
Students' Perceptions of Green Chemistry in a Project-Based Learning (PjBL) Model Integrated with Local Culture

Familia Novita Simanjuntak¹, Candra Ditasona², Sri Rejeki Ignasia Sitohang³, Angelia Patricia Situmorang⁴

¹ Department of Chemistry Education, Faculty of Teacher Training and Education, Indonesian Christian University, East Jakarta, Indonesia

² Department of Mathematics Education, Faculty of Teacher Training and Education, Indonesian Christian University, East Jakarta, Indonesia

³ Don Bosco 1 Senior High School, East Jakarta, Indonesia

⁴ Kalam Kudus Senior High School, Surabaya, Indonesia

email: familia.simanjuntak@uki.ac.id

Article Info

Article history:

Received: March 9th, 2026

Revised: April 9th, 2026

Accepted: April 12th, 2026

Available online: April 30th, 2026

<https://doi.org/10.33541/edumatsains.v10i4.7168>

Abstract

The purpose of this study is to examine how students see studying green chemistry using a culturally integrated project-based learning (PjBL) approach. This study used a qualitative descriptive methodology and was carried out at Don Bosco High School in Jakarta. A saturation sampling strategy was used to choose a sample of 35 tenth-grade science students. Students' written reflections after the PjBL exercises and observations made during the learning process were used to gather data. Data reduction, data presentation, and conclusion drawing were the phases of data analysis. The study's findings show that students' perspectives of studying chemistry have changed from being initially seen as challenging and abstract to being more relevant and significant. While some difficulties with group cooperation were still noted, the majority of students showed active involvement and positive responses throughout the learning process, as evidenced by increased interest, curiosity, and participation in project activities. More than half of the students selected the composting project as their final result, and they were able to connect it to actual environmental problems, especially how organic waste is managed in everyday life and cultural customs. These results show that the use of culturally integrated PjBL promotes collaborative and relevant learning experiences in addition to giving students a more practical understanding of green chemistry principles. As a result, this teaching approach helps students develop more favorable opinions of chemistry and strengthens the link between scientific ideas and practical applications.

Keywords: Project-Based Learning, cultural integration, students' perceptions, environmental awareness

1. Introduction

In order to meet the demands of globalization, which calls for a workforce that is both competitive and morally upright, education is essential to national growth (Suryanto, 2025). Through a methodical learning process, education not only transfers information but also shapes students' attitudes, beliefs, and actions (Marbun, 2022). According to Simanjuntak (2017), education is supposed to promote environmental awareness and build creative and inventive thinking abilities for the prudent use of natural resources in the framework of sustainable development. As a result, learning must be contextualized, considering pupils' social and cultural surroundings. The integration of culture into education is a strategic approach to creating contextual and meaningful learning. Culture, as a product of human creativity, emotion, and will, embodies values, knowledge, and customs that have been passed down through generations within a society (Akhmad, 2020; Alifia, 2021). In the context of Indonesia, with its cultural diversity, integrating local wisdom into learning can help students understand the material in a way that is more closely connected to their daily lives and foster a sense of care and social responsibility (Windayani, 2024).

The Merdeka Curriculum supports this by providing space for educational institutions to develop learning that aligns with the socio-cultural context and characteristics of students (Rahmat, 2024; Dasmo, 2022). Nonetheless, there is definitely room for improvement in the use of culture-based learning in science, especially chemistry. Students find it challenging to comprehend chemistry training since it is frequently delivered in an abstract and symbolic way (Hatimah, 2021). Chemistry is sometimes seen as a challenging and boring science since microscopic principles are often seen as sophisticated (Muderawan, 2019). As a result, students typically have poor levels of motivation and interest when learning chemistry.

