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Effectiveness of Project-Based Learning (PjBL) Model Implementation in Lectures at the Faculty of Engineering, Universitas Negeri Makassar

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ABSTRACT

This research aims to: (1) determine the understanding of Faculty of Engineering lecturers regarding Project Based Learning (PjBL); (2) the depth of students' understanding of the teaching material received from the lecturer; (3) knowing the level of student critical thinking and the level of student collaboration; (4) know the procedures for implementing PjBL carried out by lecturers at the Faculty of Engineering. The method used is Quasi-Experimental Design. After the learning, lecturers and students in the three groups were given a performance test to determine the effectiveness of the learning provided. The performance test referred to is PjBL project-based learning. The research results showed that: lecturers' understanding of PjBL was 50% understood; the depth of students' understanding of the teaching material received from lecturers, 60% really understand; students' critical thinking level is in the very high category of 68%; PjBL implementation procedures carried out by lecturers are in the 75% very structured category, the level of student collaboration is in the 90% very high category; The general student response to the implementation of the PjBL model was 92% in the very good category. For this reason, it is recommended that lecturers at the Faculty of Engineering, Makassar State University use PjBL in their lectures.

KEYWORDS: PjBL, Critical Thinking

1. Introduction

The current paradigm of higher education has shifted significantly from a traditional, instructional approach to one that emphasizes active, collaborative learning integrated with technology. This new paradigm reflects an evolved understanding of how students acquire the knowledge and skills necessary to navigate the complexities of the modern world. Furthermore, it underscores the importance of preparing students to face a rapidly changing world with relevant skills. It acknowledges that learning is not merely about the transmission of information but also about developing critical thinking skills, adaptability, and a grasp of social and global contexts. Within this paradigm, higher education institutions play a pivotal role in fostering an environment that supports students' full potential as lifelong learners.

Project-Based Learning (PjBL) is an instructional approach that allows students to learn through projects or tasks relevant to real-world contexts. This approach aims to cultivate a deeper conceptual understanding, critical thinking skills, collaboration, and problem-solving abilities. The implementation of PjBL begins with meticulous planning, during which instructors design challenging projects aligned with specific learning objectives. During the planning phase, both students and lecturers collaboratively define project goals and outline the steps needed to achieve them. This involves identifying necessary resources, setting timeframes, and selecting appropriate methods and tools for the project. Instructors act as facilitators, providing guidance and support throughout the planning process.

After planning is complete, the execution phase begins. Students actively engage in their projects, applying prior knowledge and skills. They participate in research, exploration, experimentation, and various activities that help achieve project goals. Collaboration among students is emphasized in this phase, allowing them to learn from each other and solve problems collectively. Throughout project implementation, instructors serve as supporters and monitors, providing guidance, feedback, and facilitating reflective discussions. Students are encouraged to consider their roles and responsibilities within the project and identify potential challenges. Finally, upon project completion, the evaluation and reflection phase occurs. Students and instructors jointly evaluate the project outcomes, both in terms of achieving learning objectives and the quality of project execution. Project results may also be presented to the class or group, allowing students to share their learning outcomes. This opportunity enables students to reflect on their learning process and identify areas for improvement in future endeavors.

The implementation of PjBL offers students meaningful and in-depth learning experiences. They gain not only a theoretical understanding of concepts but also the ability to apply them in real-world contexts. Additionally, PjBL fosters critical thinking, collaboration, and a sense of accountability for their learning outcomes, which can be valuable in their future lives.

Discussions within the Faculty of Engineering at Universitas Negeri Makassar (UNM) regarding the learning process have revealed that the implementation of teaching models remains varied. Not all instructors fully understand the benefits of the PjBL model. The variability in teaching models has led to issues such as limited student comprehension of course material, insufficient critical thinking, restricted collaboration among students, and a lack of student-centered learning to enhance competency. Therefore, detailed and thorough research on the implementation of PjBL in the Faculty of Engineering at UNM is essential. The importance of this research lies in providing a foundation for policy decisions regarding workshops or training on competency development and instructional models, particularly PjBL, for faculty members. Without such research, higher education institutions lack accurate data on the implementation of instructional models, specifically PjBL.

