

Research Article

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Evaluating the Effectiveness of Scaffolding Techniques in Enhancing Students' Self-Awareness through Case-Based Learning Across Academic Disciplines

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Abstract

Background/purpose. This study aims to improve students' self-awareness of various study programs. Self-awareness establishes a vital supporting aspect in students' academic accomplishment, as it allows them to identify their potential and make confident decisions related to mastering course content. This research employed the combination of Case-Based Learning (CBL) with scaffolding strategies as the instructional design. Learning stages fostering the development of self-awareness are essential because of their potential influence on students' cognitive domains.

Materials/methods. This study adapts a quantitative research design. The instrument used is a Likert-type scale with content related to self-awareness. Data analysis was conducted using both descriptive and inferential statistical techniques, with the Mann-Whitney U test employed to examine differences in students' self-awareness increase across study program groups. Students from the Mathematics and Biology Education study programs, located in Ciamis Regency, served as the sample for this research.

Results. The results of this study reveal that the improvement in students' self-awareness in classes using scaffolding within the Case-Based Learning (CBL) model is significantly better than that of those who received conventional instruction in cross-study program groups. Moreover, the proportion of students in the experimental class classified in the high n-gain category exceeds that observed in the control class.

Conclusion. The implementation of scaffolding within the Case-Based Learning (CBL) model demonstrates effectiveness in enhancing students' self-awareness across various study programs. The inclusion of scaffolding into the learning stages enables both intrapersonal and interpersonal interactions, which are essential aspects in the development and improvement of students' self-awareness.

1. Introduction

Indonesia has undergone a curriculum transformation since 2019, following the introduction of the Merdeka Belajar (Independent learning) policy, established by the Ministry of Education and Culture. This policy aims to foster high-quality human resources capable of contributing to the reduction of the national unemployment rate (Saa, 2024). Higher education institutions, in particular, which serve as the backbone of national innovation, follow up on this policy through the Merdeka Belajar Kampus Merdeka (MBKM) program (Independent Learning of Independent Campus), established for higher education institutions (Abidin et al., 2023).

The Merdeka Belajar curriculum policy encompasses several key points: (1) the introduction of new study programs, (2) a system of university accreditation, (3) the transformation of universities into a legal institution, and (4) the provision of the students' right to start learning for three semesters outside their primary study program. The policy permitting students to engage in three-semester learning activities outside of their study programs represents one of the fundamental mandates of the Merdeka Belajar curriculum, as stipulated in higher education regulations. This initiative aims to prepare graduates who can adapt to the demands of the workplace while enhancing the overall quality of their learning experience. The right to study outside the primary program allows students to take courses beyond their core curriculum, provided that these courses are relevant and can be formally recognised. Through the careful design and implementation of the Merdeka Belajar program, it is expected that students will develop hard and soft skills comprehensively and robustly (Fauzan et al., 2023).

One essential component of soft skills is self-awareness (Sutton, 2016; Majolo et al., 2023). Self-awareness creates an internal factor that is important in prompting student success (Mograbi et al., 2023). Among the various factors that affect learning outcomes, internal factors are generally deemed to be more influential on students' achievement in mathematics (Sohail, 2025).

Self-awareness is defined as a personal skill to identify and reflect on one's characteristics, as well as to perceive and understand others. In this sense, self-awareness encompasses both intrapersonal and interpersonal dimensions (London et al., 2023). It engages students' ability to sense, receive, and regulate their potential, which supports their future development. Self-awareness is important for students to make informed and reflective decisions by exploring their values and strengths (Thaintheerasombat & Chookhampaeng, 2022; Alfredsson et al., 2021). Additionally, self-awareness is an integral part of attitude learning, which is characterised by a conscious engagement with meaningful values both to oneself and to the surroundings (Kreibich et al., 2022).

Several related studies have been conducted on the self-awareness among teenagers who wanted to be teachers. First, Merlin & Soubramanian (2024) found that young learners usually have low self-awareness. So, it requires the ability to develop their affective and professional domains. Likewise, Zlotnik & Togli (2018) noted that teenagers, aged 12 to 18, tend to have low self-awareness. This indicates that a preliminary gap occurred. Furthermore, Asare & Boateng (2025) recommended that teacher education programs require comprehensive pre-service training to foster better self-awareness based on a survey of 352 pre-service mathematics teachers. Thus, these findings underscore the importance of comprehensive self-awareness development as part of the educational frameworks of adolescents who aspire to be prospective teachers.

Well-arranged learning activities can prompt students' self-awareness (Sohail, 2025). Students will be better able to manage their feelings and expose their strengths in learning the course content if they know their potential. This indicates an essential aspect of intrapersonal development (Miller & Verhaeghen, 2022). Additionally, interaction with others further prompts students' sensitivity and capacity to make informed decisions based on the outcomes of interpersonal relationships (Kreibich et al., 2020). Interpersonal competencies can be cultivated through a learning process that integrates

adequate support, or scaffolding, from peers or teachers. Scaffolding is defined as the provision of appropriate support tailored to the specific difficulties students encounter during learning (Calor et al., 2024). Scaffolding has proven to facilitate students' understanding of the course content (Pfister et al., 2015). Accordingly, the design of the learning environment is intended to intentionally foster effective learning strategies that promote the development of self-awareness. This should lead students to an authentic, student-centered learning process while ensuring that they receive sufficient guidance and motivation throughout the process.

