HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

February 2025. 13(1)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 110-118

The Effectiveness of the Case Method in Promoting Meaningful Learning and Enhancing Student Learning Outcomes

Munawwarah & Zuhrah Adminira Ruslan*
Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Makassar, Indonesia.
* Corresponding Author e-mail: zuhrah.adminira@unm.ac.id

Article History
Received: 17-01-2025
Revised: 17-02-2025
Published: 28-02-2025

Keywords: case method; chemistry education; student learning outcomes

Abstract
This study investigates the effectiveness of the case method in fostering meaningful learning and improving student learning outcomes. Using a quasi-experimental one-group pretest-posttest design, 20 chemistry education students participated in a series of learning activities centered around the case method. Data were collected through pretest and posttest essay assessments and analyzed using descriptive statistics and paired t-tests. Results showed a significant increase in the average student scores from 72.68 (pretest) to 85.21 (posttest), with a reduction in score variability, as evidenced by a t-statistic of -4.28 and a p-value of 0.00045. These findings indicate that the case method effectively enhances student understanding and promotes meaningful learning by engaging students in contextual problem-solving activities. This method aligns with constructivist learning theory and supports the development of essential skills such as critical thinking, collaboration, and the application of theoretical knowledge in practical contexts. Furthermore, its universal applicability across various disciplines highlights its potential to enhance educational practices. Future research should explore long-term impacts, optimize case selection, and examine integration with educational technologies.

How to Cite: Munawwarah, M., & Ruslan, Z. (2025). The Effectiveness of the Case Method in Promoting Meaningful Learning and Enhancing Student Learning Outcomes. Hydrogen: Jurnal Kependidikan Kimia, 13(1), 110-118. doi:https://doi.org/10.33394/hjkk.v13i1.14567

https://doi.org/10.33394/hjkk.v13i1.14567

INTRODUCTION

The case method has emerged as a prominent pedagogical approach in higher education, particularly in disciplines that require critical thinking and problem-solving skills. This method, which emphasizes real-world scenarios and active student engagement, has been shown to foster meaningful learning experiences and enhance student learning outcomes (Hulyadi et al., 2023). Recent studies indicate that the case method not only promotes a deeper understanding of subject matter but also cultivates essential skills such as collaboration, communication, and analytical thinking among students (Chowdhury, 2013; Herreid, 2013). As educational institutions increasingly seek to prepare students for complex, real-world challenges, the effectiveness of the case method in achieving these goals warrants thorough investigation.

In the context of chemistry education, specific challenges arise that make the case method particularly relevant. The complexity of chemical concepts often leads to student disengagement and difficulties in applying theoretical knowledge to practical situations (Bernholt et al., 2019). Traditional teaching methods may not adequately address the need for critical thinking and problem-solving skills, which are essential in the field of chemistry (Ural, 2016). The case method addresses these issues by presenting students with real-world problems that require them to apply their knowledge creatively and collaboratively (Chowdhury, 2013) This approach not only enhances engagement but also helps students develop a deeper

understanding of chemical principles and their applications in everyday life ((Rodríguez-Becerra et al., 2020).

Implementing the case method in chemistry education, however, is not without its challenges. Educators may face difficulties in selecting appropriate cases that align with learning objectives and student interests (Kartimi et al., 2021). Additionally, the facilitation of case discussions requires a shift from traditional lecturing to a more interactive and student-centered approach, which may necessitate professional development for educators (Imaduddin & Astuti, 2022). Moreover, the integration of technology into case-based learning can enhance the effectiveness of this method but also introduces complexities related to access and familiarity with digital tools (Schweiker & Levonis, 2023). Despite these challenges, the potential benefits of the case method in fostering critical thinking and problem-solving skills in chemistry students are significant.

Research supports the effectiveness of the case method in chemistry education. For instance, studies have shown that case-based learning can significantly improve student engagement and learning outcomes, particularly among those who struggle with traditional instructional methods (Rodríguez-Escrich & Pericàs, 2015). The incorporation of real-world scenarios in chemistry education has been linked to enhanced retention of knowledge and the ability to apply concepts in practical contexts (Rodríguez-Becerra et al., 2020). Furthermore, the use of technology-enhanced case-based learning has been shown to cater to diverse learning styles and proficiency levels, promoting inclusivity and personalized learning experiences (Schweiker & Levonis, 2023) These findings underscore the importance of the case method as a viable solution to the challenges faced in chemistry education.

Moreover, the integration of technology with the case method has further amplified its effectiveness. Recent advancements in educational technology have facilitated the implementation of blended learning environments that combine traditional case-based learning with online resources and collaborative tools. This hybrid approach has been shown to enhance student engagement and learning outcomes by providing diverse learning opportunities and jahangirfostering a more interactive learning environment (Jahangiri & Hajian, 2013). For example, studies have indicated that technology-enhanced case-based learning can cater to varying student proficiency levels, thereby promoting inclusivity and personalized learning experiences (Schweiker & Levonis, 2023).

