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ANALYSIS OF THE PROJECT BASED LEARNING (PJBL) MODEL IN OPTIMIZING CONCEPT UNDERSTANDING AND CRITICAL THINKING SKILLS IN ELEMENTARY SCHOOL TEACHER EDUCATION STUDENTS

Yenni Susanti[1], Najmuddin[2], Maisura[3]
Universitas Almuslim
yenni6396@gmail.com[1], najmuddin@umuslim.ac.id[2], maisura@umuslim.ac.id[3]

Abstract

Project-Based Learning encourages students to engage in an active and contextual learning process, in which they are confronted with real-world problems that require problem-solving. This study aims to analyze the implementation of the Project-Based Learning (PjBL) model in optimizing critical thinking skills and understanding of science concepts in the Science Media Product *course for undergraduate PGSD students. The sample was determined through purposive sampling and consisted of lecturers and students as respondents. Data were collected through interview guidelines, tests, and observations. The validity of qualitative data was tested through credibility, transferability, dependability, and confirmability. Data analysis was conducted using descriptive qualitative methods, including data reduction, data display, and conclusion drawing. The results indicate that the implementation of PjBL in science learning was successfully carried out systematically and created a dynamic learning environment. The application of the Project-Based Learning model in the science course was effective. The implementation of PjBL significantly improved students' conceptual understanding and critical thinking skills. The PjBL model proved to optimize both aspects simultaneously. Students' understanding of science concepts showed substantial improvement, shifting from theoretical memorization to the construction of applicable knowledge, with learning mastery reaching 100%.*

Keywords: Project-Based Learning, Critical Thinking Skills, Science Concept Understanding, PGSD

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INTRODUCTION

Natural Sciences (IPA) courses require a deep understanding of concepts and critical thinking skills. But in fact, science learning at PGSD often uses lecture methods and giving written assignments. As a result, students only memorize concepts without relating them to real phenomena, so their analysis and problem-solving skills do not develop.

The results of initial observations at PGSD Almuslim University showed that most students had difficulty connecting the concept of science with daily problems. They have not been able to analyze data, formulate arguments, or provide science-based solutions. This finding is in line with Djufri research, which reported that only 6.25% of students were in the category of high critical thinking, while 57.5% were moderate, and 36.25% were low.[1] Wiyoko's research also revealed that the evaluation and inference indicators of PGSD students were only 26-30%, which showed the weakness of critical thinking skills.[2]

Research by Hakim & Lefudin showed that before the innovative intervention, students' understanding was in the low category (n-gain < 0.3), and increased to the high category (0.72) after the use of constructivism-based teaching materials (Hakim & Lefudin 2020). The reason is that conventional methods do not provide space for students to actively build concepts. As a result, students are not used to doing in-depth exploration.

According to Fathurrohman, *project-based learning* is a learning model that uses projects or activities as a means of learning to achieve the competencies of attitudes, knowledge and skills achieved by students.[3] *According* to Eliza, project-based learning is a learning method that uses problems as the first step in collecting and integrating new knowledge based on their experiences by doing real activities in life.[4] This is done to help, encourage and guide students to focus on cooperation by involving group work and helping students to focus on their development.[5] Meanwhile, from the perspective of Amsal, *Project Based Learning* can be interpreted as a teaching approach that is built on learning activities and real tasks that are given challenges to students

[1] Elyas Djufri et al., "Analisis Profil Keterampilan Berpikir Kritis Konsep Sains Mahasiswa PGSD," *Pendas : Jurnal Ilmiah Pendidikan Dasar* 7, no. 2 (2022), https://doi.org/10.23969/jp.v7i2.6383.

[2] Tri Wiyoko, "Analisis Profil Kemampuan Berpikir Kritis Mahasiswa PGSD Dengan Graded Response Models Pada Pembelajaran IPA," *IJIS Edu : Indonesian Journal of Integrated Science Education* 1, no. 1 (2019), https://doi.org/10.29300/ijisedu.v1i1.1402.

[3] Muhammad Fathurrohman, *Model-Model Pembelajaran Inovatif* (Ar-Ruzz Media, 2016).

