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The effect of case study-based microlearning on students' chemical problem solving skills D3 Occupational Health and Safety Company Hygiene

Fandi Ahmad[1], Yusniar Rasjid[2], Nur Indah Sari[3*]
1,3 Universitas Negeri Makassar
2 Universitas Patompo
Corresponding Author: Nur Indah Sari nur.indah.sari@unm.ac.id

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A B S T R A C T

This study investigates the effect of case study-based microlearning on students' problem-solving skills in basic chemistry courses for the D3 K3 Hygiene Study Program. Using a quasi-experimental design with purposive sampling, 56 students were divided into experimental and control groups. A problem-solving test with five valid essay questions was used as the instrument. Data analysis with a t-test (α = 0.05) showed a significant difference between the experimental (78.21) and control (72.50) groups, with a p-value of 0.011. The findings indicate that case study-based microlearning significantly enhances students' problem-solving skills compared to conventional methods, offering focused, relevant learning aligned with vocational needs.

INTRODUCTION

Higher education in Indonesia faces challenges in improving the quality of learning and has a crucial role in preparing human resources who are competent and adaptive to the dynamics of the world of work (Bennie et al, 2019; Durand et al., 2022). In this era of globalization, problem-solving skills are one of the core competencies that are needed (Susanta & Susanto, 2020; Juniartina & Erlina, 2024), especially in complex and multidisciplinary fields such as students of the Diploma three (D3) Corporate Hygiene, Occupational Health and Safety or Hygiene K3 study program (Sari & Aufannisa, 2024; Lumadja et al., 2024). Therefore, students are required to have strong analytical skills, critical thinking, and be able to make the right decisions in various challenging situations in the workplace (Novita, et al., 2024; Ahmad & Sari, 2025; Askar & Hasfat, 2025).

Basic Chemistry is a fundamental course in the curriculum of the Diploma three (D3) Hygiene K3 study program to provide an essential theoretical foundation for students in higher education (Sudarni, 2018; Dinatha, 2023; Adi, 2024). This course introduces basic chemical concepts relevant to various aspects of OSH, such as chemical hazard identification, risk control, and waste management (Setyaningsih, 2018). However, students often experience difficulties in applying basic chemical concepts in solving practical problems they face in the field, especially those related to occupational health and safety in industry (Rati et al., 2024; Dantje et al., 2016; Lestari et al., 2025).

The concept of stoichiometry is one of the basic chemical materials that are important for vocational students to master, especially the D3 Occupational Health and Safety Company Hygiene or Hygiene K3 study program. Stoichiometry is the science of the quantity of substances involved in chemical reactions (Chandrappa et al., 2021). This understanding allows students to calculate and predict the amount of chemicals involved in industrial processes, assess potential hazards, and design effective control measures (Felder et al., 2020). By understanding the concept of stoichiometry, students can also prepare themselves to become technical personnel and learn to ensure the safety of workers and the work environment (Wong & Chan, 2018).

This gap between theory and practice demands innovation in learning methods that can bridge the gap (Hidayat et al., 2025; Saripah, 2025). One promising approach is to implement microlearning as an innovative and adaptive learning strategy (Abdurrahman et al., 2024; Santi et al., 2024). Microlearning is a learning approach that presents material in small units that are concise, focused, and easily accessible (Mohammed et al., 2018; Ilic, 2024). This approach allows students to learn flexibly, independently, and according to their needs, anytime and anywhere (Mohammed et al., 2018; Gherman et al., 2021).

One effective method to integrate microlearning in basic chemistry learning is by using case studies (Nowak et al., 2023; Choo & Rahim, 2021). This method presents real-life scenarios relevant to the OHS field, which require students to apply their basic chemistry knowledge in analyzing problems, identifying solutions, and making appropriate decisions (Purwanto et al., 2022).