The impact of the case method extends beyond individual learning outcomes; it also influences the overall educational environment. The case method fosters a collaborative learning culture where students learn from one another, share diverse perspectives, and engage in critical discussions (MHLONGO & Sedumedi, 2024). This collaborative aspect is particularly beneficial in professional education, where teamwork and communication are essential competencies. As noted by Ridley and Byrom, the case method encourages students to develop essential skills such as collaborative working and effective communication, which are vital for their future careers in healthcare and other fields (Ananikov, 2024). Despite the growing body of evidence supporting the effectiveness of the case method, challenges remain in its implementation. Educators must be adequately trained to facilitate case-based learning effectively, ensuring that they can guide discussions and support student engagement (Imaduddin & Astuti, 2022).

Furthermore, the selection of appropriate cases is crucial, as the relevance and complexity of cases can significantly impact student learning experiences (Lewis et al., 2012). Therefore, ongoing research and professional development for educators are essential to maximize the benefits of the case method in diverse educational contexts. In conclusion, the case method represents a powerful instructional strategy that promotes meaningful learning and enhances student learning outcomes across various disciplines. As educational paradigms continue to

evolve, it is imperative for educators and institutions to embrace innovative teaching methods like the case method to prepare students for the complexities of the modern world. Future research should focus on refining case selection, enhancing educator training, and exploring the integration of technology to further optimize the effectiveness of the case method in higher education.

The novelty of this research lies in its comprehensive exploration of the case method as a pedagogical tool, particularly in its capacity to promote meaningful learning and enhance student learning outcomes across diverse educational contexts. While existing literature has acknowledged the benefits of the case method, this study uniquely integrates contemporary educational theories, particularly the principles of active learning and technology-enhanced learning environments. For instance, Wijaya et al. emphasize that incorporating active learning strategies significantly increases student engagement, which is a core component of the case method (Blonder et al., 2013). Furthermore, the integration of technology in case-based learning, as highlighted by recent studies, allows for more interactive and collaborative learning experiences, thereby enhancing the overall effectiveness of this pedagogical approach (Chowdhury, 2013; Raihanah et al., 2024). By examining these intersections, this research aims to provide a nuanced understanding of how the case method can be optimized for various learning settings, ultimately contributing to the existing body of literature on educational methodologies.

Additionally, this study will address the critical development of essential skills such as critical thinking and problem-solving, which are increasingly vital in today's complex professional landscape. The case method effectively fosters these competencies, preparing students for real-world challenges (Ley et al., 2015). However, the research will also investigate the barriers to effective implementation of the case method, as previous studies have identified various challenges that educators face in applying this approach. By identifying these obstacles and proposing actionable solutions, this research aims to offer practical recommendations for educators and institutions seeking to enhance case-based learning in their curricula. Thus, this study not only contributes to the theoretical understanding of the case method but also provides valuable insights for its practical application in educational settings.

METHOD

This study employed a quasi-experimental research method, specifically the One-Group Pretest-Posttest Design. This design involves measuring outcomes both before and after an intervention within a single group (experimental class) without a comparison group. The subjects of this study were 20 students enrolled in a chemistry education program. The research design utilized was the One-Group Pretest-Posttest Design.

$$O1 \rightarrow X \rightarrow O2$$

The data collection instrument consisted of essay test questions administered at the beginning (Pre-test) and the end (Post-test) of the learning process employing the case method. The case method was implemented throughout half of the semester, allowing for in-depth exploration of real-world chemistry problems and their application in various contexts. This method encourages critical thinking, collaborative learning, and the application of theoretical knowledge to practical scenarios (Andrini & Pratama, 2021; Wicaksono & Rahmawati, 2022).

The implementation of the case method involved presenting students with complex cases relevant to chemistry education, where they were required to analyze, discuss, and propose solutions based on the material they had learned. The process was facilitated by both instructor-led discussions and student group work, ensuring a comprehensive learning experience. To

ensure the validity and reliability of the instruments used, particularly the essay tests, several procedures were followed. In this study, the validity of the essay questions was ensured through expert judgment, where the test items were reviewed by subject matter experts and educators in the field of chemistry education. Their feedback was used to refine and ensure that the questions adequately covered the intended learning outcomes and the cases presented (Kusuma & Busyairi, 2023).

