, the problems faced by teachers are mostly related to students' lack of ability to speak in front of their friends. Students tend to be shy and afraid of making mistakes in what they say. This occurs because of a lack of refinement in students' speaking skills.

Based on the above description, there are efforts or solutions that can be taken to overcome these obstacles according to Malikah (2017:46) in the form of: 1) In order for students to be more active in observing, teachers need to create a fun learning atmosphere that stimulates curiosity. Teachers must also provide opportunities for students to analyze their observations and share them with their friends. 2) To encourage students to ask questions, teachers need to apply appropriate learning strategies. These strategies aim to increase students' motivation to learn so that they dare to ask questions, express their opinions, and understand the material better. 3) One of the obstacles at this stage is the limited learning facilities and resources. To overcome this, there needs to be cooperation between schools and the government to meet the needs for facilities and infrastructure. In addition, teachers must also understand the characteristics of each student in order to provide appropriate assistance. 4) To help students connect the information they have obtained, teachers can use group discussion methods. In addition, the use of a variety of learning methods is also important to maintain students' interest in learning. 5) Teachers need to accustom students to presenting their work both individually and in groups. Giving awards or prizes can also be an additional motivation for students.

The Effect of the PJBL Model through a Scientific Approach on Student Learning Outcomes in Elementary Schools

The Project Based Learning (PjBL) model is one learning approach that can improve student learning outcomes in elementary schools, especially when combined with a scientific approach. Student learning outcomes, which include cognitive, affective, and psychomotor aspects, are influenced by learning processes that encourage active student involvement in real projects. According to Apriliani & Panggayuh (2018), the application of PjBL helps students work together in groups, making it easier to solve complex problems. This process not only improves collaboration skills but also encourages in-depth mastery of the material. Pratiwi et al. (2018) found that with an integrated scientific approach, students are actively involved in learning stages such as observing, questioning, collecting data, and associating, which directly improves students' cognitive learning outcomes and critical thinking skills. Thus, the PjBL model through a scientific approach allows elementary school students to learn more deeply and practically, strengthening their understanding and skills relevant to the real world.

The effectiveness of the Project-Based Learning (PjBL) model through a scientific approach can be seen not only from the improvement in students' collaboration or

problem-solving skills but also through its direct impact on achieving deeper, more holistic, and contextual learning outcomes. Muamar et al. (2017) argue that PjBL allows students to engage in projects that require the application of concepts learned in real life, thereby strengthening their understanding and practical application of theory. This is consistent with the findings of Rahayu & Saputra (2020), which show that the scientific approach in PjBL improves students' analytical and critical thinking skills, which ultimately improves cognitive learning outcomes. Furthermore, the scientific approach that encourages students to observe, question, experiment, and associate information, as described by Firdaus et al. (2018), supports the creation of a more active and meaningful learning environment. This model is also associated with increased learning motivation, as students feel more emotionally and intellectually involved in completing projects that are relevant to the real world (Fathurrohman et al., 2019). This combination not only improves academic learning outcomes but also students' social and emotional skills, which are very important in the development of elementary school students.

D. CONCLUSION

Scientific methodologies and project-based learning (PBL) frameworks have the potential to enhance student academic performance. This pedagogical strategy is anticipated to foster increased engagement, motivation, and educational achievements among both students and educators. Nevertheless, the execution of PBL encounters numerous obstacles, including challenges related to time management for instructors, particularly given that projects necessitate extended durations for completion. Additionally, students frequently exhibit passivity, particularly those who demonstrate lower academic abilities, and certain individuals lack the requisite discipline, exhibiting deficiencies in critical thinking and communication skills. To address these impediments, it is essential to implement improved time management strategies, provide intensive mentorship, diversify instructional methodologies, and secure adequate support from educational institutions and governmental bodies. The provision of incentives and the practice of public speaking can significantly bolster students' self-efficacy. In summary, project-based learning integrated with a scientific approach has been empirically validated as effective in enhancing students' cognitive, affective, psychomotor, and socio-emotional competencies. This model encourages active participation in authentic projects, promotes collaborative efforts, enhances critical thinking abilities, and facilitates a deeper understanding of theoretical concepts.

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