Case studies can help students to develop critical (Hinson, 2023), analytical (Cai et al., 2014), and creative (Vani et al., 2022) thinking skills, as well as improve their understanding of the practical applications (Bernardi & Pazinato, 2022) of the basic chemical concepts that underpin the D3 Hygiene OHS material. In addition, by understanding chemical concepts such as stoichiometry, students can better evaluate risks and take appropriate actions to protect workers' health and safety.

The integration of case study-based microlearning is expected to improve the problem-solving skills of D3 Hygiene K3 students in Basic Chemistry courses. Through this approach, students not only master theoretical concepts, but also have the opportunity to apply them directly in a context relevant to their future field of work (Billert et al., 2022) and result in better knowledge retention (Aritonang et al., 2023). Thus, case study-based microlearning can help students to develop the competencies needed to become reliable and competent OHS professionals.

Several studies have shown the effectiveness of microlearning in improving student learning outcomes (Mohammed et al., 2018; Yusnidar and Syahri, 2022). In addition, the results of research by Wina et al., (2017) and Mahendra et al., (2023) revealed that case studies also proved effective in developing students' critical thinking and problem solving skills. Furthermore, the results of Zarshenas et al. (2022) revealed that microlearning is an effective training method to improve learning outcomes and self-efficacy among nursing students, especially in internship units. This method is recommended because multimedia takes into account all learning styles of learners and affects learning outcomes and self-efficacy of learners. Microlearning is particularly suitable for corporate practice learning, including the healthcare industry as it is easily adaptable to the specific needs of different businesses (Pinto et al., 2025). However, research that specifically examines the effect of case study-based microlearning on the problem solving skills of K3 Corporate Hygiene D3 students in Basic Chemistry courses is still limited.

This study aims to determine the effect of case study-based microlearning on the problem solving skills of D3 Hygiene K3 students in the Basic Chemistry course. This research will use quantitative and qualitative methods to collect comprehensive and in-depth data about students' learning experiences. The results of this study are expected to contribute to the development of learning methods that are more effective and relevant to student needs.

LITERATURE REVIEW

In the context of 21st-century learning, education is expected to foster students' critical thinking, problem-solving skills, and the ability to apply knowledge in real-world contexts (Abdurahman, Wiliyanti, & Tarrapa, 2024). One effective approach that aligns with these demands is microlearning, which presents content in small, focused units that are easily accessible and engaging. Aritonang, Parmiti, and Sudarma (2023) emphasize that microlearning-based instructional videos can improve learning outcomes by delivering information

in a concise and targeted manner, making it easier for students to retain and apply knowledge.

In vocational education, especially in health and safety-related programs like the D3 Occupational Health and Safety Company Hygiene, it is essential to contextualize learning with practical and relevant scenarios. Integrating case studies into microlearning adds this context, allowing students to apply chemical concepts to real-life occupational safety issues. According to Askar and Hasfat (2025), health students benefit from instructional methods that emphasize critical thinking and problem solving, as these skills are central to navigating complex workplace challenges.

Ahmad and Sari (2025) found that students in pharmacy-related fields showed improved science process skills when engaging with problem-oriented learning in basic chemistry. This supports the notion that microlearning combined with contextual case studies can foster not only understanding but also analytical and procedural skills. Furthermore, Aristiawan (2022) observed that the use of structured essay questions in physics helped reveal students' depth of problem-solving abilities, suggesting that assessment formats should align with cognitive development goals.

From the occupational health education perspective, Adi (2024) highlights that student understanding of K3 (occupational safety and health) is often limited when practicum activities lack proper pedagogical design. Thus, integrating case-based microlearning may enhance both conceptual understanding and awareness of real-world hazards.

Taken together, the literature supports that case study-based microlearning is a promising strategy for enhancing problem-solving skills in chemical education for vocational programs. This method aligns with the needs of 21st-century learners, improves knowledge retention, and prepares students for practical, workplace-oriented challenges in the field of occupational health and safety.