The appropriate learning model will make applied Scaffolding meaningful. There are many benefits to be gained from Case-Based Learning (CBL) when it is properly implemented, as it is learned through real-world cases that align with the observed study (Raza et al., 2020 ; Rhodes et al., 2020). Real-life cases can enhance students' self-awareness because the course being studied is relevant to real-life situations (Carden et al., 2022).

A previous study, as conducted by Tammeleht et al. (2021), revealed that scaffolding using collaborative CBL encourages students to actively participate in group discussions during learning, as they take on greater responsibility and perceive the learning experience positively. Likewise, Al-Bedaery et al. (2024) found that changes in students' attitudes can be comprehensively derived from well-constructed cases in CBL. CBL has the paramount strength to enable students to construct self-reflection, thereby comprehending their affective domain. This indeed becomes a motivation for students to adjust their emotions and improve their learning outcomes.

As previous studies have reported similar findings regarding the importance of fostering self-awareness among prospective teachers aligned with the Merdeka learning approach, the objective of this study is to investigate the improvement of students' self-awareness in cross-study program classes. The proportion emphasises two instructional designs: scaffolding using CBL model and conventional learning. In addition, this study examines the proportion of students in each class categorised as high, medium, or low based on their normalised gain in self-awareness. Thus, two objectives of this study are constructed as follows:

RQ1: Is the increase of students' self-awareness in the class with the Scaffolding instruction better than in the class with conventional instruction within groups of (a) cross-study program classes; (b) Mathematics Education; and (c) Biology Education?

RQ2: What is the percentage of students classified as having high, medium, or low normalised gains in self-awareness in the class with Scaffolding instruction using CBL and in the class with conventional instruction?

2. Literature Review

2.1. Self-awareness

Self-awareness is defined as one's skill to recognise oneself comprehensively and express their thoughts, emotions, strengths, weaknesses, values, and how these factors influence their behaviour and interactions with others. This construct serves as a fundamental basis for personal development, sound decision-making, and the establishment of healthy interpersonal relationships. Self-awareness is a central component of emotional intelligence, particularly in comprehending personal emotion (Al-Tkayneh et al., 2024; Wiryananta et al., 2021). The primary domain of self-awareness consists of emotional awareness, accurate self-assessment, and self-confidence (Malekzad et al., 2023; Amidi et al., 2025). The main point is that students' self-awareness is essential in controlling academic and learning success. Individuals with a well-developed understanding of their strengths, limitations, emotions, values, and learning preferences are usually better able to maintain and optimize their learning processes (Karaali, 2015).

2.2. Scaffolding

Higher education fosters Scaffolding as the structured and gradual assistance given by lecturers to support students in mastering new ideas or skills that may initially be challenging (Anwar et al., 2017). The main goal of scaffolding is to enable students to achieve their Zone of Proximal Development (ZPD), a Vygotsky concept, which designates multiple tasks that learners cannot complete independently unless appropriate guidance is provided (Tammeleht et al., 2021). Scaffolding enables students to perform tasks that would otherwise be beyond their current capabilities. Scaffolding also refers to the level of progressive assistance that gradually reduces as competence and confidence increase, ultimately fostering greater independence. Additionally, scaffolding plays a significant role in enhancing active learning. In contrast, students are led to take part actively in the learning, compared to when they play as inactive recipients of knowledge (Pfister et al., 2015). Scaffolding can take various forms, including providing explanations, posing structured questions, encouraging conceptual development, using probing and prompting techniques, offering reviews, and incorporating visual aids, among others (Calor et al., 2022). These strategies collectively contribute to the creation of a supportive learning environment that facilitates more profound understanding and skill acquisition.

2.3. Case-Based Learning

A teaching strategy known as Case-Based Learning (CBL) utilises case studies as the primary tool to enhance active and collaborative learning (Bonney, 2015). CBL enables students to learn using complex, real-world scenarios or cases that they must analyse, discuss, and solve (Nkhoma et al., 2017). The CBL's main characteristics comprise its student-centred design, emphasis on teamwork and cooperation, use of authentic or contextual real cases, focus on analysis and problem-solving, prompt critical and reflective thinking, integrated knowledge across disciplines, and the function of the teacher as a facilitator rather than a direct instructor (Sartania et al., 2022). The overall stages of conducting CBL naturally comprise the overview of the case, construction of student groups, preliminary case analysis, group discussion, a set of further information as needed, presentation and discussion in the larger class setting, and finally, reflection and generalisation of the concepts learned (Sithsungnoen, 2018).

