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Differences in Students' Self-Efficacy and Learning Outcomes between Case-Based Learning and Direct Instruction in Basic Chemistry

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ABSTRACT

This study is motivated by low levels of self-efficacy and learning achievement among students in General Chemistry, which are often associated with the material's abstract nature and the limited use of active learning approaches. This study aims to examine differences in students' self-efficacy and learning outcomes between the Case-Based Learning (CBL) and Direct Instruction (DI) models. The study employed an intact-group comparison (quasi-experimental) design involving 44 students from the Chemistry Education Program at Malikussaleh University, divided into an experimental group (CBL) and a control group (DI). Research instruments included a self-efficacy questionnaire and a multiple-choice posttest. The results revealed statistically significant differences between the two groups in both self-efficacy ($t = 13.715$; $p < .001$) and learning outcomes ($t = 8.793$; $p < .001$). Students in the CBL group obtained higher mean scores in self-efficacy (72.86) and learning outcomes (83.27) compared to those in the DI group. These findings indicate that Case-Based Learning is associated with higher self-efficacy and better learning outcomes in General Chemistry. The study suggests that CBL can be considered an alternative instructional approach to support active and contextual learning in science education.

Keywords: Case-Based Learning, Direct Instruction, General Chemistry, Learning Outcomes, Self-Efficacy.

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INTRODUCTION

Basic Chemistry instruction serves as an essential foundation for science students, particularly those in chemistry education and other science-related programs. However, numerous studies have shown that students often struggle to understand abstract concepts such as atomic structure, chemical bonding, stoichiometry, and thermochemistry. These concepts require high-level representational and reasoning skills, which frequently lead students to experience misconceptions and a lack of confidence when solving chemistry problems (Fanfiana et al., 2024). Such difficulties negatively affect learning outcomes and contribute to the perception that chemistry is difficult and less meaningful.

On the other hand, self-efficacy—defined as an individual's belief in their own abilities—plays a crucial role in learning success. Students with high self-efficacy tend to handle challenges better, solve complex tasks, and demonstrate stronger self-regulation (Putro & Bernarto, 2024). Conversely, students with low self-efficacy are more likely to give up easily and avoid challenging tasks. In the context of Basic Chemistry, self-efficacy is vital because students' ability to comprehend the material is strongly influenced by their confidence in tackling scientific problem-solving (Kurt & Taş, 2023). Therefore, instructional interventions that strengthen self-efficacy need to be integrated into the learning process.

In addition to self-efficacy, learning outcomes remain a major issue in Basic Chemistry instruction. Several studies have found that students’ chemistry achievement tends to be low due to teacher-centered instructional methods, limited real-world context, and insufficient opportunities for active student engagement in problem-solving (Getu et al., 2024). Conventional instruction that focuses solely on explaining concepts and giving context-free exercises makes it difficult for students to connect the material with real-life situations. In fact, students’ understanding of chemical concepts becomes more robust when presented in authentic, relevant contexts that support meaningful knowledge construction.

To address these issues, an innovative learning model is needed—one that not only improves conceptual understanding but also builds students’ self-efficacy. One widely recommended model in science education is Case-Based Learning (CBL). This model provides students with opportunities to learn through real or authentic cases relevant to the lesson content. Through case analysis, discussion, and problem-solving, students engage actively in the learning process, enabling deeper understanding and enhancing their confidence in solving problems (Ridho et al., 2025).

Previous studies have demonstrated the effectiveness of CBL in improving critical thinking skills, learning outcomes, and student self-efficacy. For example, Ridho et al. (2025) found that CBL significantly enhances problem-solving abilities and science learning outcomes. Other studies have reported that case-based instruction allows students to evaluate their abilities, thereby fostering self-efficacy (Linforth et al., 2023). In the context of chemistry education, implementing CBL creates more meaningful learning experiences by confronting students with real-world chemical phenomena.