[4] Fivia Eliza et al., "Peningkatan Kompetensi Psikomotor Siswa Melalui Model Pembelajaran Project Based Learning (PjBL) Di SMKN 5 Padang," *INVOTEK: Jurnal Inovasi Vokasional Dan Teknologi* 19, no. 2 (2019), https://doi.org/10.24036/invotek.v19i2.427.

[5] Irdalisa Irdalisa et al., "Project-Based Learning on STEAM-Based Student's Worksheet with Ecoprint Technique: Effects on Student Scientific Reasoning and Creativity," *Jurnal Inovasi Pendidikan IPA* 10, no. 2 (2024), https://doi.org/10.21831/jipi.v10i2.77676.

related to daily needs.[6] That way, students are expected to feel "owned" over the project or projects that have been carried out, the availability of sufficient facilities and learning resources so that students or groups of students can meet their needs, educators must ensure that participants have the suitability of project time with the schedule or academic calendar so that project activities do not clash or experience certain obstacles.[7]

According to Ilhamdi, critical thinking is a person's ability to find information and solve a problem by asking themselves to dig up information about the problem they are facing.[8] Meanwhile, according to Herlian, a critical thinker has an *inquisitive*, *judicious*, *truth-seeking*, *confident in reasoning*, open-minded, *analytical*, and systematic.[9] Anderson & Krathwohl explain that conceptual understanding is divided into seven cognitive categories of understanding, namely: (1) interpreting is the process of converting an image into another form of information; (2) *exemplifying* is a step to provide an illustration of a concept; (3) classifying is the activity of forming concepts in a category of groups; (4) *summarizing* is the act of abstracting the main point or general point; (5) *inferring* is the activity of making conclusions based on the information provided (6) comparing is the process of adjusting between two ideas, two objects and the like; (7) *explaining* is the activity of seeking and presenting information obtained from the process of analyzing concepts.[10]

A number of studies prove the effectiveness of PjBL Hasibuan found that the application of PjBL significantly improves critical thinking skills.[11] Frestika Mulia reported an increase in critical thinking scores from 76.13 to 86.50 after the PjBL cycle. Majid also found that PjBL strengthens students' creative thinking skills.[12] Although empirical evidence supports PjBL, its

[6] Amsal Alhayat et al., "The Relevance of the Project-Based Learning (PjBL) Learning Model with 'Kurikulum Merdeka Belajar,'" *DWIJA CENDEKIA: Jurnal Riset Pedagogik* 7, no. 1 (2023), https://doi.org/10.20961/jdc.v7i1.69363.

[7] Suci Setiyaningsih and Heru Subrata, "Penerapan Problem Based Learning Terpadu Paradigma Konstruktivisme Vygotsky Pada Kurikulum Merdeka Belajar," *Jurnal Ilmiah Mandala Education* 9, no. 2 (2023), https://doi.org/10.58258/jime.v9i2.5051.

[8] Mohammad Liwa Ilhamdi et al., "Pengaruh Model Pembelajaran Inkuiri Terbimbing Terhadap Kemampuan Berpikir Kritis IPA SD," *Jurnal Ilmiah KONTEKSTUAL* 1, no. 02 (2020), https://doi.org/10.46772/kontekstual.v1i02.162.

[9] Herlian Dessi Kusumawati and Mohamad Aminudin, "Menanamkan Pendidikan Karakter Melalui Pembelajaran Matematika Dengan Mengembangkan Ketrampilan Berpikir Kritis Sebagai Salah Satu Upaya Untuk Meningkatkan Jiwa Nasionalisme Siswa SMA Negeri 1 Ungaran," *Kontinu: Jurnal Penelitian Didaktik Matematika* 2, no. 2 (2019), https://doi.org/10.30659/kontinu.2.2.88-97.

[10] Lorin W. Anderson and David R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (Longman, 2001).

[11] Hanisah Hasibuan et al., "Implementasi Project Based Learning Di Perguruan Tinggi Untuk Meningkatkan Kemampuan Berpikir Kritis: Sebuah Tinjauan," *Pubmedia Jurnal Penelitian Tindakan Kelas Indonesia* 2, no. 4 (2025), https://doi.org/10.47134/ptk.v2i4.2107.