2.4. Case-Based Learning with Scaffolding as a Strategy to Improve Self-Awareness

Some evidence suggests that promising learning outcomes result from the implementation of scaffolding instruction in different studies. Mustaji et al. (2024) and Dassa et al. (2024) reported the same findings. They reported that CBL in scaffolding instruction successfully increases students' motivation and self-efficacy, which connects to students' self-awareness and becomes integrated with students' emotions in education. Thus, these findings strengthen the present study's focus on CBL and scaffolding instruction, which underpin students' self-awareness. This concept is illustrated in Figure 1, which portrays how CBL, scaffolding, and the development of self-awareness are closely linked.

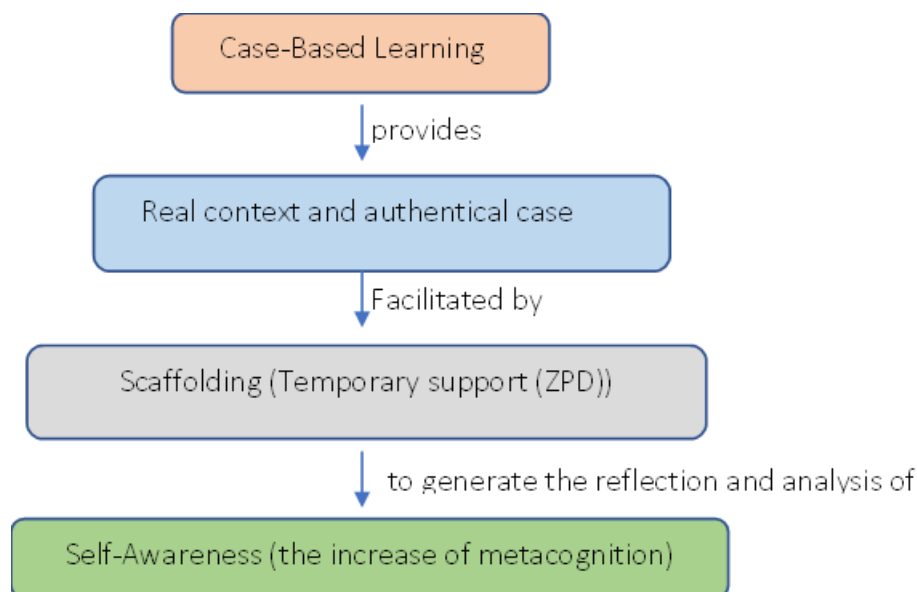


Figure 1. The connection between Case-Based Learning and Scaffolding in Enhancing Self-Awareness

Figure 1 illustrates the flow chart of scaffolding instruction using the CBL model, which assists students in understanding the concept of learning material, thereby increasing their self-awareness during learning. Additionally, students are encouraged to enhance their cognitive domain. Step by step, Scaffolding was reduced after students had fully understood the learning material. It means that scaffolding using CBL can make students become autonomous learners.

3. Methodology

This research employs a quasi-experimental design comprising two groups. They are an experimental group, which receives the well-planned teaching, and a control group, which does not receive the well-planned teaching (Em, 2024). The pretest-posttest non-equivalent group design is the specific design in this research. Mathematics and Biology Education programs, during the 2024–2025 academic year, are the focus of this study, specifically in the odd semester, at one of the universities in Ciamis Regency, as some courses in Mathematics are also offered in Biology study programs. This has been mentioned in the Merdeka Curriculum about credit recognition across study programs. However, this study focused on mathematical concepts in mathematics and Biology study programs as well as in senior high school. The duration of the instruction in the experimental and control classes was six sessions.

Simple random sampling was used as the sampling technique of this research, aiming to clarify that each member of the population has the same probability of selection (Elfil & Negida, 2019). The sample was selected using a random draw method, where numbered balls were placed in a jar and then drawn without replacement. Each ball represented a group of students from either the Mathematics Education or Biology Education study program.

The procedure for determining the experimental and control groups is presented in Figure 2.