Based on the previous explanation, it can be concluded that low self-efficacy and unsatisfactory learning outcomes in Basic Chemistry are problems that must be addressed through instructional innovation. Case-Based Learning is considered a relevant solution because it emphasizes active student engagement and provides contextual learning experiences. Therefore, this study aims to examine differences in students’ self-efficacy and learning outcomes between those taught using Case-Based Learning and those taught using Direct Instruction in Basic Chemistry. The research is guided by the following questions: (1) Are there differences in students’ self-efficacy between those taught using Case-Based Learning and those taught using Direct Instruction in Basic Chemistry? and (2) Are there differences in students’ learning outcomes between those taught using Case-Based Learning and those taught using Direct Instruction in Basic Chemistry? This study is expected to contribute to the development of innovative instructional strategies in higher education.

METHODS

This study was conducted in the Chemistry Education Study Program at Malikussaleh University in 2025. The research location was selected to improve the quality of Basic Chemistry instruction by implementing innovative learning models that align with students' program characteristics. In addition, the Chemistry Education Program at Malikussaleh University has an adequate number of students and a learning structure that supports the implementation of an intact group experimental design, making it suitable for the purposes of this study.

The research sample consisted of 44 students divided into two classes: an experimental class and a control class, each comprising 22 students. The sampling technique used was purposive sampling, as the selection of classes was based on specific considerations such as course scheduling, equivalence of initial abilities, and other academic factors. Purposive sampling is commonly used in educational research when researchers require groups that meet specific characteristics to ensure optimal implementation of the intervention (Memon et al., 2025).

This study employed a **quasi-experimental research method** using an **intact group comparison (static-group comparison) design**. In this design, naturally formed classes were assigned as the experimental and control groups without random assignment (Sugiyono, 2020). In this design, naturally formed classes were used as the experimental and control groups, without random assignment (Sugiyono, 2020). The experimental group received instruction using the Case-Based Learning (CBL) model, while the control group was taught using the Direct Instruction (DI) model or conventional teaching. Both groups were given only a posttest; therefore, the purpose of this design was to examine **differences in learning outcomes and self-efficacy between the two instructional groups** after the learning process. The research design is presented in Table 1 below.

Table 1. Research Design

Group	Treatment	Posttest
Eksperimental	X_1	O_1
Control	X_2	O_2

Description:

X_1 = Instruction using the Case-Based Learning (CBL) model)

X_2 = Instruction using the Direct Instruction (DI) model

$O_{1,2}$ = Posttest

The research instruments consisted of a written test and a self-efficacy questionnaire. The written test was used to measure students' learning outcomes after completing the Basic Chemistry instruction. The test consisted of multiple-choice questions developed based on learning outcome indicators and cognitive levels aligned with the revised Bloom's Taxonomy. Objective tests, such as multiple-choice items, are recommended for assessing cognitive abilities because they offer greater reliability and allow for objective scoring (Setyaedhi et al., 2023). The test was administered only at the end of the treatment as a posttest.

The second instrument was a student self-efficacy questionnaire. This questionnaire was designed to measure students' confidence in understanding and completing Basic Chemistry tasks after the learning process. It consisted of both positive and negative statements, rated on a four-point Likert scale: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). Likert scales are widely used to measure self-efficacy because they can represent students' perceptions and confidence levels quantitatively and are easy to analyze (Pratiwi et al., 2024). The statements in the questionnaire were developed based on self-efficacy indicators, including confidence in academic ability, task completion, and the ability to handle academic challenges.

Data collection consisted of two main steps: administering the self-efficacy questionnaire and administering the posttest in both groups after treatment. Data obtained from the questionnaire and posttest were then analyzed to determine the effect of the Case-Based Learning model on students' self-efficacy and learning outcomes. Statistical analysis was performed using mean-difference tests between groups to examine the research hypotheses, as recommended in educational experimental studies (Putri et al., 2023).

RESULTS AND DISCUSSION

Table 2 summarizes the mean scores and standard deviations of students' self-efficacy and learning outcomes in the Case-Based Learning (CBL) and Direct Instruction (DI) groups

Table 2. Mean Scores of Self-Efficacy and Learning Outcomes

Variable	Group	n	Mean	Std. Dev.	Min	Max
Learning Outcome	Model CBL	22	83.27	5.34	74	92
Learning Outcome	Model DI (control)	22	71.05	3.75	65	78
Self-Efficacy	Model CBL	22	72.86	3.03	68	78
Self-Efficacy	Model DI (control)	22	60.05	3.17	55	65

The CBL group had higher mean scores than the DI group for both variables. These differences in means appear substantial and consistent, and the variation (SD) in the CBL group was slightly larger for learning outcomes but smaller for self-efficacy compared to the control group.