2. Literature Review

Project-Based Learning

Definition of Project-Based Learning

Project-Based Learning (PjBL) is a learning model grounded in real-world issues, challenging learners to derive meaningful understanding and collaboratively develop solutions through project-based outcomes (William, 2012). According to Blumenfeld et al. (1991), PjBL is a comprehensive approach to classroom learning designed to engage learners in inquiry rooted in authentic problems. Similarly, Bell describes PjBL as a learning approach that delivers curriculum content through projects guided by questions that stimulate research and enable learners to apply acquired knowledge (Bell, 2010).

Wolpert-Gawron (2018) further explains that PjBL involves simultaneous learning across different subject areas, achieved by guiding learners to identify real-world problems (from local to global contexts), develop solutions based on evidence, and present their findings using 21st-century skills. Learners demonstrate what they have learned as they work on project units, interact in the learning process, collaborate, and engage in self and peer assessment, rather than relying solely on tests or final products to indicate learning. Wolpert-Gawron also emphasizes that PjBL fundamentally teaches learners to use the "4Cs" (Collaboration, Communication, Critical Thinking, and Creativity) to work on and produce project outcomes. Schlemmer and Schlemmer (2005) similarly state that projects are key to providing challenges and motivating learners. According to Lenz et al. (2015), learner success is achieved when they acquire knowledge, apply it, and continuously update and develop it through reflective practices.

Iseminger (2012) notes that PjBL implementation involves a lengthy inquiry process where learners respond to complex questions, problems, or challenges. This process develops learners' abilities in presenting arguments, making choices, and solving projects with a structured approach. Projects are carefully planned, managed, and evaluated to build skills in collaboration, communication, and critical thinking essential 21st-century practical skills and to produce high-quality, original, and publishable results. Supporting Iseminger, Bradley-Levine & Mosier (2014) assert that PjBL promotes rigorous learning by requiring learners to take an active role in comprehending concepts and content, while fostering 21st-century skills, a persistent curiosity, and a strong drive for knowledge acquisition. Simultaneously, learners apply classroom content to real-life phenomena, fostering career development, technological engagement, and interaction with communities in relevant contexts.

Iseminger identifies several essential 21st-century skills: (1) collaboration within groups or teams and affiliation with other teams, (2) effective communication in expressing opinions and presenting projects, and (3) higher-order critical thinking skills to address general learning challenges and specific project responsibilities. Each of these skills involves specific indicators, such as teamwork responsibility, group decision facilitation, resource organization, and respect for diverse ideas. For communication skills, indicators include organizing ideas for audience relevance, effective oral presentation, visual aid design, audience responsiveness, and appropriate question responses. Critical thinking and problem-solving skills include defining and clarifying issues, gathering credible information from various sources, synthesizing conclusions, and evaluating alternatives to anticipate consequences.

Laur (2013) emphasizes that assigning tasks that are overly simplistic results in quick, superficial learner responses, while overly challenging tasks lead to frustration. It is therefore essential to create engaging, authentic learning experiences that encourage deep exploration of content in line with learning standards. In modern classrooms, learners should be confronted with complex, real-world problems that not only encourage critical thinking but also provide authentic learning experiences that differ across learner groups, accommodating varied learning styles and backgrounds. According to Laur, no one can immediately answer complex questions without guidance. Thus, PjBL requires facilitators to help learners guide their own learning based on their interests. PjBL simultaneously challenges and supports learners, motivating them even without direct incentive.

Ravitz (n.d) supports Iseminger's views, describing PjBL as an innovative and empirically proven strategy that fosters in-depth learner engagement and understanding. Ravitz argues that PjBL should include: (1) extended inquiry time, (2) deep topic investigation, (3) learner autonomy in choices, and (4) presentation of findings or conclusions. Synthesizing various definitions, PjBL can be understood as a learning model designed to facilitate learners in producing one or more projects representing the achievement of curriculum-aligned learning objectives. Projects include various challenging issues and questions that require solutions from learners to successfully complete the project. Project concepts and plans are designed by facilitators and chosen or constructed by learners, individually or in groups, to work and complete through learning and working activities. These projects leverage multiple resources, disciplines, and even contemporary technologies, such as the internet, for research. Learners form specific learning communities, communicate, discuss, and debate to achieve their best projects. Projects encourage collaboration and affiliation with peers, argument development, and project presentations, which may extend beyond the classroom and potentially reach a global audience.