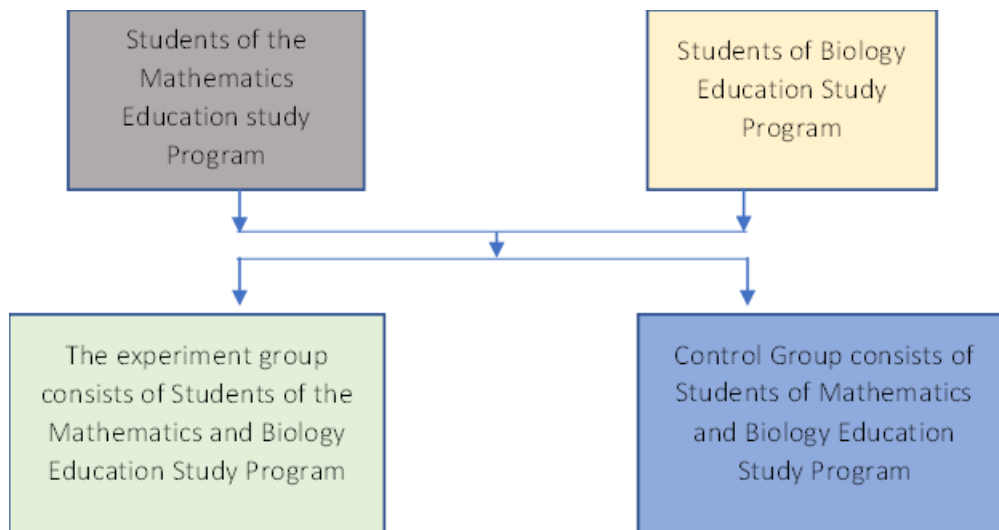


Figure 2. Research sampling technique

The experimental class employed the CBL model to conduct scaffolding. In contrast, the control class received the instruction using conventional learning methods. There were 15 students in the experimental class from the Mathematics Education program and five students from the Biology Education program. Likewise, the control class consisted of 16 students from the Mathematics Education program and five students from the Biology Education program. The study was conducted in the Linear Programming course throughout six meetings.

The instrument in this study was a self-awareness scale developed using the Likert scale method (Joshi et al., 2015). Before its implementation, the instrument underwent expert validation, followed by a preliminary trial. Subsequently, tests of validity and reliability were conducted to ensure the instrument's appropriateness (de Castro et al., 2023). The blueprint of the self-awareness scale is presented in Table 1.

Table 1. The blueprint of the self-awareness scale

ASPECT	INDICATOR	STATEMENT CONTENT		NUMBER OF STATEMENTS
		(+)	(-)	
Emotional self-awareness	Understanding the essence of emotions and identifying the connection between emotional and cognitive processes.	3	2	5
	Good at emotional management.	3	2	5
Appropriate self-awareness	Demonstrates the capacity for self-directed learning and personal development, exhibits a sense of humour, and displays openness to reflecting on oneself from a broader perspective.	3	2	5
Self-confidence	Demonstrates the courage to express personal opinions and displays confidence.	2	3	5
	Shows firmness and self-discipline in attitudes and actions	3	2	5
TOTAL NUMBER		14	11	25

The research procedure consisted of four stages: (1) preparation, (2) implementation, (3) data analysis, and (4) conclusion. The distribution of the initial self-awareness scale (pretest) was conducted before instruction was delivered in the experimental and control classes. The final self-awareness scale (posttest) was administered following the completion of instruction in both groups. Then, SPSS was used to analyse the pre-test scores using inferential statistical techniques to find out the significant differences in self-awareness between the groups. The pretest and posttest scores were subsequently analysed to calculate the normalised gain (n-gain). The n-gain was computed using the formula proposed by Hake (Coletta & Steinert, 2020), as follows:

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Possible\ Score - Pretest\ Score}$$

The analysis of the normalised gain (n-gain) data revealed that the pre-test scores were examined to determine the preliminary condition of students' self-awareness and to identify the significant difference between the experimental and control groups. In the pre-test scores of students' self-awareness, the assumption of normality was met using tests of homogeneity and a t-test. However, the normality assumption was not met in the n-gain values (Ghasemi & Zahediasl, 2012). Then, the data were analysed through the non-parametric Mann–Whitney U test (Majolo et al., 2023). Table 2 displays the guidelines for categorising n-gain as follows:

Table 2. Normalised n-gain classification

Normalized n-gain	Analysis result
$-1,00 \leq g \leq 0,00$	There is a decrease
$g = 0,00$	There is no increase.
$0,00 < g < 0,30$	Low
$0,30 \leq g \leq 0,70$	Mild
$0,70 \leq g < 1$	High

4. Results

4.1. Processing the Pre-test scores of students' Self-Awareness in the Mathematics Education and Biology Education Programs

The data analysis examined the pre-test scores of students' self-awareness to determine any significant differences between the experimental and control classes. The normality test results are illustrated in Table 3.

Tabel 3. Tests of Normality

Class		Shapiro-Wilk		
		Statistic	df	Sig.
Result	Experiment Class	.933	20	.174
	Control Class	.914	21	.067

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

a. Lilliefors Significance Correction

The normality test indicated that the experimental class resulted in a significance value of 0.174 ($p > 0.05$), suggesting that the data were normally distributed. Similarly, the control class resulted in a significance value of 0.067 ($p > 0.05$), which also met the assumption of normality. Because the

normality assumption was met for both groups, the analysis proceeded using a homogeneity test. The results of the homogeneity test are illustrated in Table 4.

Table 4. Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
,148	1	39	,703

The homogeneity test showed a significance value of 0.703 ($p > 0.05$), suggesting that the data included homogeneous variances. Since the normality and homogeneity assumptions were met, the analysis was conducted using parametric statistical testing, specifically an independent samples t-test. The results of the homogeneity test are illustrated in Table 4, while the independent samples t-test is demonstrated in Table 5.

Table 5. Independent Sample Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
SA	Equal variances assumed	,020	39	,984
	Equal variances not assumed	,020	38,896	,984

Based on the data analysis results, the significance value was 0.984 ($p > 0.05$), indicating that there was no significant difference in the mean of the pre-test score of students' self-awareness between the class that received scaffolded learning through the CBL model and those in the class that received conventional learning.