Reliability refers to the consistency of the measurements over time. The reliability of the essay questions was assessed using inter-rater reliability, where multiple raters scored the same set of essays (Buitre, 2023). In addition, the essay questions were evaluated for both content and construct validity. Content validity was ensured by ensuring that the questions comprehensively covered the relevant topics addressed in the case method sessions. Construct validity was confirmed by examining the alignment between the test items and the specific learning objectives set forth for the course (Syam & Ismanti, 2022). Furthermore, a pilot study was conducted before the main data collection to refine the essay questions and eliminate any ambiguities or inconsistencies that could affect the reliability and validity of the instrument (Warju et al., 2020). The one-group pretest-posttest design is particularly effective in educational research as it allows for the assessment of changes in student learning outcomes as a direct result of the intervention, thus providing valuable insights into the effectiveness of the case method in chemistry education (Amyyana, Paristiowati, and Kurniadewi 2017).

RESULTS AND DISCUSSION

This study was conducted by grouping students into small groups during the learning process. The researcher implemented the case method as the instructional approach to provide students with a more in-depth learning experience. Information regarding the effectiveness of this model in the learning process was derived from the analysis of students' pre-test and post-test results, as presented in Table 1.

Table 1. Descriptive Analysis and t-Test Results

Parameter	Pre-test	Post-test
Mean	72.684	85.211
Standard Deviation (SD)	13.009	1.843
Minimum Score	45.000	80.000
Maximum Score	90.000	88.000
t-statistic	-	-4.282
p-value	-	0.00045
Cohen's d (effect size)		1.35

From the descriptive analysis table, the average pretest score of students was 72.68 with a standard deviation of 13.01, indicating a considerable variation in scores among students prior to the implementation of the case method. Following the application of this method, the average posttest score significantly increased to 85.21, with a smaller standard deviation of 1.84. This reduction in standard deviation suggests that student scores became more uniform after the intervention. Furthermore, the minimum score improved from 45 on the pretest to 80 on the posttest, highlighting that nearly all students benefited from this instructional approach. This finding aligns with the research conducted by (Haatainen & Aksela, 2021), which demonstrated that the implementation of project-based learning can significantly enhance students' understanding while reducing variability in learning outcomes, reflecting increased collaboration and engagement among students.

Moreover, the study by Wang, Jianhua Xuan, et al. (2021) supports these results by indicating that both problem-based learning (PBL) and case-based learning (CBL) can enhance student

motivation and engagement, which in turn contributes to improved learning outcomes. They noted that CBL not only introduces knowledge in a more relevant context but also increases students' interest in learning, which may explain the significant increase in posttest scores observed in this study. Thus, the findings from this descriptive analysis indicate that the application of the case method is not only effective in improving students' academic performance but also in creating a more uniform and meaningful learning experience.

The Cohen's d value of approximately 1.35 indicates a large effect size, suggesting that the implementation of the case method in the chemistry education program had a significant impact on student learning outcomes. This substantial effect size reflects a considerable improvement in students' understanding and performance in chemistry, as evidenced by the difference in pre-test and post-test scores. The case method, which presents students with real-world scenarios requiring the application of theoretical knowledge, effectively fosters deeper engagement with the subject matter. By encouraging students to analyze and solve complex problems, the case method enhances critical thinking and problem-solving abilities, which are crucial in chemistry education. Research has shown that active learning strategies, such as the case method, significantly improve student performance in science disciplines, highlighting the importance of context-based learning in enhancing understanding and retention of complex concepts (Harris et al., 2020; Rodríguez-Becerra et al., 2020).

Furthermore, the collaborative nature of the case method promotes teamwork and communication skills, as students work together to discuss and solve cases, thereby enhancing their critical thinking in a social context. The real-world relevance of the cases also increases student motivation, making the learning process more engaging and applicable to their future careers (Ballard & Mooring, 2021; Tjalla & Fitriani, 2017). Studies have demonstrated that the case method not only improves academic performance but also contributes to a more comprehensive understanding of chemistry among students, preparing them for the complexities of their future professional roles (Peechapol, 2021; Williams, 2020). Thus, the findings underscore the effectiveness of the case method as a transformative educational approach in chemistry, fostering essential skills and knowledge that are vital for students' success in the field.

The paired t-test results, with a t-statistic of -4.28 and a p-value of 0.00045 ($p < 0.05$), reinforce the assertion that the increase in posttest scores is statistically significant. This indicates that the case method is effective in enhancing student learning outcomes. This finding aligns with constructivist learning theory, which posits that learning through case analysis allows students to construct new understanding based on real and relevant experiences. Furthermore, (Turk et al., 2019) emphasize that case-based blended learning can facilitate the transfer of declarative knowledge to procedural knowledge, which is essential for practical application in real-world scenarios. Their findings suggest that the structured progression through increasingly complex cases not only enhances comprehension but also aids in the retention of knowledge, thereby improving overall learning outcomes. Additionally, Lee et al. (2018) highlight the importance of integrating case studies into educational frameworks, as they foster an environment conducive to developing entrepreneurial capabilities and critical thinking skills among students. Together, these studies underscore the effectiveness of the case method in promoting significant learning advancements, as evidenced by the statistical improvements observed in this research.

