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Perceptions of Students and Lecturers on *Project-Based Learning* in Higher Education

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Abstract: This study examines the perceptions of students and lecturers on Project-Based Learning (PjBL) in environmental chemistry courses at Jambi University, Indonesia, to evaluate its effectiveness and challenges. A mixed-method survey was conducted with 30 students and 30 lecturers using Likert-scale questionnaires and open-ended questions. Data were analyzed descriptively and thematically. All lecturers (100%) adopted PjBL, but only 46.67% published student outcomes. Meanwhile, 78% of students reported improved problem-solving skills, though 40% struggled with theory-practice linkages. While PjBL enhances engagement and skills, gaps in guidance (only 63.33% of lecturers provided written guidelines) and institutional support hinder optimal implementation. PjBL is effective but requires structured frameworks and resource allocation to address time constraints and material complexity in Indonesian higher education.

Keywords: Environmental chemistry; Higher education; Lecturer perception; Project-based learning; Student perception.

Introduction

1st-century education requires the mastery of essential skills such as critical thinking, problem-solving, collaboration, and creativity, yet traditional lecture-based methods still dominate higher education in Indonesia. Studies have shown that project-based approaches and the integration of technology in learning can significantly enhance student engagement while also facilitating the understanding of complex scientific concepts (Akçayır & Akçayır, 2018). One pedagogical model that effectively supports the development of these skills is Project-Based Learning (PjBL). Through this approach, students are not only exposed to theoretical knowledge but are also encouraged to apply it in real-world contexts through meaningful projects. Recent research highlights that PjBL substantially strengthens 21st-century skills, particularly critical thinking, teamwork, and creativity, especially within higher education settings (Yuanti et al., 2025) (Risnawati & Purwaningsih, 2025). This aligns with findings that active student participation fosters deeper understanding and long-term retention of knowledge (Chistyakov et al., 2023). Moreover, recent systematic reviews emphasize the increasing relevance of green and sustainable chemistry education, reinforcing the importance of integrating PjBL into environmental contexts. Within environmental chemistry courses, this approach proves especially valuable, as it bridges core chemical concepts with pressing sustainability challenges faced by society today.

This study introduces several key innovations that contribute to the advancement of project-based learning (PjBL) in Indonesian higher education, particularly in the context of environmental chemistry. While PjBL has been widely examined in STEM education globally, its application in Indonesian environmental chemistry courses especially those addressing local issues such as peatland fires and waste management remains limited. To address this gap, the study adopts a dual-perspective approach by analyzing both student and lecturer experiences, thereby uncovering systemic challenges that often go unnoticed when focusing on a single group. Furthermore, the research explicitly integrates PjBL with

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the principles of green chemistry (Asyhar & Minarni, 2023). demonstrating how projects can foster sustainable practices, including safer laboratory techniques and circular economy models. This integration builds on existing evidence, such as the findings who showed that problem-based learning enables students to deeply engage with green chemistry concepts through real-world applications. Likewise, studies on the development of e-worksheets in green chemistry contexts indicate that PjBL significantly enhances students' creative thinking (Janah & Hidayah, 2025), while the incorporation of PjBL-based modules in high schools has been proven to improve science process skills (Afriana et al., 2016). Additional research also highlights that teaching materials designed with the PjBL-STEM model substantially strengthen students' creative thinking abilities (Purba et al., 2024).

The significance of this work lies not only in its academic contribution but also in its alignment with national education policy and global relevance. In Indonesia, the study directly supports the Merdeka Belajar curriculum and the principles of Outcome-Based Education as mandated by Permendikbudristek No. 53/2023. Its findings will be communicated to the Directorate of Learning to inform revisions of the national PjBL guidelines, thereby ensuring stronger policy-practice coherence. At the practical level, the research responds to pressing barriers in implementation, such as the 67.6% of lecturers who report time constraints, by proposing actionable strategies, including the adaptation of standardized PjBL templates suggested by (Walther et al., 2013). Beyond Indonesia, the outcomes of this study offer insights for other universities in the Global South facing similar limitations, as reflected in comparable contexts in the Philippines (Pratami et al., 2024)

Through the exploration of lecturer and student perspectives, this study ultimately seeks to diagnose the implementation challenges of PjBL, such as inconsistencies in guidelines and the persistent gap between theory and practice. More importantly, it aims to develop a contextualized PjBL framework for environmental chemistry education that not only upholds academic rigor but also generates real-world impact by promoting sustainability-oriented learning.