4.2. N-Gain Self-Awareness Data Processing of Mathematics and Biology Education Students

The analysis of students' n-gain self-awareness began with descriptive statistics to provide a preliminary overview of the improvements in self-awareness within the experimental and control classes. The analysis result is illustrated in Table 6.

Table 6. Descriptive Statistical Analysis Results of N-gain Data

Analysis	N-gain	
	Experiment Class	Control Class
Mean	0,90	0,60
Median	0,89	0,65
Modus	1,00	0,84
Maximum	1,00	0,98
Minimum	0,32	0,03
Range	0,68	0,95
Deviation Standard	0,17	0,24

The subsequent data processing employs Inferential statistics.

4.2.1. The Analysis of N-Gain Self-Awareness between Mathematics and Biology Education Students

A prerequisite test functions to examine the normal distribution of the data. The normality test result is presented in Table 7.

Table 7. Tests of Normality

Group		Shapiro-Wilk		
		Statistic	df	Sig.
Result	Experiment Class	.786	20	.001
	Control Class	.951	21	.358

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

a. Lilliefors Significance Correction

Table 7 pointed out that the experimental class obtained a significance value of 0.001 ($p < 0.05$), suggesting that the data were not normally distributed. In contrast, the control class obtained a significance value of 0.358 ($p > 0.05$), indicating a normal distribution. Since the assumption of normality was not met for the overall data, the Mann–Whitney U test was employed to test the research hypothesis. The analysis results are presented in Table 8.

Table 8. Test of Statistics

	Hasil
Mann-Whitney U	87.500
Wilcoxon W	318.500
Z	-3.205
Asymp. Sig. (2-tailed)	.001

a. Grouping Variable: Group

Table 8 pointed out that the significance value was 0.001, which is less than 0.05 (the increase of students' self-awareness in the class who received learning with scaffolding in CBL was significantly greater than that of students who received conventional instruction within the combined group of students).

4.2.2. N-Gain Self-Awareness Data Processing of Mathematics Education Students

The prerequisite test examined the normal data distribution. The results of the normalisation test are presented in Table 9.

Table 9. Tests of Normality

Group		Shapiro-Wilk		
		Statistic	df	Sig.
Result	Experiment Class	.805	15	.004
	Control Class	.933	16	.273

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

a. Lilliefors Significance Correction

Table 9 indicates that a significance value of 0.004 ($p < 0.05$), indicating that the data were not normally distributed. Meanwhile, the control class had a significance value of 0.273 ($p > 0.05$), pointing out that the data followed a normal distribution. Since the overall data did not meet the assumption of normality, the Mann–Whitney U test was employed to test the hypothesis. The analysis results are presented in Table 10.

Table 10. Statistics Test

	Result
Mann-Whitney U	63.500
Wilcoxon W	199.500
Z	-2.237
Asymp. Sig. (2-tailed)	.025
Exact Sig. [2*(1-tailed Sig.)]	.024 ^b

a. Grouping Variable: Group

b. Not corrected for ties.

Based on the data analysis results, the significance value was 0.025 ($p < 0.05$), indicating that the improvement in self-awareness among students who received scaffolded learning through the CBL model was significantly greater than that of students who received conventional learning in the Mathematics Education study program.

4.2.3. N-Gain Self-Awareness Data Processing of Biology Education Students

The prerequisite test is used to find out the normal data distribution. The analysis results of the normalisation test are presented in Table 11.

Table 11. Tests of Normality

		Shapiro-Wilk		
Group		Statistic	df	Sig.
Hasil	Experiment Class	.725	5	.017
	Kelas Kontrol	.953	5	.760

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

a. Lilliefors Significance Correction

Table 11 showed that the experimental class obtained a significance value of 0.017 ($p < 0.05$), indicating that the data were not normally distributed. In contrast, the control class obtained a significance value of 0.760 ($p > 0.05$), indicating that the data were normally distributed. Since the normality assumption was not met, the Mann–Whitney U test was employed to test the hypothesis. The analysis results are presented in Table 12.

Table 12. Test Statistics

	Hasil
Mann-Whitney U	1.500
Wilcoxon W	16.500
Z	-2.333
Asymp. Sig. (2-tailed)	.020
Exact Sig. [2*(1-tailed Sig.)]	.016 ^b

a. Grouping Variable: Group

b. Not corrected for ties.

Based on the data analysis results, the significance value was 0.020 ($p < 0.05$), indicating that the improvement in self-awareness among students who received scaffolded learning through the CBL model was significantly greater than that of students who received conventional learning in the Biology Education study program.

4.3. Students' Proportion in the Experiment and the Control Class

The processing data results for the proportion of students between the experimental class and the control class is illustrated in Table 13. Furthermore, the comparison in percentage form is elaborated in Figure 3.