Characteristics of Project-Based Learning

Project-Based Learning (PjBL) is characterized by distinct qualities that set it apart from other learning models. According to Boss & Krauss (n.d), PjBL, supported by contemporary technology, transforms the traditional classroom into an enhanced learning environment. Learners engage with real-world projects, fundamentally altering their learning experience. This shift changes the role of the instructor, who no longer merely dispenses content in bite-sized portions. Learners, in turn, evolve from passive participants to active inquirers, motivated to answer their own questions and construct meaning individually. Additionally, the classroom environment itself adapts, as instructors design projects that encourage students to explore diverse learning resources and utilize technology to access and analyze information globally. Real-time interaction between learners and experts becomes possible, fostering a new learning community where they can communicate, discuss, debate, and exchange ideas collaboratively. Bender underscores that PjBL is well-suited as a principal teaching model for future education, recommending it as an innovative approach for educators (n.d).

Warren (2014) provides an insightful perspective on the unique nature of projects created through PjBL, explaining that traditional projects often rely on "hands-on" activities, which may not necessarily engage the "mind-on" component. In contrast, PjBL projects inherently require both mental and manual engagement, combining hands-on activities with critical thinking by integrating inquiry-based, research-based, and technology-based learning strategies that utilize 21st-century skills. Consequently, PjBL fosters knowledge transfer to real-world scenarios, preparing learners for continued education and future careers. Based on these characteristics, PjBL can be identified by several core elements: (1) clear, well-defined learning objectives, (2) projects aligned with learning goals that present complex issues and questions requiring solutions, (3) opportunities for students to express opinions and choose projects, encouraging active participation, and (4) the role of the instructor as a facilitator who supports students in completing projects through the use of diverse resources and interdisciplinary knowledge. Furthermore, PjBL includes detailed project guidelines that help learners construct knowledge and experience, ultimately sharing their projects within and beyond the classroom.

Project-Based Learning Implementation Steps

PjBL implementation comprises a structured process designed to help students acquire essential 21st-century skills, including collaboration, communication, and critical thinking. Du and Han outline the general PjBL process as follows: (1) Introduction for planning, (2) Core for project implementation, and (3) Conclusion for evaluation (Du, & Han, 2012).

Various authors propose specific PjBL frameworks. Papandreou's six-step model includes preparation, planning, research, conclusion, presentation, and evaluation, while offer a similar structure Papandreou et al. (n.d.). Stoller's (1997) ten-step model adds more detailed procedures, such as selecting themes and data analysis. Du & Han (201) suggest that step variations depend on subject matter and learner characteristics. A standardized seven-step PjBL process includes (Du & Han, 2012); (1) Designing and Planning the Project: Instructors plan and prepare the learning framework, ensuring that projects align with student contexts and implementation goals, allowing for student input and choices; (2) Aligning the Project to Standards: Instructors utilize curriculum standards to ensure that project objectives meet core learning goals and subject matter understanding; (3) Building a Collaborative Culture: Creating an independent classroom culture, instructors encourage students to develop habits of open inquiry, teamwork, and quality focus; (4) Managing Project Activities: Instructors help students organize tasks, set schedules, manage resources, create products, and facilitate presentation opportunities; (5) Scaffolding Student Learning: Instructors provide diverse resources, tools, and strategies to support all learners in achieving learning goals and completing projects; (6) Assessing Student Learning: Through formative and summative assessments, instructors measure students' knowledge and skills, including self-assessment and peer review within team or individual work; (7) Engaging and Coaching Student Performance: Instructors actively guide students throughout the learning and project process, addressing needs, providing feedback, and celebrating project achievements.

Cameron and Craig (2004) describe project tasks as authentic activities, which may include presenting questions, conducting research, and creating multimedia products for appropriate audiences. Such tasks require students to present and reflect on their learning. The number of PjBL steps may vary depending on learning objectives, instructional needs, and project types (Du & Han, 2012).

They suggest that project tasks are authentic learning activities executed through the following steps (Cameron & Craig, 2004); (a) Introduction: The instructor introduces the project steps, using visuals, videos, audio, and detailed scenarios; (b) Presenting Essential Questions: The instructor poses questions central to the project focus; (c) Research and Documentation: Students conduct research to answer the questions, drawing conclusions and solving tasks; (d) Project Execution: Students create multimedia products to present project information; (e) Presentation: Students present their projects to appropriate audiences, such as school staff, parents, or relevant community groups; (f) Evaluation and Reflection: Instructors and students assess learning and performance using rubrics, feedback, self-assessment, and reflection.