Green chemistry is one field of chemistry that is applicable to daily life but is nonetheless seen as challenging. Because this subject is still relatively new to the curriculum, students' comprehension of its ideas and applications is still somewhat restricted (Harefa, 2023). Through waste reduction, energy efficiency, and the use of safer materials, green chemistry focuses on designing chemical products and processes that are safer, more effective, and ecologically beneficial (Mustafa, 2016; Widyawati, 2024). Thus, teaching green chemistry has a lot of potential to assist sustainable development goals and increase students' knowledge of the environment (Maharani, 2024).

A learning paradigm that can relate chemical principles to students' practical experiences is required to overcome these problems. One such approach is Project-Based Learning (PjBL), which places an emphasis on using contextual and collaborative project activities to solve real-world challenges (Nurhamidah, 2023). Students may actively improve conceptual comprehension, cultivate critical and creative thinking abilities, and come up with solutions to environmental issues using PjBL (Abdurrahman, 2024). Additionally, the incorporation of culture into PjBL makes

learning more relevant by allowing students to relate green chemistry ideas to everyday activities based on local knowledge (Ningsih, 2024; Ramadani, 2025; Januardi, 2024).

Several studies have shown that PjBL is effective in enhancing students' conceptual understanding and engagement in chemistry learning (Nurhamidah, 2023; Abdurrahman, 2024), while the integration of local wisdom has been shown to improve students' contextual understanding (Ramadani, 2025; Januardi, 2024). However, these studies generally focus on cognitive learning outcomes and have not specifically examined how students' perceptions are formed and changed in green chemistry learning that integrates PjBL and culture. In other words, studies that directly link green chemistry, PjBL, local culture, and students' perceptions remain limited. In actuality, students' motivation, enthusiasm, and involvement in the learning process are greatly influenced by their views. According to Triyono (2018), perception is the individual process of processing inputs through the five senses in order to build a viewpoint on the learning experience. Understanding how culturally integrated, project-based green chemistry learning is received, processed, and offers a meaningful learning experience in this environment requires an analysis of students' views.

Based on the above discussion, this study aims to analyze students' perceptions of green chemistry learning through the application of a project-based learning (PjBL) model integrated with culture. This study is expected to contribute to the development of chemistry learning strategies that are more contextual, meaningful, and relevant to students' lives, as well as to support the development of environmentally conscious character in accordance with the requirements of the Merdeka Curriculum.

2. Methods

This study employs a qualitative approach, specifically a descriptive qualitative research design, aimed at systematically and thoroughly describing the phenomena observed during the learning process. This approach was chosen to gain a comprehensive understanding of students' perceptions of green chemistry learning through the implementation of culturally integrated project-based learning (PjBL). According to Margono (2010:8) and Fadli (2021), qualitative descriptive research seeks to present accurate and up-to-date facts to understand phenomena occurring in the field. This study was conducted at Don Bosco High School, Jakarta, during the 2024/2025 academic year. The research subjects were all 35 students in the 10th grade science class. The sampling technique used was a saturated sample, in which the entire population was used as the research sample (Jati, 2017). Data collection techniques employed diary methods, namely observation and student reflection. Observations were conducted to monitor the PjBL learning process, including teacher activities and student engagement throughout the activities (Nasution, 2016; Mugianto, 2017). Student reflections in the form of written responses were used to explore students' perceptions regarding their learning experiences, understanding, feelings, and difficulties encountered during project-based green chemistry learning. Data analysis was conducted

qualitatively through data reduction, data presentation, and drawing conclusions to identify patterns and changes in students' perceptions.

3. Result and Discussion

The results of this study are presented based on the relationship between the culturally integrated Project-Based Learning (PjBL) process and students' perceptions of green chemistry learning. The stages of activities in the Project-Based Learning (PjBL) model consist of three main parts: introductory activities, core activities, and concluding activities. In the core activities, learning is carried out through six steps: determining fundamental questions, designing product plans, scheduling production, monitoring project activity and progress, testing results, and evaluating the learning experience (Ardiansyah, 2020). During the introductory syntaxes, the researcher reinforced character education through prayer, attendance checks, and the presentation of learning objectives. Additionally, the researcher posed initial questions to identify students' initial perceptions of chemistry learning. Observation results indicated that most students expressed interest and curiosity in chemistry, although these were accompanied by feelings of anxiety and the perception that it was a difficult subject. These findings indicate that students' initial perceptions remain mixed, oscillating between interest and anxiety. This is further underscored by students' initial reflections, which reveal a combination of curiosity and concern regarding the difficulty level of the material.