[12] Abdul Majid Junaidi et al., "Project Based Learning Menggunakan Pendekatan Higher Order Thinking Skills (HOTS) Untuk Meningkatkan Kemampuan Mahasiswa Abad 21 Di Universitas Gunung Rinjani," *PALAPA* 10, no. 2 (2022), https://doi.org/10.36088/palapa.v10i2.2181.

implementation at Almuslim University is still rare. As a result, students are not accustomed to real-world problem-based learning and do not develop 21st century skills.

This problem is increasingly important because critical thinking skills and conceptual understanding are interrelated. Without analytical skills, students are unable to evaluate scientific information. In contrast, without an understanding of concepts, they cannot develop science-based solutions. Therefore, an analysis of the effectiveness of PjBL is needed in optimizing these two capabilities. PjBL allows students to design, implement, and evaluate real projects, so that critical thinking skills and concept understanding develop together. This approach is in line with the theory of constructivism and learning by doing Wiranti Mulyandari research proves that the herbarium creation project increased students' cognitive scores from 8.70% to 86.96%, while Amanda Widyatamaka reported an increase in science learning outcomes through PjBL.

However, at Almuslim University, learning is still dominated by lecture methods. As a result, students are not used to studying problems in depth, lack critical thinking, and do not develop optimal conceptual understanding. If this condition is left unchecked, PGSD graduates will find it difficult to implement innovative learning in elementary schools. This research has novelty because it focuses on the analysis of the application of PjBL at the university level, precisely in S1 PGSD students of Almuslim University. So far, PjBL has been applied more at the elementary and secondary school levels, while in teacher colleges the implementation is still minimal. In addition, this research emphasizes on strengthening two aspects at once, namely understanding science concepts and critical thinking skills, by integrating projects based on local contexts to be more relevant to the student environment.

The focus of this research is on the implementation of the Project *Based Learning Model* in optimizing critical thinking skills and understanding of science concepts in the Science Media Products course for S1 PGSD semester III semester students of Almuslim University. Based on the above background, the question of this research is how to apply the Project Based Learning (PjBL) model in optimizing the ability to think critically and understand science concepts in the Science Media Products course for S1 PGSD students.

RESEARCH METHODS

This study uses a qualitative approach with a descriptive method because it aims to describe or describe how lecturers apply the PjBL model in science learning, especially seen from the aspects of *Planning, Organizing, Actuating, and Controlling* (POAC). The descriptive method was used in this study to explore in depth the obstacles faced by S1 PGSD students of Almuslim University in completing their final projects, as well as how they manage the stress that arises during the process. The qualitative approach allows researchers to understand students' subjective

experiences through observations, tests, and questionnaires without prioritizing the generalization of numbers.

The determination of data sources in qualitative research is carried out purposively, which is determined by adjusting to certain research objectives or conditions. Creswell posits that in qualitative research, we identify participants and places with *purposive sampling* that is based on the places and people that best help us understand our central phenomena.[13] The data sources in this study were obtained from the main informants and supporting documents relevant to the implementation of *the PjBL project-based learning model* in science learning. The main informants consist of PGSD S1 students and lecturers who are directly involved in project-based learning activities in science courses. Data collection techniques with tests, interview guidelines and questionnaires. Interview guidelines are used as a guide when the interview is conducted, so that it is in accordance with the purpose and objectives to be achieved. observation To find out the implementation of the PjBL model in science learning. The test sheetaims to measure students' critical thinking skills and understanding of science concepts.

The validity test of qualitative data includes the test of credibility (credibility), transferability (transfer value), dependability and confirmability. The validity test of qualitative data includes the test of credibility (credibility), transferability (transfer value), dependability and confirmability. Data analysis was carried out using qualitative descriptive, namely data reduction, data presentation and conclusions.