Based on these procedural variations, it can be concluded that the number of steps in PjBL depends on the specific learning objectives, instructional characteristics, and the type and scope of the project being undertaken.

3. Methods

Type of Research

This study employs a Quasi-Experimental Design (Fraenkel & Wallen, 2009), involving three experimental groups selected through purposive sampling. Each group engaged in a curriculum based on Usbec over one semester (Haenilah, 2018). Following the instructional period, both instructors and students from these groups undertook performance tests to assess the effectiveness of the provided instruction. The performance test implemented was Project-Based Learning (PjBL). A simplified overview of the research design is presented in Figure 1.

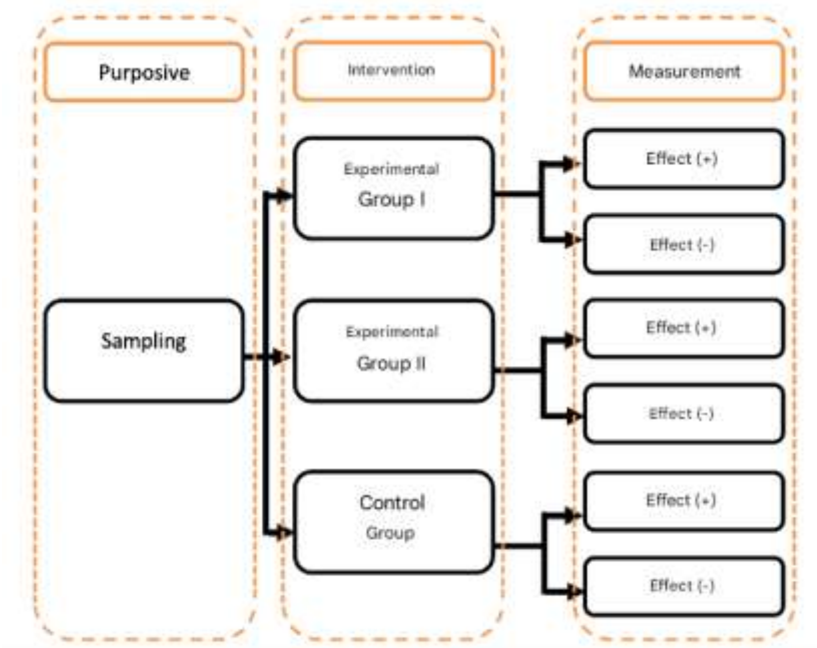

Figure. 1. Research Design

AI Tools

The research was conducted at the host university using The Static Group Pretest-Posttest Design (Sukmadinata, 2010; Fraenkel et al., 2011). In this study, static groups refer to classes with equivalent skill levels taught by the same instructor. The intervention involved PjBL instruction. The research team comprised two investigators (one lead and one member), supported by administrative staff and involving engineering students from Universitas Negeri Makassar (UNM), over a period of eight months.

The research procedure included the planning stage, the implementation stage, and the final stage. In the planning stage, researchers developed the Semester Learning Plan (RPS), Student Worksheets (LKM), PjBL guidelines, and critical thinking skills tests. During the implementation stage, PjBL instruction was administered. The final stage involved data analysis, discussion, and conclusion drawing. Data collected comprised scientific literacy test scores and student feedback on PjBL. Instruments included critical thinking skill tests assessing knowledge and competence, attitude scales, and student feedback forms on PjBL.

The scientific literacy test assessed not only students' scientific knowledge but also their competency in science, application skills, scientific attitudes, and competency in real-world scenarios. Student feedback was collected using a questionnaire consisting of statements rated on a Likert scale. Data collection techniques included written tests and questionnaires.

The test items were validated by expert judgment and trial-tested. Multiple-choice questions measured knowledge and competence within specific material contexts, while scientific attitude was assessed via a Likert scale. The trial test of multiple-choice questions yielded a correlation coefficient (rxy) of 0.58 and a reliability coefficient of 0.73 (high category). For the scientific attitude scale, Cronbach's Alpha reliability was 0.619 (high category).