As part of the process of identifying key questions, the researcher posed questions related to the concept of green chemistry to assess students' initial understanding. Based on the observation results, students actively responded, but the understanding they demonstrated was still limited. These findings indicate that students have not yet comprehensively understood the concept of green chemistry. After the lesson, students' reflections showed a shift in understanding, as they began to view chemistry as a more contextual and meaningful science in daily life.



Diagram 1. The answer to the question of what work your team created and why you made that work?



Diagram 2. Answer the question: is there a regional condition that you imagined while making this work?

During the project planning phase, students were divided into several groups to design a waste treatment project. Observation results indicate variations in group discussion dynamics influenced by students' cultural backgrounds. These findings suggest that culture influences students' thinking and decision-making when designing solutions. This is supported by students' reflection data in Diagram 1 and Diagram 2, which show that most groups chose to build composters and linked the project to real-world environmental conditions, such as household organic waste management and agricultural activities. These findings demonstrate that students are able to relate the concept of green chemistry to real-life contexts based on local culture. These results align with Utomo (2024), Simanjuntak (2019), and Kustiyah (2024), who state that PjBL promotes context-based, environment-oriented problem-solving.



Diagram 3. Answers to the question of what difficulties you faced in creating this work and how you overcame those difficulties?

During the project scheduling and monitoring phase, activities were carried out over a three-week period. Observations revealed that student engagement was generally good, but group collaboration was not yet fully optimal. This was evident from the disparity in contributions among group members. This finding is reinforced by student reflections in Diagram 3, which indicate difficulties in task distribution, coordination, and project implementation. Nevertheless, students were able to overcome these obstacles through discussion and cooperation, demonstrating the development of collaborative skills. This finding is supported by Sormin (2024) and Saihu (2019).

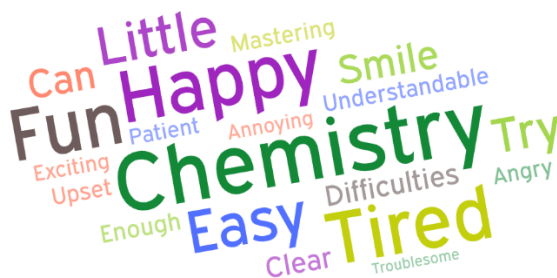


Diagram 4. Answers to the question of how you felt while learning green chemistry and being able to create this work?

During the results testing phase, each group presented the products they had created. In general, the products were similar in type, but there were variations in creativity and the way ideas were conveyed. This indicates differences in creative thinking abilities among students. The students' reflections in Diagram 4 show that most students felt happy, interested, and more engaged in the learning process, despite facing some challenges. These findings indicate that project-based learning is capable of creating positive learning experiences and increasing student engagement. These results align with those of Maulidiningsih (2023), Simanjuntak (2023), and Hapsari (2021), who state that PjBL can increase student motivation and participation in learning.



Diagram 5. Answers to the question of whether your views on chemistry changed during the creation of this work?

During the evaluation of the learning experience, the results of the observations showed that students became more active and demonstrated a more positive attitude toward chemistry learning. This was confirmed by the students' reflections in Diagram 5, which indicated that chemistry previously considered difficult and abstract had become more interesting, practical, and relevant to daily life. These findings indicate a transformation in students' perceptions of chemistry learning after participating in project-based learning. These results align with the work of Nurhayati (2024), Sari (2025), and Zubaidah (2016) regarding the development of 21st-century skills.

