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Article

Supporting Students' Logical Thinking Ability with Case Based Learning Model with Smart Quiz Technique

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ABSTRACT

Indonesia faces serious challenges in developing logical thinking skills, particularly in science. This skill is crucial because it serves as the foundation for students to analyze, evaluate, and create solutions to complex problems, not only in school but also in everyday life. Unfortunately, data from various sources indicates that Indonesian students' logical thinking skills are still far below global standards. The TIMSS consistently ranks Indonesia at the bottom, ranking 44th out of 49 countries with a score of 397. This study aims to 1. Determine the implementation of the CBL with the quiz technique on logical thinking skills. 2. Determine student activities during the implementation of the CBL model with the quiz technique on logical thinking skills. 3. Determine the effectiveness of the CBL with the quiz technique on logical thinking skills. This study used a quantitative approach with a quasi-experimental design. The research design involved an experimental class implementing the CBL with the quiz technique, and a control class using conventional learning methods. Data were collected after being tested for validity and reliability. The results of the study showed that the average student activity during the implementation of the CBL with the quiz technique reached 83% which is included in the good category. The results of the hypothesis test showed a significant difference in students' logical thinking abilities between the experimental class and the control class, where the sig value (2 tailed) was 0.000. The N-Gain analysis showed that the average N-Gain value of the experimental class was 0.74, which was categorized as "moderate and quite effective". Thus, this study concluded that the CBL with the quiz technique was effective in improving students' logical thinking abilities.

INTRODUCTION

In today's modern society, the most important aspect that can improve the progress of the Indonesian nation is education. Educational activities include not only the cognitive dimension but also the cultivation of attitudes and improvement of student skills (Masruroh & Arif, 2021). The skills that must be developed here are thinking skills. In learning, thinking skills must be continuously improved. Because in learning the ability to think is a supporting aspect that can

greatly impact the level of student understanding of the knowledge taught by the teacher. The development of thinking skills is very important for education in the long run. When someone has strong thinking skills, they can not only memorize information, but they can also analyze, evaluate, and create new ideas.

Science education in Indonesia remains severely lacking, despite logical thinking being a crucial skill for improving students' academic success. However, logical reasoning capacity is still considered limited in practical contexts. The findings of the 2019 "Trends in International Mathematics and Science Study," Indonesia's final year of participation in TIMSS, emphasize logical reasoning skills, supporting this claim. The study found that Indonesia ranked 44th out of 49 countries with a score of 397. This finding indicates that Indonesia is considered a country with poor reasoning skills (Bintari & Fatmahanik, 2023). In science and mathematics, it's like a lock and key: if the key is lost, the lock won't open. Furthermore, logical thinking is also something students should possess to enhance their problem-solving abilities.

The ability to think logically can help students understand lessons, and also provide them with lifelong critical thinking skills, allowing them to rationally analyze data, solve difficult problems, and make rational decisions in various aspects of life, allowing them to question, evaluate, and construct strong arguments (Zuwariyah, Irawan, & Artikel, 2021). From the explanation above, it can be seen as a basis for why logical thinking is important and related to science learning, this is because learning natural sciences requires various kinds of complex thinking skills, Logical thinking is a complex skill that must be developed. One of the strong foundations for improving students' academic performance is the ability to think logically (Arifiya, 2023).

Indonesia's education quality is relatively low, ranking 67th out of 209 countries, as reported by WorldTop in 2023. Meanwhile, education spending ranks first in the world. According to the World Bank in 2020, Indonesia's education budget is twice as large as that of developed East Asian countries such as Japan and South Korea (Hastari Pamulatsih, 2024).

According to Natasya Sari Nababan and Prihatin Ningsih Sagala, the CBL learning paradigm is a case-based approach because it engages students in discussions about specific real-world examples or challenges. In the case-based learning (CBL) model, the teacher or educator acts solely as a facilitator, and students are required to actively participate in the learning and engage in intense discussions (Natasya Sari Nababan, 2023). Based on the theory, case-based learning was chosen for research because it has many positive influences on the development of science education in Indonesia. One of the most visible aspects is how students learn to process the cases presented by educators when using the CBL model.