Method

This study employed a mixed-methods descriptive survey design to capture both quantitative and qualitative perspectives on PjBL implementation. This study engaged 30 environmental chemistry students from Bachelor's Program in Chemistry Education and 30 lecturers from Jambi University, selected through purposive sampling to ensure depth of PjBL experience. While the sample size is modest, it provides focused insights into discipline-specific PjBL implementation. Lecturers were drawn from multiple departments to capture cross-disciplinary perspectives, all with ≥2 years of active PjBL use, a deliberate criterion to prioritize informed viewpoints.

Quantitative data were collected through structured questionnaires using a 4-point Likert scale (1 = Very Poor to 4 = Excellent), while qualitative insights were gathered via open-ended questions embedded in the same instruments (e.g., "Describe your most significant challenge in applying PjBL. Quantitative responses were analyzed using percentage scoring:

$$p = \frac{\sum R \times 100\%}{N} \quad (1)$$

where N = number of respondents. Qualitative data underwent thematic analysis following Braun and Clarke's (2006) framework to identify patterns in open-ended responses.

Quantitative data were analyzed using percentage formulas to determine the distribution of responses in each category. The results were then classified into interpretation levels (Table 1), which allowed us to identify whether the perception was highly positive, positive, neutral, or needed improvement. For example, if 24 of 30 students reported improved problem-solving skills, the score was calculated as:

$$P = \frac{24}{30} \times 100\% = 80\% \quad (1)$$

which falls into the "Positive" category. Qualitative data were analyzed through thematic analysis (Braun & Clarke, 2006), which included the following steps: (1) familiarization with the data by repeatedly reading student and lecturer responses, (2) generating initial codes for recurring statements, (3) grouping codes into potential themes such as "time constraints" or "theory–practice gap," (4) reviewing and refining the themes, (5) naming and defining each theme, and (6) compiling the results into a narrative report.

To ensure validity, findings from the quantitative analysis (percentage scores) were triangulated with qualitative themes from open-ended responses. This combination strengthened the interpretation by not only showing the proportion of agreement but also explaining the reasons behind those numbers.

Perception scores were categorized using established educational assessment thresholds (Ministry of Education Indonesia, 2022), where ≥61% indicates positive reception – a benchmark consistent with PjBL studies in similar contexts (e.g., Smith et al., 2021). Notably, no responses fell below 40%, suggesting broadly favorable outcomes. Details are provided in Table 1.

Table 1. Validation Criteria or Achievement Levels Used in Student and Lecturer Responses

Percentage range	Interpretation
81.00–100.00	Highly positive
61.00–80.00	Positive
41.00–60.00	Neutral/mixed
≤40.00	Needs improvement

Note: Thresholds follow common educational assessment standards (Ministry of Education Indonesia, 2022) and prior PjBL studies (Arasaratnam-smith & Hodson, 2021).

Result and Discussion

Lecturers' Perspectives on PjBL

In general, the study results show that the majority of lecturers have experience implementing PjBL in their teaching. According to Table 2, While all lecturers adopted PjBL, only 80% successfully integrated it, suggesting a gap between adoption and effective implementation. This could stem from lack of training or unclear institutional guidelines. Furthermore, as shown in Figure 1, most lecturers demonstrate a strong conceptual understanding of the PjBL model. These findings are in line with research indicating that integrating STEM elements within PjBL significantly strengthens students' higher-order thinking skills in chemistry (Setiawan et al., 2025). This aligns with evidence from STEM-integrated PjBL studies combined with lesson study approaches, which effectively enhance students' critical thinking skills in chemistry education (Nurdiana et al., 2024). Additionally, analyses of PjBL-STEM lesson design in renewable energy contexts support its potential in boosting students' creative problem-solving skills (Rabbani et al., 2023).