The improvement in students' critical thinking skills after PjBL instruction at the host institution was calculated by determining the normalized average gain (N-Gain). This approach mitigates potential errors in interpreting individual gain scores

(Gunawan, & Liliasari, 2013). The formula by Hake ((1998) used for this calculation is:

$$\boxed{< g > = \frac{\%(S_f) - \%(S_i)}{100 - \%(S_f)}}$$

Where g is the normalized gain, Sf is the average posttest score, and Si is the average pretest score. According to Hake, the interpretation of the average normalized gain is as follows: (<g>) < 0,3, low; 0,3 ≤ (<g>) < 0,7, moderate; and (<g>) ≥ 0,7, high (Hake, 1998).

Once the normalized average gain scores for both groups are obtained, they are compared to determine the differential increase in critical thinking skills between the classes. If the normalized average gain of one class is higher than that of the other, it suggests a potential gender difference in critical thinking skill outcomes. Hypothesis testing is conducted using a one-sided t-test for the upper tail, employing SPSS 17 software for a two-sample independent t-test. The purpose of the two-variable t-test is to compare whether the two variables are statistically similar or different, enabling generalization of the research findings by comparing two sample means.

4. Results and Discussion

Faculty of Engineering Lecturers' Understanding of Project Based Learning

The analysis indicates significant variation in the understanding of Project-Based Learning (PjBL) among faculty members in the Faculty of Engineering. Based on the diagram, 50% of the faculty identify themselves as knowledgeable about PjBL, suggesting that half of the instructors are familiar and competent with this teaching method. Additionally, 25% report a high level of understanding, indicating a deeper comprehension and likely more experience in applying PjBL. Meanwhile, 15% of faculty members classify themselves as having a moderate understanding, implying foundational knowledge but room for further development. On the other hand, 10% admit to limited understanding, highlighting a need for additional training or learning to enhance their competence in this area. No faculty members reported a complete lack of understanding, indicating that all instructors possess at least some awareness of PjBL.

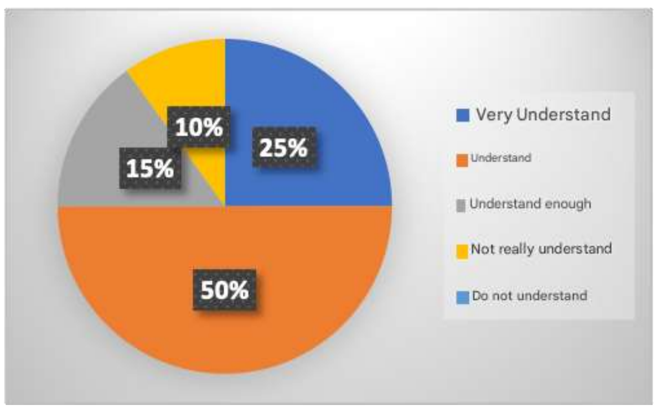

Figure 2. Diagram of Lecturers' Understanding of Project Based Learning

Depth of Student Understanding of Course Material Provided by Faculty

The analysis reveals notable variation in students' depth of understanding of the course material provided by their instructors. The majority, 60%, report a high level of understanding, indicating that most students not only receive but also grasp the concepts effectively. An additional 30% categorize themselves as understanding, reflecting a sound, albeit potentially less profound, comprehension compared to the previous group. A smaller proportion of students, 5%, report moderate understanding, suggesting a foundational grasp but a need for further reinforcement. Another 5% report limited understanding, pointing to a potential need for more effective teaching approaches or additional support. No students indicated a complete lack of understanding, suggesting that all students have some level of comprehension, though to varying degrees.