METHODOLOGY

This research is a quantitative study with a quasi-experimental design nonequivalent control group design (Creswell, 2017; Frankel, et al., 2012) to determine the effect of case study-based microlearning on the problem solving skills of D3 Hygiene K3 students in basic chemistry courses. This design was chosen because it was not possible to randomize participants into experimental and control groups. The study population was all students of the D3 Hygiene K3 study program at the Makassar College of Health Sciences (STIK) in the odd semester of the 2024/2025 Academic Year, the sample was selected by purposive sampling and obtained 2 classes, namely class A25 as an experimental class of 28 students and class B25 as a control class of 28 students. The experimental group was taught with a case study-based microlearning approach and the control group was taught using conventional learning with the help of PowerPoint media

G_1	O_1	X	O_2
G_2	O_3	-	O_4

Figure 1. Research Design (Wiersma and Jurs, 2009; Ramlawati et al., 2025)

Description:
X : Microlearning based case study
O_1, O_3 : Initial test
O_2, O_4 : Final test
G_1 : Experimental group
G_2 : Control group

Data collection used a problem-solving skills test instrument consisting of 5 numbers of questions in the form of descriptions. Table 1 shows the steps and indicators of problem solving according to Polya (1973)

Table 1. Problem Solving Steps and Indicators

Troubleshooting Steps	Problem Solving Indicator
Understand the problem	Understand what is known and asked in the given problem
Developing a plan	Determine the formula/way/method to solve the given problem
Implementing the plan	Using the method/formula/method that has been planned to solve the given problem
Checking back	Re-correcting the answers that have been given in solving the problem to ensure the answer.

(Polya, 1973; Voskoglou, 2011)

The research data will then be analyzed using descriptive and inferential methods. Descriptive statistical analysis includes the number of samples, highest score, lowest score, average score, standard deviation, and variance. Inferential statistical techniques were carried out to determine the effect of case study-based microlearning on problem solving skills analyzed using the t-test at a significance level of 5% which was preceded by the requirements test, namely normality test and homogeneity test.

RESEARCH RESULT

The research was conducted for three meetings in class A25, the experimental group taught with case study-based microlearning modules and class B25, the control group taught with basic chemistry lecture modules. The microlearning module is presented in a concise, focused, and interesting manner, with each module discussing specific learning objectives and including a relevant K3 case study on stoichiometry material.

Descriptive Statistics Analysis

This analysis aims to describe the problem solving skills of students in the experimental and control groups. The results of descriptive analysis are presented in Table 2.

Table 2. Results of descriptive analysis of problem solving skills

No.	Statistics	Experiment Group		Control Group	
		Pretest	Posttest	Pretest	Posttest
1	Number of samples	28	28	28	28
2	Highest score	81	98	80	98
3	Lowest score	40	40	40	50
4	Average score	59.79	78.21	58.96	72.50
5	Standard deviation	12.54	13.59	9.08	12.56
6	Variance	157.21	184.69	82.48	157.82

Based on the descriptive analysis of problem solving skills presented in Table 2, there was an increase in the average score in the experimental group and control group from pretest to posttest. The experimental group experienced an increase in problem solving skills from 59.79 to 78.21, while the control group increased from 58.96 to 72.50. This indicates that both groups experienced an increase in problem solving skills. The increase in standard deviation in the experimental group from 12.54 to 13.59 indicates that the variation of scores in this group increased after the intervention. In contrast, the standard deviation in the control group decreased slightly, from 9.08 to 12.56. This indicates a more even distribution of scores. Both groups showed improved skills in problem solving skills based on the increase in mean scores between pretest and posttest (Aristiawan, 2022).

This study measured four indicators of problem solving skills, namely understanding the problem, planning a solution, solving the problem, and checking back. Based on the test results, the achievement of problem solving skills of D3 Hygiene K3 students in the experimental class and control class is presented in Table 3.

