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ANALYSIS OF PROJECT-BASED LEARNING MODELS IN IMPROVING STUDENTS' UNDERSTANDING OF SCIENCE LEARNING

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Abstract: Students often have difficulty understanding science concepts in depth because learning is still centered on lecturers. The project-based learning (PjBL) model is an approach that emphasizes the active involvement of students in completing tasks relevant to real-world contexts. This study aims to analyze the effectiveness of the PjBL model in improving students' understanding of science learning materials. The research method employed a qualitative approach, utilizing data collection techniques through interviews and questionnaires with 36 students from the Tadris IPA Study Program in their fourth semester at UIN Madura. The results showed that the majority of students felt an increase in conceptual understanding, critical thinking skills, and collaborative skills after participating in project-based learning. These finding suggest that the PjBL model can be an effective alternative for enhancing the quality of science learning in higher education.

Keywords: Project-Based Learning, Student Understanding, Science Education, PjBL

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INTRODUCTION

Current developments in the world of education demand a transformation in the learning approaches applied in higher education. The teaching and learning process can no longer be centered solely on lecturers as the main source of information; rather, it must provide space for students to construct knowledge through meaningful learning experiences actively. Contextual, collaborative, and applicative learning approaches are key to addressing these challenges. One learning model that is considered capable of meeting these needs is the project-based learning (PBL) model (Ayu et al., 2013).

The project-based learning (PjBL) model is an approach that places students as active subjects in completing a project related to learning materials. In its implementation, students are invited to be directly involved in the process of designing, investigating, and producing solutions to a problem, even if it is in a simulated form (Rati et al., 2017). Through this involvement, students not only gain a deeper understanding of the material but also develop critical thinking, communication, and collaboration skills (Diani et al., 2019; Huda et al., 2020). However, in science learning practices in higher education, including at UIN Madura, the learning process still tends to be theory- and lecture-oriented, resulting in fewer opportunities for students to apply the concepts they learn in real-world contexts. The condition often causes students' conceptual understanding to be superficial and unsustainable (Huda et al., 2019; Saregar et al., 2025). Therefore, this study aims to addres these issues by examining the effectiveness of applying the PjBL model in enchancing students' understanding of science learning, while also evaluating the extent to which this model can foster critical and collaborative thinking skills relevant to the needs of 21st-century education.

According to the Big Indonesian Dictionary, a project is defined as an endeavor planned to achieve a specific goal within a certain period of time. Furthermore, Joel L. Klein in Widyantini's (2014) work explains that project-based learning is a learning strategy that allows students to acquire new knowledge and understanding through direct, albeit simulated, experiences and through the presentation process they undertake. This strategy encourages active student involvement in learning through challenging and meaningful activities (Al-Habbah & Suparji, 2015).

In addition, according to the Burck Institute for Education (in Hosnan, 2014), project-based learning is a systematic and structured form of learning that involves students directly in the process of investigating and observing a problem. Through this approach, students are expected to produce scientific work or products based on critical thinking, precision, and accuracy skills (Munifah et al., 2019; S. Sumarni et al., 2019). This places students in a

strategic position as problem solvers and solution creators in the context of learning (Mudarwan, 2017).

The Center for Youth Development and Education Boston (in Hosnan, 2015) identifies six main characteristics of project-based learning: (1) students can make decisions independently within a mutually agreed framework; (2) students are able to solve problems and find solutions, even without definite answers; (3) they are encouraged to think critically, collaborate, and communicate actively; (4) students are responsible for searching for and managing information; (5) evaluation of achievement is carried out continuously throughout the project; and (6) students reflect on the process and results of the project (Rafiud Ilmudinulloh, 2022).

The Project-Based Learning (PjBL) model is highly relevant to science education because this approach bridges theory and practice (W. Sumarni et al., 2019). Students tend to be more interested in learning that is realistic and applicable and providing direct, contextual experiences. They are not only encouraged to understand concepts but also to test them through exploratory and collaborative project activities. Especially in the digital era, students have broad access to information sources, allowing so that learning projects to be developed more creatively and independently (Putra et al., 2024; Yasin et al., 2020). The use of information technology also strengthens the effectiveness of this model in supporting active and collaborative learning (Kurniawati et al., 2021).