Table 3. t-Test Results for Self-Efficacy and Learning Outcomes

Variabel	t	df	Sig. (2-tailed)	Mean Diff.	95% CI Lower	95% CI Upper	Keputusan
Learning Outcome	8.793	42	.0001	12.227	9.421	15.033	p < .001 → Ha accepted (CBL > DI)
Self-Efficacy	13.715	42	.0001	12.818	10.932	14.704	p < .001 → Ha accepted (CBL > DI)

Both tests showed highly significant differences ($p < .001$) between the group taught using Case-Based Learning (CBL) and the control group taught using Direct Instruction. The 95% confidence interval for the mean difference did not cross zero, indicating a statistically significant difference in learning outcomes between the two instructional approaches**.**

These findings indicate that students who participated in Case-Based Learning demonstrated higher learning outcomes than those who experienced Direct Instruction. This result can be interpreted in light of CBL's characteristics, which emphasize student engagement with authentic cases, discussion, and collaborative problem-solving. Such learning environments encourage students to actively process information and apply chemical concepts to contextual situations, which supports deeper conceptual understanding (Dewi et al., 2022).

In addition to learning outcomes, the results also show significant differences in students' self-efficacy. Students in the CBL group reported higher confidence in understanding and completing Basic Chemistry tasks than those in the DI group. This finding is consistent with previous studies suggesting that learning environments that involve active participation, discussion, and problem-solving opportunities are associated with higher levels of self-efficacy (Muliaman et al., 2023).

From a theoretical perspective, these results align with Bandura's self-efficacy theory, which emphasizes the role of mastery experiences and social interaction in shaping individuals' beliefs about their abilities. In Case-Based Learning, students are exposed to realistic problem situations and are encouraged to collaboratively explore solutions. Successfully engaging with these cases may provide meaningful learning experiences that build students' confidence in handling complex chemistry concepts.

Furthermore, the collaborative nature of CBL may also contribute to the observed differences. Group discussions allow students to exchange ideas, observe peer strategies, and receive feedback, which can strengthen learning engagement and confidence. Previous research has shown that collaborative and case-based approaches are associated with improved academic performance and affective outcomes in science education (Idris et al., 2025).

Although the results show clear statistical differences between the two instructional approaches, it is important to interpret these findings within the limitations of the research design. Because this study employed an intact-group comparison design without random assignment and used a posttest-only design, the results indicate associations and group differences rather than definitive causal effects. Nevertheless, the findings provide empirical evidence that Case-Based Learning is associated with higher self-efficacy and learning outcomes compared to Direct Instruction in the context of Basic Chemistry.

CONCLUSION

Based on the findings of this study, it can be concluded that there are statistically significant differences in students' self-efficacy and learning outcomes between those taught using Case-Based Learning (CBL) and those taught using Direct Instruction (DI) in Basic Chemistry. Students in the CBL group demonstrated higher average scores on both learning outcomes and self-efficacy than students in the DI group.

These results suggest that implementing Case-Based Learning is associated with more favorable cognitive and affective learning outcomes, particularly in students' confidence and understanding of chemical concepts. By engaging students in authentic cases and collaborative problem-solving activities, CBL provides learning experiences that support active participation and contextual understanding.

Based on these findings, it is recommended that lecturers in Basic Chemistry and related courses consider adopting Case-Based Learning as an alternative instructional approach to promote active, meaningful learning. Lecturers are encouraged to design relevant and authentic cases that align with course objectives to support student engagement and confidence.

Future research is recommended to employ more robust research designs, such as pretest–posttest or randomized designs, as well as mixed-methods approaches, to further examine the relationships among instructional models, self-efficacy, and learning outcomes in chemistry education.

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