Overall, the integration of observation results from each PjBL syntaxes and student reflection data indicates that learning took place in a contextual, collaborative, and meaningful manner. Student reflections served not only as supplementary data but also as empirical evidence reinforcing the observational findings regarding the learning process. Furthermore, qualitative data analysis of student statements revealed significant changes in students' perceptions of chemistry learning. In the early stages, students' perceptions tended to be negative, viewing chemistry as a difficult, confusing, and rote-learning subject. However, after participating in Project-Based Learning (PjBL), these perceptions evolved into more positive ones, where students viewed chemistry as engaging, contextual, easy to understand, and relevant to daily life. This change indicates that project-based learning not only enhances conceptual understanding but also fosters a more open, critical, and practical approach to addressing environmental issues in their surroundings.

4. Conclusion

This study found that the implementation of a project-based learning (PjBL) model integrated with culture helps foster students' positive perceptions of green chemistry learning. Learning that was initially perceived as difficult, abstract, and uninteresting became more contextual, meaningful, and relevant to students' daily lives. Through project activities, students demonstrated improved conceptual understanding, active engagement, and heightened interest and curiosity. Cultural integration also helped students connect the material to real-world conditions in their surroundings, making the learning more practical. Furthermore, project-based learning experiences fostered the development of collaborative skills, although significant challenges in group collaboration persisted. Overall, green chemistry instruction through culturally integrated PjBL provided a collaborative, contextual, and meaningful learning experience, contributing to enhanced positive student perceptions of chemistry and increased environmental awareness.

5. Acknowledgments

The researchers would like to express their gratitude to the Institute for Research and Community Service (LPPM) of Universitas Kristen Indonesia for funding this research through to its completion. We also thank our fellow researchers for their cooperation. We hope that this learning innovation through knowledge sharing will be beneficial to the field of education.

6. References

- Abdurahman, A., Christine, S. E., & Pradesa, K. (2024). Students' perceptions of project-based learning in chemistry subjects: A qualitative analysis at SMA Ramu Bogor. *Belaindika Journal of Learning and Educational Innovation*, 6(3), 330–341.
- Akhmad, A. (2020). Perencanaan dalam peningkatan mutu pendidikan di era globalisasi. *SCHOLASTICA: Jurnal Pendidikan dan Kebudayaan*, 2(2), 94–104.
- Alifia, H. N., Salma, D., Arifin, M. H., & Istianti, T. (2021). Internalisasi keberagaman budaya dengan pendidikan karakter di sekolah dasar. *Jurnal Gentala Pendidikan Dasar*, 6(2), 100–111.
- Ardiansyah, R., Diella, D., & Suhendi, H. Y. (2020). Pelatihan pengembangan perangkat pembelajaran abad 21 dengan model pembelajaran project based learning berbasis STEM bagi guru IPA. *Publikasi Pendidikan*, 10(1), 31.
- Dasmo, D., Okyranida, I. Y., Fitriani, A., Mulyaningsih, N. N., Widiyatun, F., & Astuti, I. A. D. (2022). Analysis of senior high school teachers' perception on implementing Project-Based Learning (PjBL) integrated with local culture. *JIPFRI*, 6(2), 113–118.
- Fadli, M. R. (2021). Memahami desain metode penelitian kualitatif. *Humanika*, 21(1), 33–54.
- Hapsari, F., Desnaranti, L., & Wahyuni, S. (2021). The role of teachers in motivating students' learning during distance learning activities. *Research and Development Journal of Education*, 7(1), 193–204.
- Harefa, N. (2023). *Integrated learning approach: Mini research*.
- Hatimah, H., & Khery, Y. (2021). Concept understanding and science literacy in the implementation of Android-based chemistry learning media. *IKIP Mataram Scientific Journal*, 8(1), 111–120.
- Januardi, A., Superman, S., & Nur, S. (2024). Integration of traditional values of Sambas community in history learning. *JPPI*, 4(2), 794–805.
- Jati, W., & Yuliansyah, H. (2017). Pengaruh Strategi Pemasaran Online (Online marketing Strategy) Terhadap Minat Beli Konsumen. *Jurnal Pemasaran Kompetitif*, 125
- Kustiyah, E., Naidir, F., Nuraliyah, A., Hasaya, H., & Ismaniah, I. (2024). Building young generation perceptions in protecting the environment through "Think Green" literacy using composters. *Journal of Appropriate Technology for Community Services*, 5(2), 129–136.
- Maharani, C. E. (2024). Development of PjBL-based e-module in recycling waste as implementation of green chemistry principles for grade 10 senior high school (Doctoral dissertation). Jambi University.
- Margono, S. (2010). *Metode penelitian pendidikan*. Jakarta: Rineka Cipta.
- Maulidiningsih, M., & Kusumaningrum, I. A. (2023). Contextual learning model on green chemistry material to improve students' learning interest. *Research and Practice of Educational Chemistry*, 2(1).
- Marbun, L., & Saragih, J. R. P. (2022). Philosophical study of Christian religious education in the