According to Arianto, the key advantages of the CBL learning approach are as follows: Students can articulate scenarios or problems and apply them to new contexts. Students can improve their analytical, collaborative, and communicative skills. Students can increase their engagement in the learning process, and case-based learning can enhance student competency (Arianto & Fauziah, 2020). From the explanation above, it can be seen that the Case-Based Learning (CBL) model has advantages in revealing cases and analyzing them, both of which are important indicators in assessing students' logical thinking. Then, the researcher reinforced the material using a quiz game to strengthen and foster logical thinking in students. This quiz competition is a form of recognition from educators and the government for students who demonstrate excellence. In addition to being a means of disseminating knowledge, the quiz competition can serve as an evaluative instrument for the educational material provided by instructors to students (Sutrikanti, Situmorang, & ..., 2018).

Research conducted by Nanda Syah Putra shows that carefully using intelligent games when teaching protein synthesis can significantly improve students' conceptual mastery (Putra, 2023). This finding aligns with the principles of the Independent Curriculum, which prioritizes student-centered and active learning methodologies. Basic aviation components can also be used in quiz games.

Research conducted by Amanda Syahri Nasution and Nurdailah shows that quizzes function as a pedagogical method through competitive activities to increase student engagement in learning. This strategy allows students to assess their abilities by answering questions quickly and accurately (Nasution & Nurdailah, 2018).

The Case-Based Learning model is used as a platform for case based learning, which requires students to think logically. Students are then asked to think quickly to solve the case, which is then facilitated by a quiz game. This combination of the two is expected to develop students' logical thinking skills, accurately and accurately.

METHODS

The type of research used was a quasi-experimental quantitative study. The quantitative design was used to compare the effectiveness of problem-based learning with conventional learning methods on students' logical and critical thinking skills. A quantitative research approach is defined as a research method that uses populations and samples to obtain data using numerical/statistical instruments and data analysis. Statistics are a quantitative research tool used in data analysis activities (Oktavia & Rismawati, 2022).

Participants and assessment instruments

The sample population in this study were students of class VIII of SMPN 5 Ponorogo in the 2024/2025 academic year consisting of 8 classes with a total of 34 students. The research was conducted by involving two classes selected by random cluster sampling (Sugiyono, 2010). Of the eight classes, class VIII-C was selected as the experimental class and class VIII-D as the control class. The experimental class used Case Based Learning model with the application of quizzing, while the control class used conventional learning using PowerPoint media. This study used a quasi-experimental research model, comparing 2 groups of students. There are 3 variables and operational definitions used in this study, namely: a) Independent Variable: Case Based Learning (CBL) Learning Model with Quizzing Technique. Operational definition: The learning model applied in the experimental class, where students work in small groups to learn certain parts of simple aircraft material using the Case Based Learning Model (CBL), then share knowledge with each other. A quiz activity is conducted to train learners' logical thinking skills through science-based questions. The successful implementation of this model will be assessed based on learner engagement, interaction within the group, and the effectiveness of using logical connectors in their scientific writing. b) Dependent Variable: Learners' Logical Thinking Ability. Operational definition: Learners' ability to analyze, interpret, and apply scientific concepts related to simple aircraft. This ability is measured through pre-test and post-test results consisting of questions that assess aspects of logical thinking, such as understanding cause-and-effect relationships, using logical connectors in arguments, and the ability to organize information systematically. c) Learners' Learning Outcomes in Simple Aircraft Materials (Sholikhah, Irawan, & Wijaya, 2023). Operational definition: The level of understanding and mastery of learners of simple aircraft material measured through quantitative assessment of pre-test and post-test results. These learning outcomes include learners' ability to explain simple aircraft concepts, connect between various concepts, as well as their ability to write coherent and well-structured scientific arguments using logical connectors (Nofida & Arif, 2020).

The subject used as the experimental class was class VIII C at SMP Negeri 5 Ponorogo and the control class was class VIII D at the same school. These classes were chosen without any significant differences in the learners' profiles or in the learners' performance in logical thinking and natural science. According to the results obtained in the official internal assessment prior to the research, the scores of the two classes were not much different.

There are six important stages in the implementation of this research: a) Observation Stage: At the initial stage, the researcher made observations to observe the learning process in the classroom. Researchers pay attention to the teaching methods used by teachers, the