Table 3. Percentage of Achievement of Problem Solving Skills

No.	Indicators of Problem Solving Skills	Percentage of Achievement (%)	
		Experiment	Control
1	Understand the problem	73,21	69,35
2	Planning the solution	65	63,64
3	Solving the problem	64,21	63,21
4	Checking back	63,71	61,35
	Average	**66,54**	**64,39**

Based on Table 3 by comparing the achievement of problem solving skills on each indicator, it reveals that the experimental group with an average percentage of higher achievement (66.54%) compared to the control group (64.39%). This indicates a difference in problem solving skills between the two groups (Laliyo et al., 2020).

Inferential Statistical Analysis

Inferential analysis in this study aims to draw conclusions on the effect of case study-based microlearning based on student problem solving skills data in the Experiment group and control group.

1) Normality Test

The results of the normality test of students' problem solving skills in the experimental group and control group can be seen in Table 4.

Table 4. Normality Test of Problem Solving Skills

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil	Pre-Test Eksperimen	.241	28	.128	.877	28	.645
	Post-Test Eksperimen	.133	28	.200*	.894	28	.389
	Pre-Test Kontrol	.153	28	.093	.961	28	.368
	Post-Test Kontrol	.091	28	.200*	.973	28	.669

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 4, it reveals the results of the normality test on the problem solving skills of D3 Hygiene K3 students analyzed in the experimental group and control group. The results of the analysis using Kolmogorov Smirnov and Shapiro Wilk in Table 3 obtained a significance value greater than 0.05, meaning that the problem solving skills data in the experimental and control groups were normally distributed.

2) Homogeneity Test

The test is continued with the calculation of the homogeneity test on the data of chemical problem solving skills of D3 Hygiene K3 students can be seen in Table 5.

Table 5. Homogeneity Test of Problem Solving Skills

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	.063	1	54	.803
	Based on Median	.061	1	54	.806
	Based on Median and with adjusted df	.061	1	50.719	.806
	Based on trimmed mean	.032	1	54	.858

Based on table 5, the results of the analysis are revealed and the significance value (Sig) of the mean is 0.803, which is greater than 0.05, it can be concluded that the data variance is homogeneous.

3) Hypothesis Test

The results of the prerequisite analysis test for normality, distribution and homogeneity of variance of the experimental class and control class are fulfilled, then hypothesis testing is carried out. Table 6 shows the results of the Independent sample T test.

Table 6. Hypothesis Test of problem-solving skills

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	.063	.803	1.634	54	.011	5.714	3.497	-1.298	12.726
	Equal variances not assumed			1.634	53.669	.011	5.714	3.497	-1.299	12.727

Based on the results of the Independent Sample T test hypothesis test in Table 5, the Sig value of 0.011 is smaller than 0.05, meaning that H_0 is rejected and H_1 is accepted . H_1 states that the problem solving skills of students taught using case study-based microlearning are higher than those taught using basic chemistry modules. The average difference between the pre-test and post-test results shows the effect. So that the conclusion is obtained that there is an effect of case study-based microlearning on the problem solving skills of K3 Hygiene D3 students in basic chemistry courses.

DISCUSSION

This research was conducted in the Odd Semester of the 2024-2025 Academic Year in the Diploma three (D3) Corporate Hygiene, Occupational Health and Safety (Hygiene K3) study program which was taught with a case study-based microlearning approach in the experimental class and direct learning with learning media usually applied by lecturers in the control class, then data processing was carried out to analyze the data obtained from the research. Based on the descriptive analysis of problem solving skills, it can be seen that there is an increase in the average score in the experimental and control groups from the pretest to posttest. The experimental group, taught with microlearning, based on case studies related to the competencies of the study program, showed an increase from 59.79 to 78.21, while the control group, taught with conventional basic chemistry lecture modules, increased from 58.96 to 72.50. This increase indicates that both teaching methods and approaches are effective in improving students' problem solving skills.