However, previous studies have focused more on the influence of PjBL on increasing creativity (Rati et al., 2017), learning motivation (Winatha, 2018), and students' communication and collaboration skills (Ramadhan & Hindun, 2023) while studies that specifically examine its influence on students' conceptual understanding, especially in the early semesters of religious universities, are still very limited. Therefore, this study was conducted to fill this gap by analyzing the effectiveness of the PjBL model in improving students' understanding of science learning at UIN Madura.

However, in-depth empirical studies are still needed regarding the implementation of PjBL in the context of higher education, particularly in improving students' understanding of science material. Not many studies have specifically highlighted the impact of PjBL on students' conceptual understanding in their early semesters, especially in religious-based higher education institutions such as UIN Madura. Therefore, this study aims to analyze the effectiveness of project-based learning models in enhancing students' understanding of science learning. The findings of this study are expected to serve as a valuable reference for

educators in developing innovative and contextually relevant learning strategies in the modern era.

METHOD

This study employ a descriptive qualitative approach, aiming to provide an in-depth description of students' perceptions and experiences regarding the application of project-based learning models in science learning. A qualitative approach was chosen because this study focuses on understanding the meaning and interpretation of subjects towards an educational phenomenon, rather than on quantitative measurements (Simanjuntak et al., 2024).

The subjects in this study were 36 fourth-semester students majoring in Natural Sciences Education at UIN Madura. The students involved in the study were selected purposively, specially those with experience in project-based learning, both at the university level and at previous levels of education. By involving truly relevant students, the researchers hoped to obtain an authentic and in-depth picture of the learning model being studied.

To collect data, the researcher employed two primary techniques: semi-structured interviews and open-ended questionnaires. These two instruments were designed and used directly by the researcher, based on the main principles of project-based learning. Several important aspects that were the focus included the extent to which students understood the material in depth, their level of involvement during the learning process, how they worked in groups, and how they reflected on their learning experiences.

The interviews were conducted personally to explore the students' stories, impressions, and thoughts more openly. Meanwhile, questionnaires were used to obtain a broader overview of all participants. All data obtained from these two sources were collected, compiled, and analyzed using a thematic analysis approach. The researchers read and reviewed each piece of data to find patterns, themes, or meanings that emerged consistently. The researchers developed the interview and questionnaire instruments based on the main indicators in the project-based learning model.

Table 1 presents the research indicators used as the basis for developing the instruments.

Table 1. Research Indicators

No	Aspects Explored	Research Indicators
1	Understanding of Material	Students are able to explain the science material they have learned through project activities
2	Involvement in Projects	Students are actively involved in the planning, discussion, and implementation of projects
3	Teamwork	Students demonstrate the ability to work effectively with group members

4	Problem Solving	Students are able to identify obstacles and develop relevant and applicable solutions.
5	Reflection and Learning	Students are able to reflect on the learning process and understand the value gained from the project.

The data obtained from interviews and questionnaires were analyzed using thematic analysis. The researchers repeatedly read and examined the data to identify consistent patterns or themes. Each theme that emerged was linked to predetermined indicators, and then compiled into descriptive narratives.

To ensure data validity, the researcher used triangulation techniques, namely by comparing the results of interviews and questionnaires. This triangulation process was carried out to ensure the consistency, accuracy, and reliability of the data obtained from both techniques before thematic analysis was performed. Thus, the research results are expected to have strong internal validity and accurately represent the students' experiences. In addition, the researcher's direct involvement as a collector, processor, and interpreter of data made the analysis process more reflective and in-depth, as recommended in qualitative research.

Based on the results of triangulation between interviews and questionnaires, consistent and mutually reinforcing findings were obtained. The interview data showed that most students experienced an increase in their understanding of science concepts after participating in project-based learning, while the questionnaire results also showed a high percentage on the indicators of active engagement and conceptual understanding. The similarity of the results from these two data sources strengthens the validity of the research findings, indicating that the application of the Project-Based Learning (PjBL) model has a positive impact on students' conceptual understanding. Thus, the triangulation process plays an important role in ensuring that the results of this study are reliable and reflect the actual conditions in the field.