Table 2. Lecturers' Perspectives on PjBL

Question	Response Percentage (%)	Category
Have you ever implemented PjBL in your teaching?	100	Excellent/ Very Positive
To what extent is the course you teach integrated with the PjBL approach?	80	Good/ Positive
Can all the materials be delivered as planned?	66.57	Good/ Positive
Have you ever created a written guideline for the project?	63.33	Good/ Positive
Have students' project results ever been compiled into a book or published?	46.67	Fairly Good/Fairly Positive

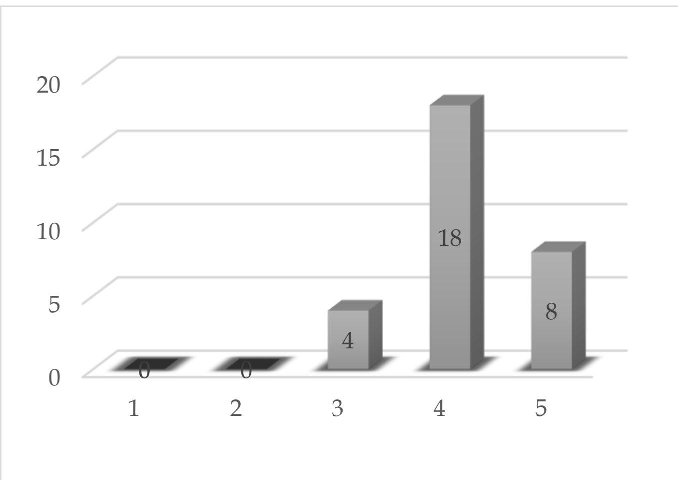

Figure 1. Lecturers' Understanding of the PjBL Concept

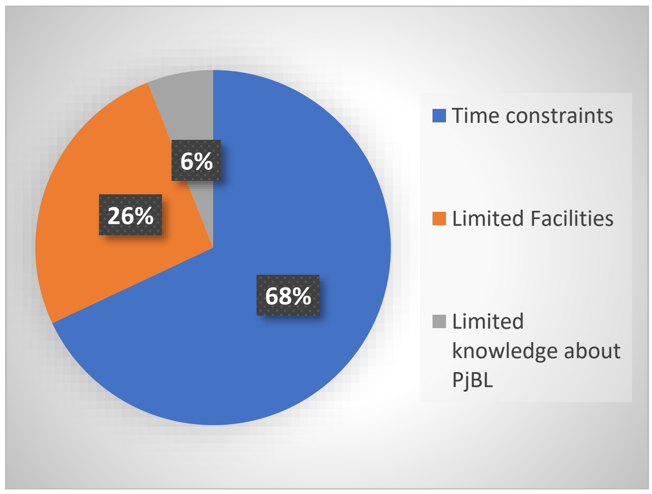

Figure 2. Challenges Faced by Lecturers in Implementing PjBL

Additionally, several challenges persist in its implementation, as shown in Figure 2. This suggests that while the implementation of PjBL has been progressing well, there is still room for improvement, this aligns with (Minarni, Afrida, et al., 2022), who found that PjBL significantly improves students' science process skills and learning outcomes in chemistry education. Despite this, there is still room for improvement, especially in publishing student project outcomes to further enhance learning quality.

Students' Perceptions of PjBL

The study results also show that 100% of students have participated in PjBL activities in the Environmental Chemistry course, demonstrating that this method has been fully implemented. Furthermore, 78% of students reported an improvement in their problem-solving skills after engaging in the projects, which placing them in the Good/Positive category as shown in Table 3.

Table 3. Students' Perceptions of PjBL

Question	Response Percentage (%)	Category
Have you ever been involved in a learning project in an environmental chemistry course?	100	Excellent/ Very Positive
How do you assess your problem-solving skills after completing the project?	78	Good/ Positive
Do you agree that this course should be studied for further instructional development?	89.30	Excellent/ Very Positive

Additionally, 89.30% of students agreed that the instructional design of the Environmental Chemistry course should be further developed. These findings highlight students' recognition of the importance of enhancing learning methods to better support their understanding of environmental concepts.
Furthermore, we also found that the students still face various challenges in the learning process, as shown in Figures 3 and 4. Similarly (Pan et al., 2024) demonstrated that the use of prequestioning strategies significantly improved student comprehension in environmental chemistry learning.