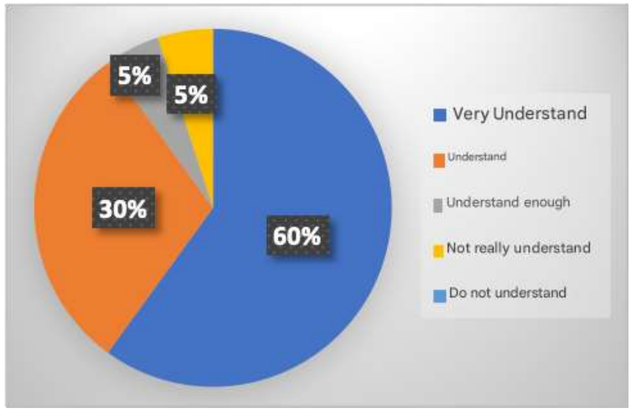

Figure 3. Depth of Student Understanding of Course Material

Implementation Procedure of Project-Based Learning by Faculty

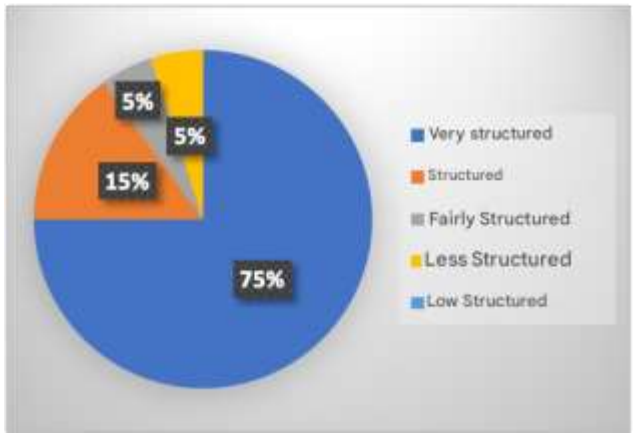

Figure 4. Diagram of Project-Based Learning Implementation

The analysis shows varied levels of structuring in the implementation of Project-Based Learning (PjBL) by faculty in the Faculty of Engineering. The majority, 75%, follow a highly structured approach, indicating that most instructors plan and execute PjBL with clear, well-organized steps to ensure that each stage aligns with learning objectives. Another 15% of faculty members implement PjBL with a structured approach, signifying a solid, though potentially improvable, planning and execution process. In contrast, 5% use a moderately structured procedure, reflecting efforts to plan but a possible lack of consistency or thoroughness in implementation. Additionally, 5% apply a minimally structured approach, suggesting challenges in systematic project execution or full adherence to PjBL principles. No faculty were found to use an unstructured approach, showing that all instructors possess at least a basic framework for implementing PjBL, albeit with varying levels of detail.

Critical Thinking Level of Students in the Learning Process

According to the analysis, students demonstrate generally positive critical thinking skills in the learning process. Most students, 68%, rank in the "Very High" category for critical thinking, indicating that they can analyze, evaluate, and synthesize information effectively. Another 25% of students rate as "High" in critical thinking, reflecting strong but somewhat less intensive skills. However, 7% are classified as "Moderate," suggesting a basic ability to think critically that could benefit from further development. No students fall into the "Low" or "Very Low" categories, indicating that all students possess adequate critical thinking skills.

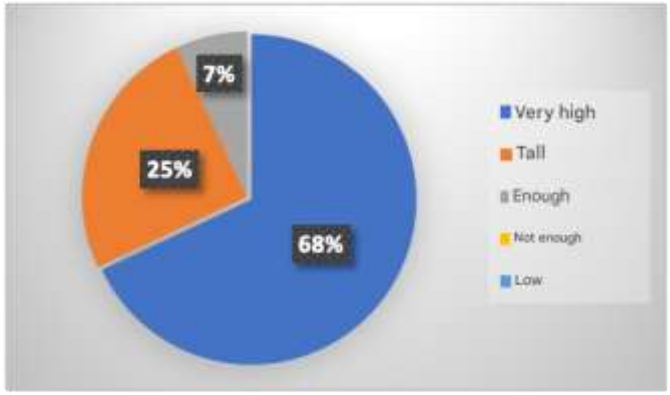

Figure 5. Diagram of Students' Critical Thinking Level in the Learning Process

Student Collaboration Level in the Learning Process

The analysis indicates a very high level of collaboration among students during the learning process. A large majority, 90%, exhibit “Very High” collaboration skills, demonstrating effective interaction, communication, and contribution within groups. An additional 7% fall into the “High” category, showing strong collaborative abilities, albeit to a slightly lesser extent. Only 3% of students rank as “Moderate,” suggesting adequate collaboration skills but a need for improvement to reach higher levels. No students are categorized as “Low” or “Very Low,” indicating that all students possess at least satisfactory collaborative abilities.