involvement of students, and how the interaction between students and teachers during learning takes place. b) Test Instrument Development Stage: At this stage, researchers developed test instruments used to measure students' logical thinking skills. This instrument is designed based on indicators of logical thinking skills that are relevant to simple aircraft learning materials. c) Pre-Test Stage: After the test instrument was ready, researchers gave a pre-test to students to measure their logical thinking skills before the application of the learning model. This test serves as initial data that will be compared with the post-test results later on. d) Stage of Learning Model Implementation: At this stage, researchers applied the Case Based Learning (CBL) learning model combined with quiz activities in the experimental class. Students work in groups to study simple aircraft material, then submit the results of the conclusion of the problem given (Lasaiba & Lasaiba, 2024). e) Post-Test Stage: After the learning is complete, the researcher gives a post-test to students in the experimental and control classes. This post-test aims to measure the extent to which students have improved in logical thinking skills after the application of the learning model in the experimental class, as well as to compare it with the control class using conventional learning methods. f) Data Processing and Analysis Stage: The last stage is the processing and analysis of data obtained from the post-test results. The data is analyzed using a t-test to determine whether there is a significant difference in the improvement of logical thinking skills between the experimental and control classes. The results of this analysis are then used to draw conclusions regarding the effectiveness of the Case Based Learning (CBL) learning model with the quiz technique in improving students' logical thinking skills (Ummah, 2019).

The instruments used in this study are test questions and observation sheets. The test questions will be used for pretest and posttest which contain all indicators of the research variables and will be given to the control class and experimental class. The following are the research variables and indicators used:

a) Logical thinking skills with the type of pre-test and post-test tests with indicators of orderly thinking, argumentation skills, and conclusion drawing.
b) Interactive quiz with the type of quiz test in indicators of speed and accuracy as well as logical and critical thinking skills.
c) Case Based Learning (CBL) learning model with observation test type in basic concept indicator, problem definition, self-learning, knowledge exchange, and assessment.

The questions used in this study have been validated by experts and natural science lecturers who are professionals in their fields. This question has been revised by adjusting input from experts so that it can be used for research.

RESULTS AND DISCUSSION

Implementation of Learning Using the Cased-Based Learning (CBL) Model with the Quiz Technique on Logical Thinking Skills

Data collection and/or implementation using the cased-based learning (CBL) model with the quiz technique were supervised by a professional teacher in the natural sciences and experienced in implementing various learning models. Therefore, it is expected that the data obtained has been observed by the teacher.

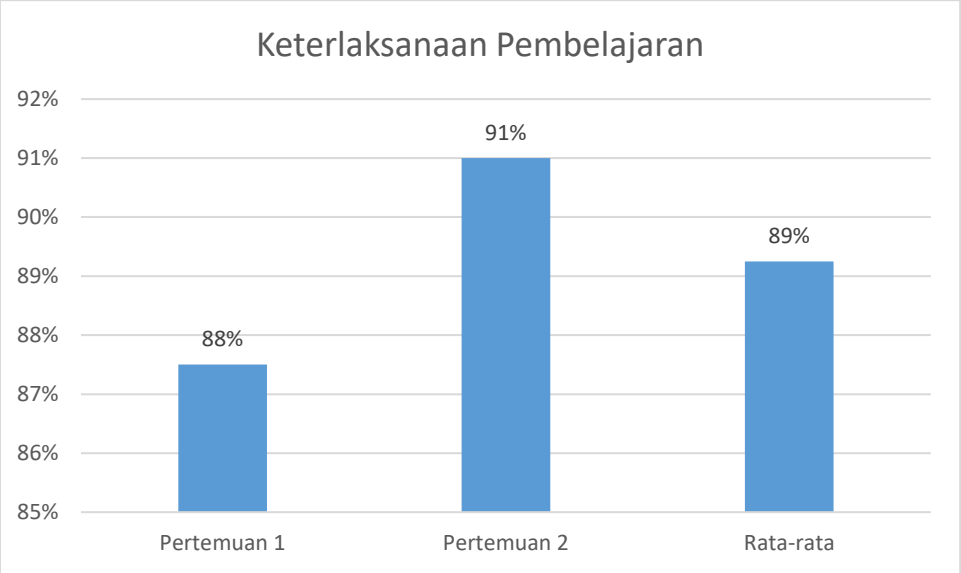

Figure 1. Observation Results of the Implementation of the Case Based Learning (CBL) Learning Model Using the Smart and Accurate Technique

Figure 1 shows that the average learning implementation using the CBL (Case-Based Learning) model with the quiz technique was 89%, indicating excellent criteria. The implementation of CBL learning was in accordance with the learning syntax. In the first meeting, the learning implementation was 88%. There were some obstacles at the beginning of the lesson, as many students were still confused about the learning steps. This was because they had never previously engaged in CBL learning, which requires students to think logically, collaborate, be active, and express their opinions. However, after being given guidance by the teacher, students were able to follow the learning process according to the CBL learning steps using the quiz technique (Silitubun et al., 2024) .