Table 13. The proportion of n-gain Classification

N-GAIN CLASSIFICATION	NUMBER OF STUDENTS	
	EXPERIMENT CLASS	CONTROL CLASS
Medium	1	11
High	19	10
Total number	20	21

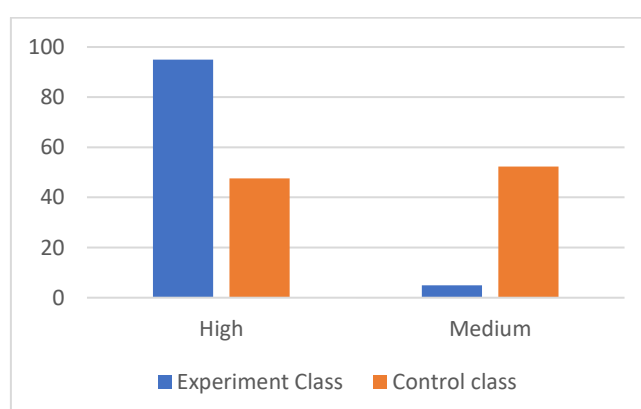
**Figure 3.** The proportion of the Student Percentage Distribution

Table 13 indicates that the number of students in the high n-gain category was 19 in the experimental class and 10 in the control class. In the medium n-gain category, there was one student in the experimental class compared to 11 students in the control class. Furthermore, Figure 3

illustrates the percentage distribution, showing that 95% of students in the experimental class fell into the high n-gain category. In comparison, only 47.62% of students in the control class achieved the same level. Conversely, 5% of students in the experimental class were in the medium category, compared to 52.38% in the control class.

5. Discussion

The data results are derived from the descriptive statistical data analysis for both the experimental and control classes, indicating that the average normalised n-gain in self-awareness of the experimental class is greater than that of the control class. Similarly, the maximum and minimum n-gain values observed in the experimental class exceed those recorded in the control class. These findings provide an initial indication that the improvement in self-awareness among students in the experimental class is greater than that of students in the control class.

The inferential statistical result on the combined group of students from the Mathematics Education and Biology Education programs indicated that, based on the prerequisite testing, specifically the normality test, one of the data sets did not meet the standard distribution requirements. Consequently, a non-parametric test was employed to examine the research hypothesis. The test result of the analysis demonstrated that the improvement in students' self-awareness in the class that received instruction with scaffolding within the Context-Based Learning CBL model was significantly higher than that of students who received conventional instruction in the combined student group.

The data analysis result for the mathematics student group indicated that, based on the prerequisite test, specifically the normality test, one of the data sets did not meet the standard distribution requirements. Thus, a non-parametric test was employed to examine the research hypothesis. The test result revealed that the improvement in self-awareness among students who received learning with scaffolding within the CBL model was higher than that of students who received conventional instruction in the Mathematics Education study program group.

The results of the data analysis for the Biology Education study program student group showed that, based on the prerequisite test, specifically the normality test, one of the data sets did not meet the standard distribution requirements. Consequently, a non-parametric test was applied to evaluate the research hypothesis. The results indicated that the increase in self-awareness among students who received learning with scaffolding in the CBL model was greater than that of students who received conventional learning in the Biology Education study program group.

The findings regarding the proportion of students across the n-gain categories show that the number of students classified in the high n-gain category is higher in the experimental class than in the control class. Conversely, the number of students in the medium n-gain category is lower in the experimental class compared to the control class.

The study findings reveal that there was no significant difference in the pre-test scores of students prior to instruction, particularly in terms of self-awareness, between the experimental and control groups. However, there was an increase in pre-test of self-awareness across all three measured aspects after the instruction. In the affective aspect, students demonstrated greater reflectiveness in managing their feelings when facing different perspectives. Regarding self-awareness, students demonstrated the ability to objectively recognize their strengths and weaknesses in problem-solving. Finally, regarding self-confidence, students demonstrated greater courage in expressing their ideas, posing questions, and actively participating in discussions.

Similarly, Raza et al. (2020) revealed a significant and good connection between case-based learning and its improvements in both affective and cognitive aspects. Then, scaffolding was gradually reduced, making students independently understand the learning material and solve the presented

problems, thereby creating more meaningful interactions. This finding is relevant to the research conducted by Calor et al. (2024), which found that learning instruction supported by scaffolding led to significantly more discussions, and the quality of these discussions was notably higher than in control classes.

The implementation of the CBL model in this study followed a structured set of steps. First, students were made into small groups. Each group consisted of five students. These groups consisted of students from the Mathematics Education and Biology Education study programs. Second, each group was provided with a case drawn from an article relevant to the subject matter. Third, the groups were given time to collaboratively discuss the case. To facilitate and guide this process, the lecturer distributed worksheets containing structured questions to each group. Finally, a whole-class discussion was conducted, which included a question-and-answer session and group presentations. This stage began with presentations by representatives from each group, followed by a comprehensive discussion involving all students in the class.

The implementation of scaffolding within the CBL model in this study was carried out during the discussion phase. At this stage, each group was allocated time to collaboratively discuss the case presented through an article or news item provided by the lecturer. To support and enhance students' understanding, the lecturer offered explanatory guidance as part of the scaffolding process. The activity carried out is presented in Figure 4.