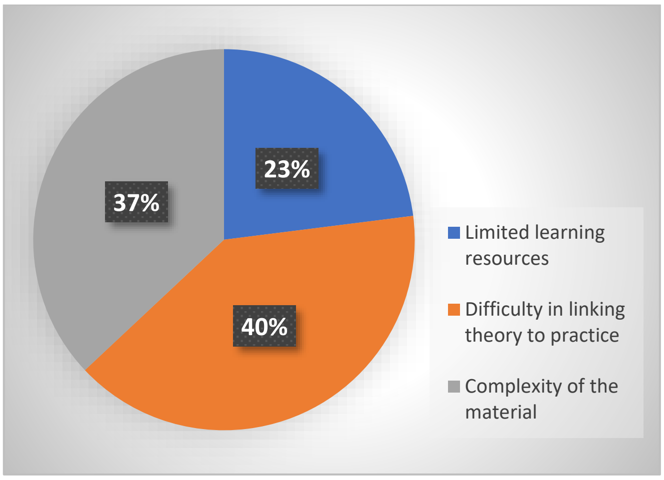

Figure 3. Students' Difficulties in Learning with the PjBL Model

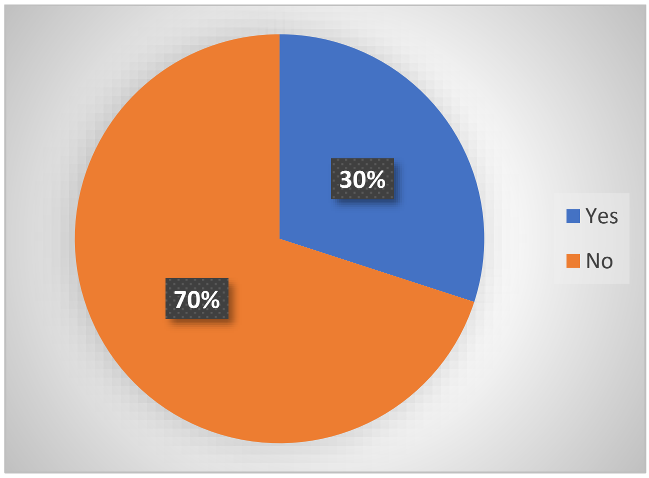

Figure 4. Students' Difficulties in Understanding Environmental Chemistry Material

Lecturers' and Students' Perceptions of PjBL Implementation in Environmental Chemistry Courses

The study results indicate that most of the lecturers (82.67%) have a good or excellent understanding of the PjBL concept. This suggests that, at a conceptual level, lecturers are aware of the PjBL approach and its benefits for students. These findings align with (Hmelo-Silver, 2004), who stated that lecturers with a strong understanding of PjBL can to increase student enthusiasm better and provide a more in-depth learning experience.

However, despite this high conceptual understanding, only 46.67% of lecturers have published student project outcomes. This highlights challenges in utilizing student projects as academic outputs This aligns with (Thomas & D, 2000) and (Quint & Condliffe, 2018), who emphasized the benefits of PjBL in supporting active engagement and meaningful learning that can be further developed. Similarly, (Setiawan et al., 2025) & (Pratami et al., 2024) noted that while PjBL positively impacts students' skill development, its implementation still faces obstacles in terms of publishing project results, time management, and team coordination during project execution.

On the other hand, students' perspectives on PjBL in environmental chemistry courses reveal that 78% of students believe that the projects they undertook helped improve their problem-solving skills. This finding supports (Afriana et al., 2016), who stated that the PjBL model contributes to enhancing students' critical thinking, communication, and decision-making skills. Additionally, 89.30% of students agreed that project-based learning methods should be further developed to improve instructional design in the course.