The case method significantly supports meaningful learning as it engages students in solving contextual problems relevant to real life. The notable increase in posttest scores indicates that students are not merely memorizing material but are also developing a deep understanding of concepts. In the context of this research, the case method provides opportunities for students

to apply their chemistry knowledge in real-world scenarios, thereby enhancing their conceptual understanding and resulting in more meaningful learning experiences.

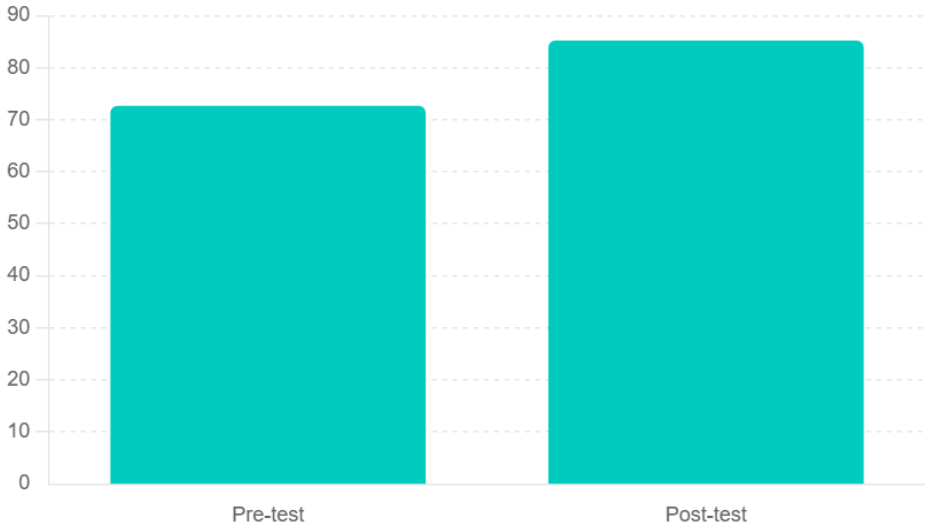

Figure 1. Comparison of Average Learning Outcomes in Pre-test and Post-test

The implementation of the case method in this study provides empirical evidence that active learning strategies can significantly enhance student learning outcomes. Furthermore, this approach enriches students' learning experiences by encouraging collaboration, critical thinking, and the ability to connect theoretical knowledge to practical applications. The implications of these findings support the view that the case method can be integrated into chemistry teacher training programs to develop Pedagogical Content Knowledge (PCK), thereby enabling educators to design relevant and meaningful learning experiences. This study also aligns with previous research highlighting the effectiveness of the case method across various disciplines, such as health sciences and business, demonstrating its potential as a universal pedagogical tool.

CONCLUSION

The findings of this study demonstrate that the case method significantly enhances student learning outcomes, as evidenced by the increase in average posttest scores from 72.68 to 85.21 and a reduction in score variability, confirmed by the paired t-test results (t-statistic = -4.28, p-value = 0.00045). This method fosters meaningful learning by engaging students in solving contextual problems, allowing them to develop a deeper conceptual understanding rather than relying on rote memorization. Furthermore, this study aligns with prior research highlighting the method's effectiveness across disciplines, such as health sciences and business, emphasizing its potential as a universal pedagogical tool for fostering collaboration, critical thinking, and real-world problem-solving skills.

RECOMMENDATIONS

Based on the findings, it is recommended that the case method be integrated into chemistry teacher training programs to enhance Pedagogical Content Knowledge (PCK) and empower educators to design meaningful and relevant learning experiences. Educational institutions should adopt this method in classrooms to foster critical thinking, collaboration, and the application of theoretical knowledge to practical problems, ultimately improving student outcomes. Additionally, curriculum developers should incorporate case-based learning into

educational frameworks, emphasizing its potential for promoting contextual problem-solving. Further research is needed to explore its long-term impact on learning retention, motivation, and adaptability across different subjects and educational levels. Professional development initiatives, such as workshops and training sessions, are also recommended to ensure educators can effectively implement the case method in diverse teaching contexts.

ACKNOWLEDGEMENTS

The authors would like to express their heartfelt gratitude to all those who contributed to the completion of this study. Special thanks are extended to the students and faculty members of the chemistry education program for their active participation and invaluable support throughout the research process. The authors also acknowledge the guidance and constructive feedback provided by academic advisors and colleagues, which greatly enriched the quality of this work. Finally, sincere appreciation is conveyed to family and friends for their unwavering encouragement and understanding, which have been a source of motivation during the course of this study.

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