RESULTS AND DISCUSSION

Based on the results of an interview with the Lecturer in Charge of the Science Course with Science Media Products, explained his views on the application of the PjBL model in science lectures or Science Media Products, as follows:

> *"In my opinion, the PjBL model is very suitable to be applied in science lectures and Science Media Products. With this model, students not only learn theory, but also directly practice through projects, such as making media or science props. Learning becomes more active, exciting, and easy to understand. In addition, students are also trained to work together, be creative, and be responsible, so that they are better prepared to become elementary school teachers later".*

According to the informant in his interview, he also explained about the steps that are usually taken in the planning of a learning project, are as follows:

> "*Usually I start by determining goals and materials, then choose a suitable project. After that, I prepared the steps of the activity, the time of work, and the assessment, so that the project runs in a directional* direction."

[13] John W. Creswell, *Penelitian Kualitatif & Desain Riset: Memilih Di Antara Lima Pendekatan*, 3rd ed. (Pustaka Pelajar, 2015).

The Research Informant in the interview also explained his experience with student involvement in the project process (discussion, group work, collaboration), which is as follows:

> "*Based on my experience, student involvement is quite active. They engage in discussions, group work, and collaboration, sharing tasks, exchanging ideas, and working together to complete projects. Although there are differences in activity, in general students are enthusiastic and responsible for their group tasks*".

According to the Informant in his interview, it was also related to the habit of reflecting or evaluating with students after the project is completed is as follows:

> "*Yes, I usually reflect with students after the project is completed, through class discussions and questions and answers. Students are asked to convey their experiences, obstacles, and things they learned from the project, then I provide feedback and evaluation of their processes and work results*".

In addition, the Informant also explained in his interview about an example of a situation where students showed an increase in understanding of science concepts after using PjBL, as follows:

> "*There is. For example, when students make science media or teaching aids, they understand the concept better because they have to explain the material again in the form of products. From the discussions and presentations, it can be seen that their understanding is better and more precise than before using PjBL".*

Furthermore, in the interview that has been conducted with the Informant, it is also explained that the application of PjBL can train students' ability to formulate clear questions or arguments (*clarity*), as follows:

> "*In my opinion, yes. PjBL trains students to structure questions and arguments more clearly, especially during discussions, presentations, and defending the results of their projects. The process makes their way of thinking and delivery more directed and coherent*".

The informant in his interview also explained that students are able to use data or scientific evidence to support their arguments (*accuracy*), as follows:

> *"Yes, students are starting to be able to use data or scientific evidence to support their arguments, for example from observations, simple experiments, or reading sources. Although not all of them are consistent, in general the precision and accuracy of their arguments have improved after using PjBL".*

The informant in his interview also explained the ability of students to analyze problems in depth and draw logical conclusions during the project, which is as follows:

> "*During the project, I see that students are increasingly able to analyze problems in more depth. They began to associate theory with practice and drew more logical conclusions, although there was still a need for guidance in some groups."*

In his interview, the Informant also explained about the Supporters of the implementation of the PJBL Model, as follows:

> "*What supports the implementation of PjBL is usually careful planning, the active role of lecturers as supervisors, enthusiasm and cooperation of students, as well as the availability*

of sufficient time and facilities. With that support, the project can run more purposefully and effectively".

Furthermore, the Informant also revealed about the obstacles to the implementation of the PJBL Model, as follows:

"*Some of the things that hinder the implementation of the PjBL model include limited lecture time, differences in the level of student activity in groups, and limited facilities and materials. In addition, not all students are used to independent learning, so they still need more intensive assistance from lecturers*".

Furthermore, the Informant explained how to overcome the obstacles from the implementation of the PjBL model, which are as follows:

"*To overcome this, I usually manage the time and stages of the project more clearly, divide group tasks in a balanced manner, and provide direction and assistance in stages. In addition, I encourage students to use simple tools and materials so that the project can continue to run*."

In addition, the informant also revealed that the shortcomings of the PJBL model, which are as follows:

"*In my opinion, the lack of PjBL takes a long time, class management is more complex, and not all students are immediately active in group work. In addition, PjBL also demands more mature preparation from lecturers and students*".

Then as the closing of the interview, the informant also explained the advantages of the PJBL model, which are as follows:

"The advantage of PjBL is that it makes students more active and creative, understands the material better because they learn while practicing, and practice cooperation, responsibility, and critical thinking skills. Learning also becomes more meaningful and not boring".