- life of believers in the postmodern era. *SIKIP*, 3(2), 106–114.
- Muderawan, I. W., Wiratma, I. G. L., & Nabila, M. Z. (2019). Analysis of factors causing students' learning difficulties. *Indonesian Journal of Chemistry Education*, 3(1), 17–23.
- Mugianto, M., Ridhani, A., & Arifin, S. (2017). Pengembangan perencanaan pembelajaran. *Ilmu Budaya*, 1(4), 353–366.
- Mustafa, D. (2016). Green chemistry and sustainable urban health development. In *Role of MST in Supporting Quality Urban Lifestyle* (pp. 177–192).
- Nasution, H. F. (2016). Instrumen penelitian dan urgensinya. *Al-Masharif*, 4(1), 59–75.
- Ningsih, D. (2024). Development of PjBL-based e-LKPD for compost fertilizer creation (Doctoral dissertation). Jambi University.
- Nurhamidah, S., & Nurachadijat, K. (2023). Project-Based Learning in improving students' learning independence. *JIEPP*, 3(2), 42–50.
- Nurhayati, I., Pramono, K. S. E., & Farida, A. (2024). 4C skills in social studies learning. *Basicedu Journal*, 8(1), 36–43.
- Rahmat, M. N. (2024). Utilization of PjBL model to enhance creativity. *Mediatik Journal*, 17–22.
- Ramadani, I. (2025). Integration of Kajang local wisdom-based teaching materials. *JPN*, 6(1), 274–284.
- Saihu, S. (2019). Character education based on local wisdom. *Edukasi Islami*, 8(01), 69–90.
- Sari, D. N., Adira, H. F., Sukiman, S., & Silfiani, H. (2025). Integration of PjBL in Merdeka Curriculum. *ARJI*, 7(4), 3452–3467.
- Simanjuntak, F. (2019). Environmental chemistry education. In *Proceedings...* (pp. 144–149).
- Simanjuntak, F. N. (2017). Education for sustainable development. *Journal of Educational Dynamics*, 10(2), 169–195.
- Simanjuntak, F. N., Utomo, S. W., et al. (2023). Learning chemistry and sustainability. *ECNU Review of Education*.
- Sormin, E., et al. (2024). Analysis of increasing students' learning interest. *Formatif*, 14(2), 465–472.
- Suryanto, S., Widodo, W., & Gunansyah, G. (2025). Indonesian students in Riyadh perceptions. *Elementary Journal*, 5(1), 188–195.
- Triyono, T., & Febriani, R. D. (2018). Students' perceptions of further education. *Edudikara*, 3(1), 70–77.
- Utomo, D. S. (2024). Effect of project-based learning model. *Journal of Geography Education*, 27(1).
- Widyawati, R., et al. (2024). Green chemistry education oriented to ESD. *Didaktika*, 13, 537–548.
- Windayani, N. L. I., et al. (2024). Building multicultural awareness. *Citra Bakti Journal*, 11(2), 383–396.
- Zubaidah, S. (2016). 21st century skills. In *Seminar Nasional Pendidikan* (pp. 1–17).