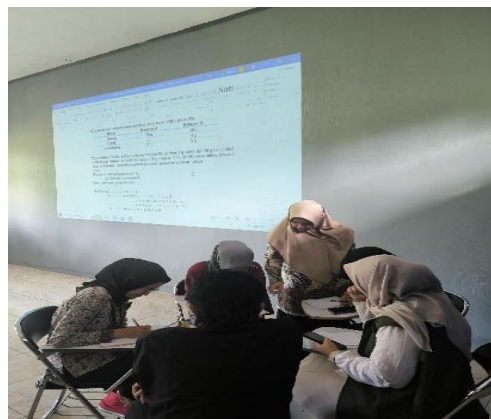


Figure 4. Scaffolding using explanation

During the discussion process, the lecturer provides each group with a set of written questions designed to guide and structure the discussion. The structured questions, formatted as worksheets, were distributed to the students through a WhatsApp group. The structured questions are presented in Figure 5.

$Z = 40(0) + 30(0)$ $Z = 0 + 0 = 0$ -) Titik B (0,15) maka $x = \dots$ dan $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Titik C (7,5; 15) maka $x = \dots$ dan $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Titik D (15, 10) maka $x = \dots$ dan $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Titik E (20, 0) maka $x = \dots$ dan $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ • Langkah ke 6, karena fungsi tujuan merupakan fungsi maksimum maka nilai z yang dipilih adalah nilai yang paling besar yaitu $Z = \dots$. Dengan demikian PT UNI harus memproduksi produk "X" sebanyak $\dots$ unit dan produk "Y" sebanyak $\dots$ unit yang menghasilkan tingkat keuntungan sebesar $\dots$.	$Z = 40(0) + 30(0)$ $Z = 0 + 0 = 0$ -) Point B (0,15) so $x = \dots$ and $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Point C (7,5; 15) so $x = \dots$ and $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Point D (15, 10) so $x = \dots$ and $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ -) Point E (20, 0) so $x = \dots$ and $y = \dots$ $Z = 40x + 30y$ $Z = 40(\dots) + 30(\dots)$ $Z = \dots + \dots = \dots$ • Stage 6, Given that the objective function is to be maximized, the optimal solution involves producing $\dots$ units of product X and $\dots$ units of product Y, resulting in a total profit of $\dots$
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Figure 5. Scaffolding using structured questions

Figure 5 shows the students' conceptual thinking development, which is facilitated using guiding questions designed to encourage students' reasoning and critical reflection. These questions are

presented in worksheets that are supposed to be completed collaboratively by students within their respective groups. The worksheets for developing students' conceptual thinking are presented in Figure 6.

2. Panitia demo masakan menyediakan 2 jenis makanan bergizi berbentuk bubuk untuk peserta. Tiap 400 g, kedua jenis makanan itu mengandung nutrisi seperti tertera pada tabel:

Unsur	Makanan A	Makanan B
Protein	15 g	10 g
Lemak	2 g	4 g
Karbohidrat	25 g	30 g

Para peserta setiap hari paling sedikit memerlukan 15 g protein, 4 g lemak, dan 30 g karbohidrat. Apabila harga makanan A Rp 15.000 setiap 400 g makanan B Rp 20.000 setiap 400 g, tentukan harga minimum dari makanan yang telah dihabiskan para peserta setiap harinya.

Jawab:
Misalkan, x = banyaknya makanan A
 y = banyaknya makanan B
Model matematika yang terbentuk:

Minimum $Z = \dots x + \dots y$
d.b $\dots x + 10y \dots 15 \rightarrow 3x + \dots y \dots 3$
 $\dots x + 4y \dots 4 \rightarrow x + \dots y \dots 2$
 $\dots x + 30y \geq \dots \rightarrow 5x + \dots y \geq 6$
u.h $x \geq 0, y \geq 0 \rightarrow x \geq 0, y \geq 0$
Lanjutkan!

The food show organizer provides two kinds of nutritious food in the form of powder for the participants. Every 400g of those foods contain the following nutrition;

Element	Food A	Food B
Protein	15 g	10 g
Fat	2 g	4 g
Carbohydrate	25 g	30 g

Each day, participants require a minimum intake of 15 grams of protein, 4 grams of fat, and 30 grams of carbohydrates. Food A is priced at Rp15,000 per 400 grams, while Food B costs Rp20,000 per 400 grams. Determine the minimum daily cost required to meet the participants' nutritional needs

Answer:
Food, x = Amount of food A
 y = Amount of food B
Established Mathematics Model:
Minimum $Z = \dots x + \dots y$
d.b $\dots x + 10y \dots 15 \rightarrow 3x + \dots y \dots 3$
 $\dots x + 4y \dots 4 \rightarrow x + \dots y \dots 2$
 $\dots x + 30y \geq \dots \rightarrow 5x + \dots y \geq 6$
u.h $x \geq 0, y \geq 0 \rightarrow x \geq 0, y \geq 0$
Please continue!