Table 1 Observation results

Observed Aspects	Observation Results	Observation Conclusion
Planing	Lecturers start the learning process by designing a systematic plan. The first step is to set learning objectives and materials, followed by choosing relevant projects. Furthermore, lecturers prepare the stages of activities, the allocation of work time, and assessment criteria to ensure that the project runs in a directional manner. The lecturer emphasized that careful planning is the main foundation that supports the successful implementation of the Project-Based Learning model.	Planning has been carried out well and systematically. Lecturers have carried out important indicators in Planing, such as: (1) setting learning objectives, (2) designing projects that are relevant to the material, (3) arranging activity steps, time allocation, and assessment systems to direct projects. This shows a strong foundation before implementation.

Organizing	In group organization, in general, students show enthusiasm and a sense of responsibility for the assigned tasks, although there are variations in the level of individual activity. To support the implementation of the project, lecturers clearly arrange the time and stages of the work. Lecturers also encourage students to take advantage of simple and accessible tools and materials. The availability of adequate time and facilities was identified as supporting factors in this process.	Organizing has been attempted, despite facing obstacles. Lecturers divide group assignments and arrange schedules and project stages. However, there are obstacles in the provision of adequate learning resources and tools (limited facilities), so they can be overcome with the use of simple tools/materials. The division of groups is dynamic but there is still an inequality of participation.
Actuating	At the implementation stage, lecturers play an active role as supervisors by providing direction and assistance in stages to students. Student involvement in learning is quite active, which is shown through participation in discussions, group work, and collaboration in the form of sharing assignments and exchanging ideas. The learning atmosphere becomes more active, interesting, and easy for students to understand.	The implementation (*Actuating*) runs according to the principles of PjBL. Lecturers play an active role as facilitators and supervisors. Students engage in active and collaborative learning strategies through discussion, cooperation, and sharing assignments in groups. This process creates a dynamic learning environment and encourages participation.
Controlling	The monitoring and evaluation process runs continuously. Lecturers observe the development of students' abilities, such as in analyzing problems, while still providing more intensive guidance to several groups in need. Feedback and evaluation are provided on the work process and the final results of the project. As part of the control, lecturers carry out reflection together with students after the project is completed, where students convey their learning experiences, obstacles faced, and insights gained during the project process.	Control and evaluation are carried out on an ongoing basis. Lecturers monitor during the process (provide guidance to the group that is lacking) and evaluate at the end through a joint reflection session. Feedback is provided for improvements. Assessment seems to refer to processes (experiences, constraints) and outcomes (presentations, products), although it is not explicitly explained the use of rubrics.

Based on observations of the implementation of PjBL, lecturers have built a very strong foundation through systematic and careful planning. He starts by formulating learning objectives, designing relevant projects, and clearly articulating steps, timings, and assessment criteria. This preparation is a directed guideline for the entire learning process. In its implementation, lecturers succeeded in creating a dynamic learning environment by playing an active role as supervisors. Students also looked enthusiastic, engaged in discussions, and collaborated to divide assignments, so that the classroom atmosphere became more lively and easy to understand.

Nonetheless, this process also faces real challenges on the ground, especially when it comes to organizing resources. The limited learning facilities and tools are finally outsmarted by using simple materials that are easily accessible. Another obstacle arises in the division of group roles, where participation among members is not completely evenly distributed. To overcome this, lecturers provide more intensive assistance to groups in need and carry out continuous supervision. At the end of the project, joint reflection is carried out so that students can convey their experiences, obstacles, and insights, so that learning is not only results-oriented, but also on meaningful processes.

Table 2. Student Critical Thinking Ability Test Results

Test Results	Analysis Results	Conclusion of the Analysis Results
Water Cycle & Condensation	Students are able to identify physical variables such as temperature differences, air circulation, surface area, and system leakage as condensation inhibitors.	The understanding of basic thermodynamics and heat transfer concepts is good and applicable in technical problem solving.
Food Chain Media	The majority of respondents chose 3D dioramas over posters because of the interactivity, concrete simulation, and sensory stimulation aspects that are appropriate for elementary school students.	Students have a high pedagogical awareness of the characteristics of cognitive development of elementary school children (concrete operational stage).
Buoyancy (Archimedes' Law)	There is a variety of answers; Some students understand the limits of the density and saturation point of the solution, while others are still fixated on the amount of salt in quantity.	Most students understand the concept of density, but it is necessary to strengthen the aspect of scientific limits so that there is no absolute misconception of "salt = buoyancy".
Safety Principle	Respondents agreed that safety is the main foundation for avoiding learning trauma and protecting students' physical during science exploration.	PGSD students have strong professional ethics in designing safe and *child-friendly* learning media.