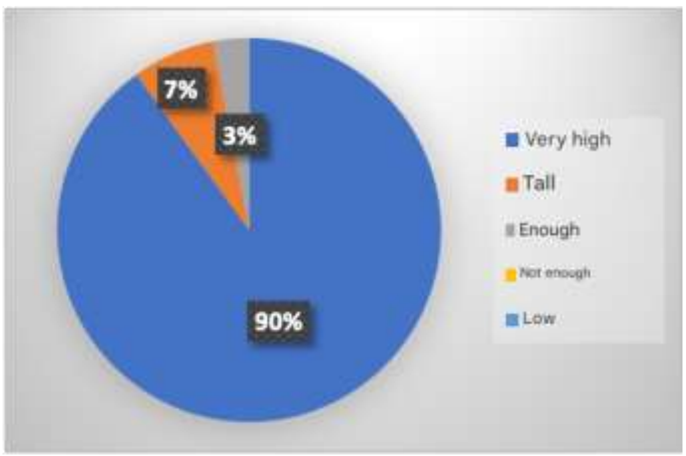

Figure 6. Diagram of Student Collaboration Level in the Learning Process

Overall Student Response to the Implementation of the PjBL Model

The analysis reveals that students generally respond very positively to the implementation of the Project-Based Learning (PjBL) model. A vast majority, 92%, rate their experience as “Very Good,” suggesting that most students find the model effective, beneficial, and in line with their learning expectations. An additional 7% rate the model as “Good,” reflecting appreciation for PjBL, though perhaps with a few areas they believe could be improved. A small proportion, 1%, rate their experience as “Moderate,” indicating satisfaction but with certain challenges encountered in PjBL implementation. No students rated the model as “Poor” or “Very Poor,” indicating that PjBL is well-received overall and considered an effective learning approach.

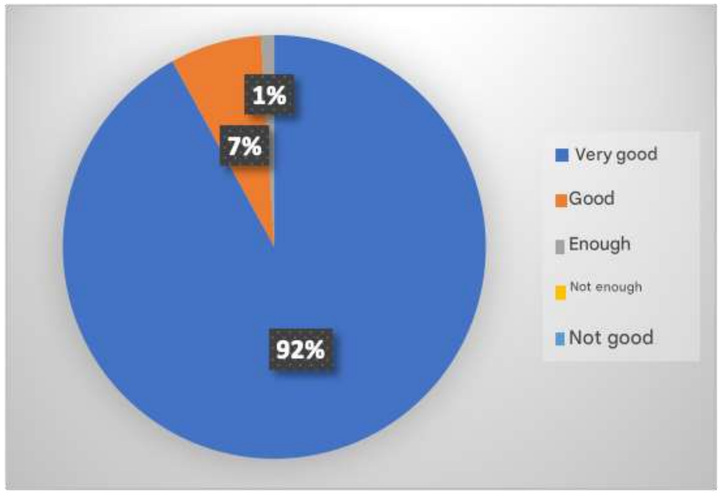

Figure 7. Diagram of Overall Student Response to PjBL Implementation

5. Conclusions and Recommendations

The research findings provide significant insights into the application and effectiveness of Project-Based Learning (PjBL) in the Faculty of Engineering at Universitas Negeri Makassar. Results show that 50% of faculty members have a moderate understanding of PjBL principles, indicating familiarity with foundational concepts yet suggesting areas where deeper knowledge and enhanced application could be beneficial. Concurrently, 60% of students report a strong understanding of course material delivered through PjBL, reflecting a commendable level of comprehension that supports positive learning outcomes. Regarding critical thinking skills, 68% of students demonstrate very high proficiency, suggesting that PjBL effectively fosters critical analysis, evaluation, and synthesis skills, which are essential competencies in engineering education. Faculty implementation of PjBL is similarly promising, with 75% of instructors adopting highly structured procedures. This structured approach suggests that most faculty members plan and execute PjBL with defined objectives and systematic steps, ensuring alignment with learning goals. Student collaboration levels are also notably strong, with 90% of students exhibiting high collaborative skills. This outcome aligns with the collaborative emphasis of PjBL, suggesting that students are engaging effectively with peers, sharing insights, and collaboratively addressing challenges. Moreover, student feedback on PjBL is overwhelmingly positive, with 92% indicating high satisfaction and recognizing the model's relevance and effectiveness in enhancing their learning experience. Based on these findings, it is recommended that the Faculty of Engineering at Universitas Negeri Makassar expand the use of PjBL within its curriculum. Expanding faculty development opportunities, particularly in PjBL training and instructional best practices, could further improve teaching effectiveness. Such integration promises to enhance students' critical thinking, collaboration skills, and overall engagement, which aligns with the objectives of modern engineering education.

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