Furthermore, there was a difference in the variation of scores between the two groups. The increase in standard deviation in the experimental group, from 12.54 to 13.59, indicates that the distribution of scores in this group increased after the intervention. In contrast, the standard deviation in the control group decreased slightly from 9.08 to 12.56, indicating a more even distribution of scores. This may indicate that case study-based microlearning had a more varied impact on students' problem-solving skills, with some students experiencing significant improvement while others experienced less.

Comparison of the achievement of problem solving skills in each indicator shows that the experimental group has a higher average percentage of achievement (66.54%) than the control group (64.39%). This indicates that the use of a case study-based microlearning approach is more effective in improving students' overall problem solving skills (Mohammed et al., 2018). Microlearning presents material in a concise, focused, and interesting manner, which can help students understand and apply relevant concepts in the case study to support the achievement of OHS (Zulueta & Panoy, 2022)

In order to strengthen the results of descriptive analysis, inferential statistical analysis was carried out to prove the proposed hypothesis. This test includes data normality test, homogeneity test, and hypothesis testing. Based on the results of normality testing through the Kolmogorov-Smirnov test in Table 4 reveals that the problem solving skills data in the experimental and control groups are greater than the significance level ($\alpha = 0.05$), so the data in both groups are normally distributed. Furthermore, the homogeneity test results in Table 5 show that the p-value = 0.803, so the data variance is homogeneous. The assumption of homogeneity of variance is important to ensure that the groups being compared have similar variability, so that the differences found are not caused by differences in variance. With the assumptions of normality and homogeneity fulfilled, hypothesis testing can be conducted.

The results of hypothesis testing using Independent Sample T-test in Table 6 show a significance value of 0.011, which is smaller than 0.05. This means that H_0 is rejected and H_1 is accepted, which states that the problem solving skills of students taught using case study-based microlearning are higher than those taught using conventional teaching in basic chemistry courses. The average difference between the pre-test and post-test results confirmed the significant effect of case study-based microlearning on problem solving skills. Thus, it can be concluded that there is a positive effect of case study-based microlearning on students' problem solving skills in basic chemistry courses, especially in stoichiometry. This approach, which presents material in a concise and focused manner, and relates it to relevant case studies, proved to have a significant effect compared to conventional teaching methods. These results are supported by some previous research results, including research by Yusnidar & Syahri showing the implementation of case study-based microlearning is effective on the learning outcomes of chemistry education students (Aritonang et al., 2023). In addition, microlearning is also in line with the principles of learner-centered learning, which emphasizes flexibility, and accessibility of materials (Goodwin, 2024).

This finding implies that case study-based microlearning can be a promising alternative in learning chemistry in vocational education (Fedrianti, 2024). By presenting material in a concise, relevant, and accessible manner, this approach has the potential to increase student learning motivation, strengthen concept understanding, and develop problem-solving skills essential for their profession (Aritonang et al., 2023). The microlearning approach is also in line with the needs of vocational students, D3 Hygiene and K3 study program who need practical and applicable learning, thus helping them link theory with reality in the world of work (Haryani et al., 2021).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research and data analysis, there is an effect of the case study-based microlearning approach on problem solving skills in basic chmicrolearninges of D3 Hyperhealth K3 Study Program students. The average acquisition of problem solving skills in the experimental class after receiving

treatment in the experimental and control groups was 78.21 and 72.50 respectively. The average difference between the pre-test and post-test results shows the effect of Microlearning based on case studies on student chemistry problem solving skills. This research is expected to contribute to students to improve basic chemical problem solving skills for D3 Hygiene K3 students through a case study-based microlearning approach to support the competencies needed to become reliable and competent K3 professionals.

FURTHER STUDY

Future research should examine the long-term effects of the case study-based microlearning approach and test its application in other health and safety-related study programs. It is also recommended to compare this method with other learning models and involve larger, more diverse samples to enhance the generalizability of results.

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