However, several challenges remain in the implementation of PjBL in higher education. This is supported by (Epinur et al., 2024), who reported that while inquiry-based flipped classroom learning in acid-base material improved students' science literacy, both lecturers and students perceived difficulties in managing time and designing projects that align with course objectives. Similarly, (Lenggogeni & Mawardi, 2022) found that although guided-inquiry flipped classroom approaches significantly increased learning outcomes and N-gain scores in acid-base chemistry, students often struggled with connecting project activities to theoretical concepts, and lecturers faced constraints in providing consistent guidance throughout project stages. Moreover, challenges such as limited learning resources (23.30%), material complexity (36.70%), and difficulties in linking theory to practice (40%) persist in PjBL implementation. Similar constraints have also been identified in environmental science courses, where research team-based learning (RTBL) has been proposed as an effective strategy to build research skills and overcome resource limitations (Daryanes et al., 2025). (Janah & Hidayah, 2025) (Yuanti et al., 2025) also noted that while PjBL enhances critical thinking and collaboration, students still encounter barriers in accessing resources and integrating theory with practice. This aligns with (Risnawati & Purwaningsih, 2025) who highlighted that institutional constraints, unclear project guidelines, and limited support systems often hinder optimal PjBL implementation, similar to the challenges identified in this study. The flipped classroom method made it possible for students to engage in active learning through experiment, investigation, and hypothesis testing. Similarly, Brady and (Brady & Voronova, 2023) demonstrated that flipped online active learning environments were effective for improving engagement and performance in large chemistry classes. This learning condition enhances students' ownership of learning, supports collaboration, and allows for meaningful contextualization.

In-depth interviews highlight that time constraints are a major obstacle in implementing PjBL. A total of 67.6% of lecturers stated that the available class time was often insufficient to fully integrate all materials with a project-based approach. This aligns (Nurdiana et al., 2024), who found that although PjBL increases student interest and enthusiasm, poor time management remains a significant barrier. Furthermore, 35.3% of lecturers admitted that they had never created written guidelines for projects, which might hinder the effectiveness of PjBL implementation. Students' perspectives also confirmed this issue, with 51% stating that they only received general instructions from lecturers without clear guidelines.

Student and Lecturer Engagement in PjBL Implementation

Survey results indicated that 64.7% of lecturers have developed written guidelines for student projects. This absence of written guidelines affects students' preparedness in carrying out their projects. A total of 49% of students stated that they received written project guidelines, while 51% only received verbal instructions. However, the absence of written guidelines (35.3% of lecturers) led to student confusion, indicating a need for structured documentation to streamline project execution.

Additionally, 37.3% of students reported experiencing difficulties in linking theory to practice during the environmental chemistry course. This aligns with the study by (Vaz et al., 2025) (Lenggogeni & Mawardi, 2022), which found that students still face challenges in integrating academic concepts with practical experiences in the field. Most students (52.83%) strongly agreed that further research is needed to develop a more effective instructional design for the course. Meanwhile, 30.19% of students supported this with a high level of agreement, while 16.98% responded with moderate agreement. These data indicate the need for instructional design innovations that can bridge the gap between theory and practice in the classroom.

Furthermore, a major challenge in implementing PjBL stems from resource limitations. (Epinur & Minarni, 2023) also found that the use of inquiry-based worksheets in a flipped classroom context can enhance students' argumentation abilities, particularly in abstract chemistry topics. A total of 26.5% of lecturers considered the lack of infrastructure and facilities a significant obstacle to the execution of project-based learning. On the other hand, students expressed the need for greater support in the form of more diverse learning resources to ensure that their projects are meaningful and applicable.

The Impact of PjBL Implementation on Students and Lecturers

The research findings indicate that students involved in project-based learning experience improvements in problem-solving skills and scientific literacy. A total of 64.7% of students reported that this method helped them think critically and find solutions to problems presented in the project. This finding aligns with the study by (Putra et al., 2024) which stated that PjBL effectively enhances students' critical and analytical thinking skills. This is also consistent with the findings of (Minarni, Epinur, et al., 2022) who conducted a study on the implementation of STEM-integrated Project-Based Learning (PjBL) in a Biochemistry II course. Their research demonstrated that the application of the PjBL-STEM model not only improved students' learning outcomes but also enhanced science process skills such as observing, predicting, experimenting, and hypothesizing. The implementation rate across three meetings averaged 84%, with consistent improvement in posttest scores (from 72.3 to 84 on average). These results indicate the effectiveness of combining PjBL with STEM elements in developing students' higher-order thinking and problem-solving skills in scientific contexts.