Figure 6. Scaffolding for developing conceptual thinking

Figure 6 shows that the worksheet was accompanied by probing and prompting provided by the lecturer for groups that required additional support. Verbal question-and-answer interactions were conducted to facilitate the construction of students' understanding of the material's underlying concepts. The activity carried out is presented in Figure 7.



Figure 7. Scaffolding using probing-prompting

Figure 7 illustrates the question-and-answer and discussion activities designed to compare the responses of each group, with the process structured to guide students in developing an in-depth understanding of the learning material. This approach was designed to encourage active student participation in the learning process. The activity carried out is presented in Figure 8.



Figure 8. Students' presentation about their discussion results

Figure 8 illustrates the reviewing activity, which serves as a form of reflection and confirmation, providing feedback, and was conducted during students' presentations of their case-based

assignments. This activity provided an opportunity to examine students who had demonstrated mastery of the learning material. Furthermore, any conceptual errors identified during the presentations could be addressed and corrected by the lecturer to support students' conceptual understanding. The activity carried out is presented in Figure 9.



Figure 9. Scaffolding using reviewing

Figure 9 illustrates that the implementation of case-based learning fosters an environment rich in authentic learning experiences, which are crucial for developing self-awareness. Through analysis, decision-making, collaboration, and in-depth reflection, students not only acquire substantive knowledge and skills but also develop an in-depth understanding of themselves, including their strengths, weaknesses, mindsets, emotional reactions, and personal values (Hartung, 2020; Sholihat et al., 2023; Hadi & Gharaibeh, 2023). The provision of CBL is increasingly meaningful in increasing student self-awareness because it applies scaffolding to its learning syntax. This is a learning process design that enables students to complete each activity independently. The discussions in scaffolding activities, both within peer groups and with students outside the group, as well as with lecturers, help students understand their potential and accept their limitations. They are also trained to make decisions related to the results of interactions with their environment. In line with Cowan (2021), scaffolding is defined as a process that helps learners, particularly novices, in solving problems, completing tasks, or obtaining goals that would be complicated to accomplish individually.

The findings of this study align with previous researches, which has demonstrated that Context-Based Learning (CBL) effectively enhances students' knowledge and self-assessment of their competency levels (Sin, 2015). The use of scaffolding is also essential, as it has been shown to support students in mastering the material and to foster the development of positive attitudes toward learning (Alrawili et al., 2022; Krain, 2016). Tammelleht et al. (2021) and Al-Bedaery et al. (2024) found that scaffolding within the CBL approach can encourage student engagement, foster a sense of responsibility, and enhance positive perceptions of the learning process.

This finding contrasts somewhat with the results of Rhodes et al. (2020), who reported that case-based learning does not necessarily lead to uniformly higher learning outcomes compared to traditional lectures. Their study found that students with lower ACT scores or fewer completed credits often reported lower learning outcomes when learning through case studies than through lectures. Such differences highlight the crucial role of lecturers in carefully selecting and structuring cases, as the design of cases directly influences students' cognitive load, which in turn affects their performance in the affective domain. To optimise learning, cognitive load should be managed progressively, beginning with simpler cases and gradually moving toward more complex ones, while avoiding excessive overlap of information in cases with multiple variables.

6. Conclusion

The study results demonstrate that the improvement of self-awareness among students with Scaffolding instruction within the CBL model was higher than that of students who received conventional instruction across all student groups: (a) the combined Mathematics and Biology Education, (b) the Mathematics Education, and (c) the Biology Education. The scaffolding was implemented within the CBL model in this study during the discussion phase, where each group was given time to discuss cases derived from articles or news items provided by the lecturer. To assist students' understanding, the lecturer offered explanations and distributed structured written questions to guide the group discussions. The development of students' conceptual thinking was facilitated through directive questions designed to promote reasoning. The completion of the worksheets was accompanied by probing and prompting provided as needed. At the final stage of learning, a review was conducted to promote reflection and provide confirmation in the form of feedback during student presentations of their assignment results. These findings suggest that the use of scaffolding within the CBL model is effective in enhancing students' self-awareness. This method can be implemented in teachers' training to cultivate prospective teachers' self-awareness, which can make a significant contribution to professional reflection in the classroom.

7. Suggestion

Based on the study's results, which show that CBL assisted by scaffolding is effective in increasing students' self-awareness in cross-study program classes, the researcher highly recommends this learning model for educational purposes. In further research, it may be beneficial to appoint group leaders, allowing scaffolding to be provided between students led by their group leaders, as not all students have the confidence to interact directly with lecturers.

Declarations

Author Contributions. Yoni Sunaryo: Review of literature, Conceptualization, and data collection. Stevanus Budi Waluya: Corresponding author, Method, Data Analysis, and supervision. Wardono: Review, editing, and research article Preparation, Nuriana Rachmani Dewi: Validity, Data visualisation, and critical revision. All writers have proofread and met the agreement of the final version of the research article to be published.

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Data Availability Statement. The datasets that support the findings of this study can be obtained from the corresponding author upon reasonable request.

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