Water Rocket Engineering	Technical analysis focused on fin mounting precision, aerodynamics, air pressure, and water volume as critical factors for successful launch.	Students' reflective thinking skills are excellent in evaluating technical failures and determining systemic improvement priorities.
Composting	Failures are identified on biological and chemical factors such as C/N ratio, oxygen circulation (aerobic), humidity, and agitation (reversal).	Students are able to conduct an in-depth analysis of simple biotechnological processes and find critical points in the decomposition phase.
Simple Aircraft (Pulley)	Students prefer rides that make work easier (mechanical advantages) than those that are only able to lift heavy loads but are difficult to operate.	Understanding the essence of a simple plane as a means of reducing effort (style) is very appropriate and in accordance with the objectives of the elementary science curriculum.
Plant Growth & Light	The students succeeded in concluding the phenomenon of etiolation (growing fast in dark but weak places) and the role of light as a growth regulator (phototropism).	The ability to infer based on biological observation data is already very sharp and supported by consistent empirical evidence.
Concept of Magnetic Force	Students were critical of the demonstration with minimal explanation about magnetic poles, magnetic fields, magnetic distances, and the selectivity properties of materials.	Students are able to detect deficiencies in the delivery of concepts and provide more comprehensive demonstration solutions.
Project Management (POAC)	Planning and Controlling *are* seen as a unit that ensures the technical quality, aesthetics, and educational validity of the product.	Students understand that the success of science products does not only depend on science theory, but also on disciplined work process management.

The test results show that prospective elementary school teacher students have comprehensive analytical skills in evaluating various science phenomena and learning media. Students not only master basic concepts such as thermodynamics in the water cycle, Archimedes' law of density, and aerodynamic principles in water rockets, but also able to identify critical points of technical failures in biotechnology and mechanical processes. In addition to the scientific aspect, they showed a keen sensitivity to pedagogical methodologies by selecting 3D interactive media that are relevant to the cognitive development of primary school age children. Furthermore, the awareness of structured project management (POAC) and the priority on the aspect of occupational safety proves that students have been able to integrate theoretical understanding with professional practical standards.

These findings indicate that students' critical thinking skills have reached a reflective and applicative level, where they are able to connect scientific principles with problem-solving solutions in the field. Their ability to detect misconceptions in the concept of magnetic force and analyze etiolation phenomena empirically shows intellectual maturity in making inferences based on data. This reflects that the learning process has succeeded in building a strong professional ethics, where students view the creation of science media not just as a technical task, but as an educational responsibility that must meet the standards of conceptual accuracy, safety, and managerial effectiveness. Overall, students show competency readiness in designing and evaluating quality and child-friendly science learning.

Discussion

Based on the results of the study, the implementation of PjBL in this study does not take place spontaneously, but through systematic and goal-oriented planning. This is in line with the concept of PjBL which emphasizes real tasks and challenges that are relevant to daily life.[14] Lecturers carefully design projects such as the creation of science media or teaching aids, starting from determining basic competencies, problem scenarios, steps, to assessment instruments. This careful planning is the foundation that ensures that the project is not just an activity of making goods, but really becomes a vehicle to achieve learning goals.

At the implementation stage, the role of lecturers shifts from instructors to facilitators and supervisors, as required by Ariadi that educators must be skilled in motivating and guiding students. This shift in roles creates a lively class dynamic.[15] Students are no longer passive recipients, but are actively involved in discussions, collaborations, and project completions. Learning becomes more contextual and easy to understand because students "engage in real activities" to construct their own understanding of science concepts.