The study confirms PjBL's effectiveness in enhancing student engagement (89.3% approval) and problem-solving skills (78% improvement), aligning with (Habibah et al., 2025) findings. However, 67.6% of lecturers cited time constraints as a barrier, mirroring challenges identified by (Rabbani et al., 2023) To address this, a flipped classroom hybrid model (Bell, 2010) could free up class time for project work.

Despite its many benefits, this study also reveals several challenges in implementing PjBL. One of the most significant obstacles is the limited time available to accommodate all project phases. (Epinur et al., 2022) (Minarni, Afrida, et al., 2022) demonstrated that implementing discovery learning supported by virtual laboratories can significantly improve students' understanding and learning outcomes in chemistry, especially for abstract topics such as reaction rates. Additionally, research shows that integrating project-phase innovation with entrepreneurship-oriented learning can strengthen students' ability to contextualize chemistry content in real-world business opportunities (Epinur et al., 2022). Similar to the findings of (Akçayır & Akçayır, 2018), students also struggled with bridging theoretical concepts and practical applications, a common challenge in STEM-focused PjBL. However, this study's emphasis on environmental chemistry adds another layer, as green chemistry concepts demand greater contextualization. Therefore, a more systematic strategy is needed to embed PjBL effectively within courses. Universities should consider adopting standardized PjBL frameworks such as rubrics and timeline templates and implement training workshops to ensure consistency, as modeled by (Capraro et al., 2013) STEM PjBL approach. Similar observations were made by (Pratami et al., 2024) and (Afriana et al., 2016) who emphasized that locally contextualized and environmentally oriented PjBL models enhance student engagement and conceptual understanding supporting this study's integration of PjBL with green chemistry principles. Furthermore, integrating AI-assisted problem-oriented project-based learning has also been shown to enhance students' critical thinking and communication skills (Epinur et al., 2024). Comparisons between PjBL and Problem-Based Learning models further confirm that PjBL offers stronger impacts on student outcomes and motivation in science learning (Simbolon & Koeswanti, 2020).

Conclusion

This study confirms widespread acceptance of Project-Based Learning (PjBL) in environmental chemistry education, with universal lecturer adoption (100%) and 78% of students reporting enhanced problem-solving skills. Meta-analyses and recent empirical studies reaffirm that PjBL, especially when combined with STEM and e-module approaches, is highly effective in improving higher-order thinking skills and practical competencies in chemistry education (Risnawati & Purwaningsih, 2025) (Setiawan et al., 2025). Additionally, recent findings demonstrate that the application of PjBL with STEM integration has a significant impact on improving students' science problem-solving abilities, further validating its relevance for chemistry education (Walther et al., 2013) However, three persistent challenges emerged: time constraints (affecting 67.6% of lecturers), inconsistent project guidelines (absent for 35.3% of lecturers, correlating with 40% student struggles in theory-practice application), and resource limitations (reported by 26.5% of lecturers and 23.3% of students). To address these barriers, we propose institutional adoption of standardized PjBL templates aligned with Indonesia's Merdeka Belajar policy, targeted investments in field equipment and digital learning resources, and curricular adjustments to accommodate project timelines. These recommendations, grounded in empirical findings, demonstrate PjBL's potential for broader implementation in Indonesian higher education when supported by structured institutional reforms.

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Author Contributions

This study explores the perceptions of lecturers and students regarding the implementation of Project-Based Learning (PjBL) in higher education. All authors were actively involved in every stage of the research process, including conceptualization, data collection and analysis, as well as writing and revising the manuscript. All authors have reviewed and approved the final version submitted for publication.

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Conflicts of interest

This research was conducted as part of an institutional mandate to enhance the competence and capacity of lecturers. The author is currently a doctoral student in Science Education at Jambi University, and this study represents an academic research output required by the program. The author declares no conflict of interest in the conduct or publication of this research. It is expected that the findings of this study will contribute significantly to the development of human resources within academic institutions and support innovation and progress in the field of education

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