In the second meeting, the learning implementation was 91%. At the second meeting, students were able to follow the lesson well without any obstacles. The learning proceeded according to the CBL learning steps using the quiz technique. The teacher was able to implement the learning steps better than in the first meeting, supported by students who already understood the learning steps (Silitubun, Mustaji, & Dewi, 2025) .

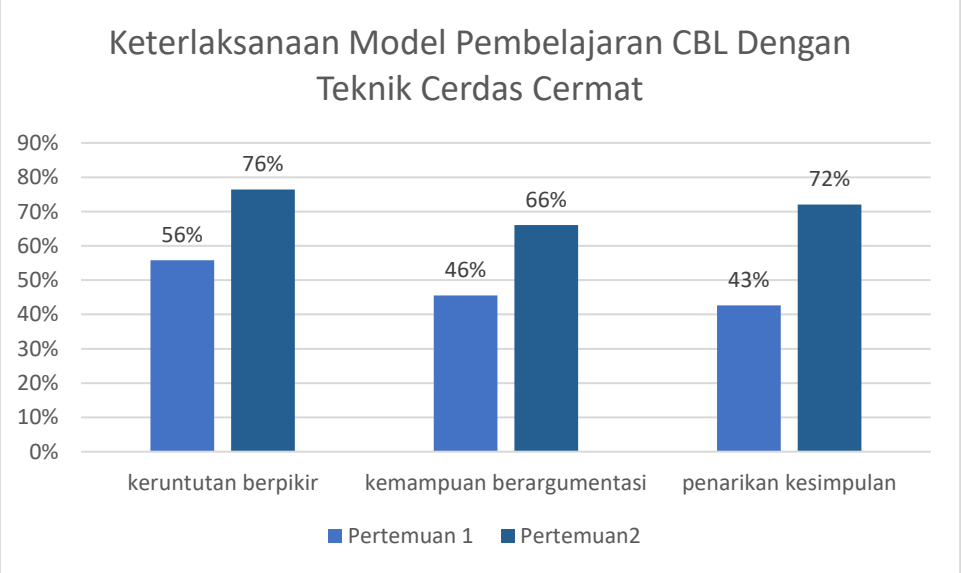

Figure 2. Results of the Implementation of the CBL Model Using the Smart and Careful Technique

Figure 2 shows that the implementation of the CBL model with the quiz technique in the first meeting, with the sequence of thinking stage, was 56% successful. Furthermore, in the argumentation stage, it was 46% successful. Furthermore, in the conclusion-drawing stage, it was 43% successful, all of which fell into the sufficient category. Because in this first meeting, students were still adapting to the case-based learning model with the quiz technique, many students still struggled with the stages of the CBL learning model.

In the second meeting, the implementation of the CBL learning model in the sequence of thinking stage was 76% successful. Furthermore, in the argumentation stage, it was 66% successful. Finally, in the final stage, conclusion-drawing, it was 72% successful, all of which fell into the good category.

Student Activities During the Implementation of the Case-Based Learning (CBL) Model with Quiz Techniques on Logical Thinking Skills

During the learning process, student activities were observed and evaluated by observers using a questionnaire. The purpose of these observations was to understand student activities throughout the learning process using the Case-Based Learning (CBL) model with quiz techniques on logical thinking skills.