The test results showed a significant increase in understanding of science concepts. Students not only master theory, but are able to analyze problems, connect concepts with practice, and draw logical conclusions. The process of discussion, presentation, and product creation trains the ability to formulate clear arguments (clarity) and supported by scientific evidence (accuracy), reaching the level of reflective-applicative thinking. The findings of the study show an excellent improvement in the understanding of science concepts. This achievement is not just memorization, but a deep understanding that is actively built by students. This process is an image of

[14] Juliana Margareta Sumilat et al., "Analisis Implementasi Model PjBL (Project Based Learning) Di Sekolah Dasar," *Jurnal Basicedu* 7, no. 6 (2023), https://doi.org/10.31004/basicedu.v7i6.6557.

[15] Wa Ariadi et al., "Pelaksanaan Peningkatan Kompetensi Bagi Tenaga Pendidik Institusi Pemerintah Dalam Negeri Kampus Papua," *SWARNA: Jurnal Pengabdian Kepada Masyarakat* 2, no. 5 (2023), https://doi.org/10.55681/swarna.v2i5.496.

constructivism, where knowledge is the result of an individual's active construction through his experience and interaction with the environment.

Through PjBL, students not only know the theory, but are challenged to apply, analyze, and synthesize this knowledge to solve problems in the project. Activities such as analyzing problems, designing solutions, connecting concepts with practice, and presenting and defending the work directly train critical thinking skills. They learn to formulate clear and accurate arguments based on scientific evidence, which shows a higher level of thinking, namely at the reflective and applicative stages. This answers the principle of PjBL which emphasizes competence at the level of application to evaluation.

This collaboration is at the heart of the PjBL approach according to Goodman & Stivers, where students are invited to solve problems in groups. This collaborative process not only supports the completion of technical projects, but also reflects the value of Confucian education on social development and learning through participation. However, in-depth observations reveal a common reality in group work: participation inequality. Not all members contribute equally. To overcome this challenge, lecturers intervene through intensive mentoring and a more structured division of tasks. This strategy demonstrates the importance of lecturers' facilitative role in ensuring that project-based learning remains inclusive and equitable for all students.

The application of the Project Based Learning (PjBL) model in science courses at PGSD Almuslim University has succeeded in transforming students' conceptual understanding from mere theoretical memorization to a complete and meaningful construction of knowledge. Statistical data showing that the average value of concept understanding reached 90.86 with 100% completeness is strong empirical evidence. This increase occurred because PjBL forced students not only to read or listen to explanations of science concepts such as thermodynamics in the water cycle or the principles of aerodynamics in water rockets, but to experience these concepts firsthand. In the process of designing and creating science media products, students must undergo a comprehensive cognitive stage: they interpret theories into design drawings, classify the components needed, and reinterpret the concepts through their finished products to others.

A cognitive framework according to Anderson & Krathwohl that states that true understanding of concepts involves the ability to externalize knowledge in various forms, such as examples, comparisons, and conclusions.[16] In observations and interviews, it can be seen that PGSD Almuslim students undergo this process. For example, to understand Archimedes' law, they not only memorized formulas, but had to create props that demonstrated the principle of density.

[16] Anderson and Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*.

CONCLUSION

The conclusion of this study is that the application of PjBL in Science Learning has been successfully implemented systematically and creates a dynamic learning environment, the application of the project-based learning model in science courses is effective because it is designed with careful planning (POAC) and actively facilitated by lecturers. The shift in the role of lecturers from instructors to facilitators has succeeded in creating a collaborative, contextual, and student-centered learning atmosphere. Despite challenges such as equitable participation in groups and limited resources, this can be overcome through intensive mentoring and resource improvisation. Regular reflection also strengthens the learning orientation to the process, not just the final product. The Implementation of PjBL Significantly Improves Students' Understanding of Concepts and Critical Thinking Skills. The PjBL model is proven to optimize these two aspects in parallel. Students' understanding of science concepts has improved deeply, moving from theoretical memorization to applicable knowledge construction, with evidence of learning completeness reaching 100%. Simultaneously, their critical thinking skills are honed through the process of problem analysis, idea synthesis, and solution evaluation in real projects. Students demonstrate the ability to think at a reflective-applicative level, such as drafting clear and accurate arguments based on scientific evidence.

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