FINDING AND DISCUSSION

This study aims to explore students' perceptions and experiences in participating in project-based learning (PBL) in science. Through interviews and open questionnaires given to 36 students of the Tadris IPA Study Program in their second semester at UIN Madura, it was found that this learning model was able to provide a more meaningful learning experience, especially in terms of conceptual understanding, active involvement, collaboration, problem solving, and students' reflective abilities.

The application of PBL allows students to be more directly involved in the learning process, not only as recipients of information, but also as active subjects who design, execute,

and evaluate their own project activities (Winatha, 2018). These findings are grouped based on five main indicators that have been determined in advance, as presented in **Table 2**.

Table 2. Summary of Student Responses Based on PBL Indicators

Indicator	Positive Responses (%)	Description of Findings
Conceptual Understanding	83	Students can explain scientific concepts better after completing the project.
Involvement in the Project	89	Students are actively involved in planning and implementing projects independently.
Group Work	78	Students are able to work together in groups despite coordination challenges ( ).
Problem-Solving Skills	75	Students demonstrate the ability to identify and solve project challenges.
Learning Reflection	80	Students can reflect on the learning process and the benefits gained.

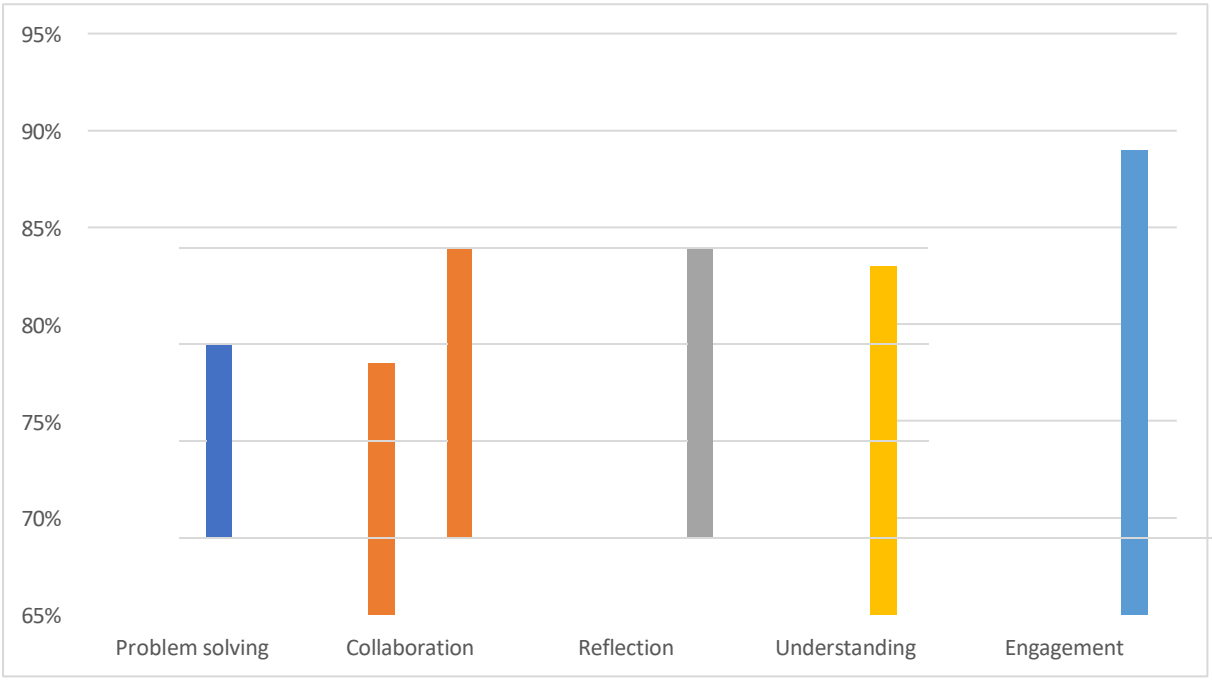

Figure 1. Diagram of Positive Student Responses Based on PjBL Indicators

The results shown in **Table 2** indicate that the application of the Project-Based Learning (PjBL) model encourages students to participate actively and independently in the learning process. The data in the table was obtained through a questionnaire using a four-point *Likert* scale, namely *Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1)*. The

questionnaire instrument was compiled based on five main indicators that reflect the application of the PjBL model, namely: (1) concept understanding, (2) involvement in projects, (3) group cooperation, (4) problem-solving skills, and (5) learning reflection. The percentage of positive responses was calculated from the number of students who chose the Agree and Strongly Agree categories for each indicator. Based on these results, the aspect of student involvement in the project showed the highest score, with a positive response rate of 89%. Students felt more challenged and motivated when given the opportunity to design and carry out projects independently. They were involved in every stage, from planning to presenting the results, so they felt more responsible and ownership of the learning process they underwent. This active involvement is an indicator that PjBL is able to change the learning pattern from passive to more participatory. This is in line with Hosnan's (2014) opinion that PBL allows students to build their own understanding through contextual and meaningful direct experiences (Wulandari, 2016).

In addition to engagement, conceptual understanding also showed a significant increase, with 83% of students stating that they found it easier to understand the material after participating in project activities. In the process of working on projects, students were required to review the material, search for relevant sources, and compile them in a more applicable form. These activities helped them build a more tangible connection between theory and practice. For example, when they made teaching aids about the human respiratory system, they not only understood the names and functions of the organs, but also understood their working mechanisms visually and functionally. These findings support Thomas' (2000) argument, which emphasizes that direct involvement in projects can strengthen learners' conceptual understanding of complex material (Arifianti et al., 2020).

On the other hand, group cooperation is also an important aspect in the success of the PjBL model. As many as 78% of students stated that they felt they were able to work well together during the project. They shared tasks, discussed ideas, and solved problems together. However, some students also expressed challenges, such as a lack of communication or uneven contributions among group members. Nevertheless, this experience became a valuable social learning space, where students learned to compromise, coordinate, and manage differences of opinion. Slavin (2006) emphasizes that group work in the context of project-based learning not only strengthens collaborative skills but also builds empathy and social responsibility (Ramadhan & Hindun, 2023).

Problem-solving skills also emerged as a positive impact of project implementation. As many as 75% of reported facing challenges during the project process and attempting to solve

them independently or with their team. These challenges ranged from technical constraints, limitations in tools and materials, to errors in planning. In facing these challenges, students demonstrated the ability to analyze problems, seek alternative solutions, and revise their steps. This shows that PjBL fosters critical and solution-oriented thinking in students, as explained by Harjani (2019) who notes that project-based learning is not only oriented towards the final product, but also towards the thought process that occurs during the activity (Hariani MD & Siregar, 2019).

The aspect of reflection in learning has also been strengthened. About 80% of students stated that the projects they did made them more aware of how they learn, what their difficulties are, and how they overcome them. Students also mentioned that they felt more confident and proud when they successfully completed the project and presented it in front of the class. This shows that the PjBL model not only shapes knowledge but also shapes attitudes and self-awareness, which are important in the educational process. Hmelo-Silver (2004) states that reflection is an important part of the constructivist approach because it helps students review their learning process and identify their personal development (Usoh et al., 2024).

Overall, the results of this study confirm that project-based learning is an effective approach to improving the quality of science learning in religious universities. Not only from a cognitive perspective, but also from an affective and social perspective. However, the effectiveness of PjBL is greatly influenced by student readiness, well-designed projects, and the active role of lecturers as facilitators who guide and direct the learning process in a contextual and focused manner. These findings are expected to be taken into consideration in the development of other innovative learning models in campus environments based on local values and Islamic character.

CONCLUSION

Based on the results of data analysis, it can be concluded that the application of the Project-Based Learning model has a positive effect on the learning process and outcomes of students in science courses. Students showed improvement in their understanding of concepts, active involvement during learning, ability to work together in groups, problem-solving skills, and ability to reflect on their learning process. Contextual and collaborative projects encouraged students to be more independent, creative, and responsible in managing their learning. In addition, the application of this model also provides students with to develop critical thinking skills and reflective attitudes that are urgently needed in facing the challenges

of 21st-century education. Thus, project-based learning can be used as an innovative approach relevant higher education, particlarly in religious studies programs that integrate science and local values.

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