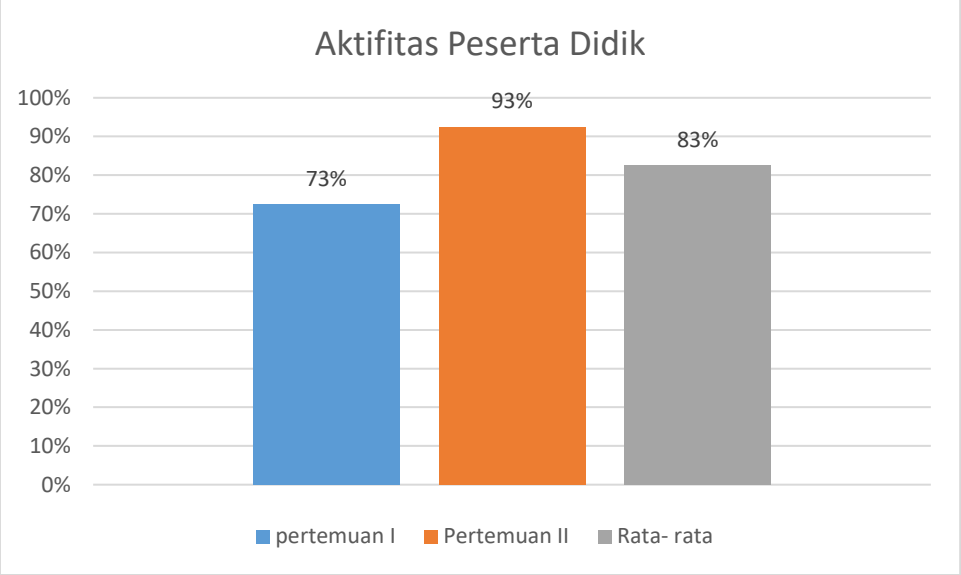

Figure 3. Observation Results of Student Activities During Learning Using the Case Based Learning (CBL) Model with the Smart and Accurate Technique

Figure 3 shows that the average student activity during the Case-Based Learning (CBL) learning process using the quiz technique reached 83%, reflecting a good category. In the first meeting, the percentage was 73%. Student activity was still relatively low during the Case-Based Learning (CBL) learning phase using the quiz technique, as they were still in the adaptation phase. While the thinking phase should have been conducted independently, students were still seen communicating or discussing with their group mates. In the pairing phase, several students were less active in the discussion (Amelia, Sukroyanti, & Prayogi, 2024).

In the second meeting, the student participation rate reached 93%. Student activity at the second meeting showed progress. They gradually adapted to the learning method, which follows the steps and rules of the Case-Based Learning (CBL) model using the quiz technique. In the second meeting, student activity increased in all three phases of CBL learning: thinking, arguing, and drawing conclusions. In the thinking phase, students have begun to think independently, ask questions, and discuss with their peers. In the argumentation phase, some students who previously played a less active role in discussions have now begun to actively

engage in group dialogue. In the conclusion-drawing phase, students have been able to explain what they observed and learned, and they have also expressed their observations confidently in front of their peers.

Logical Thinking Skills in Experimental and Control Classes

The study was conducted on students in grades VIII C and VIII D, with VIII D serving as the control group and VIII C as the experimental group. Before beginning the study, the researcher administered a pretest to the students to assess their initial understanding of the material and their logical thinking skills. After the treatment was implemented in each class according to the established learning model, the researcher then administered a posttest to the students. The pretest and posttest consisted of six questions, consisting of six multiple-choice questions. The score for the multiple-choice questions was 17. Each question was designed based on three scientific thinking indicators, so two questions reflected one scientific thinking indicator.

In this study, the experimental group will receive an intervention in the form of a teaching method utilizing the CBL (Case Based Learning) model with a quiz technique. Meanwhile, the control group will follow a traditional teaching model. The difference in treatment applied to the experimental and control groups aims to evaluate the effectiveness of the CBL (Case Based Learning) model with the quiz technique in improving logical thinking skills. The following data shows the logical thinking ability scores for the experimental group (VIII C) and the control group (VIII D).

Table 1. Average Results of Pretest and Post-test Scores

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
pretest_kontrol	34	0	85	34.00	21.340
posttest_kontrol	34	0	100	58.26	31.322
pretest_ekperimen	34	0	100	49.88	26.214
posttest_eksperimen	34	17	100	72.47	25.377
Valid N (listwise)	34				

Based on table 1 which shows the results of the study, the control class that applied the conventional learning model obtained the lowest score in the pretest of 0 and the highest of 85, with an average of 34.00 and a standard deviation of 21.340. After the post-test, the control class recorded the lowest score of 0 and the highest of 100, with an average of 58.26 and a standard deviation of 31.322. Meanwhile, for the experimental class that used the Case Base Learning (CBL) model with the quiz technique, the pretest score showed the lowest score of 0 and the highest of 100, with an average of 49.88 and a standard deviation of 26.214. In the post-test, the scores obtained by the experimental class were 17 for the lowest score and 100 for the highest score, with an average of 72.47 and a standard deviation of 25.377.

Logical thinking ability is measured through six indicators grouped into three aspects: logical reasoning, argumentation, and conclusion drawing. The logical reasoning aspect has two indicators: completeness of thought and clarity of purpose. The argumentation aspect consists of two indicators: the existence of a basis or support for an argument and justification or guarantee of the truth of the article. The conclusion drawing aspect includes two indicators: information analysis and hypothesis formation. Students' logical thinking ability scores for each indicator in the control and experimental classes can be seen in the following diagram.

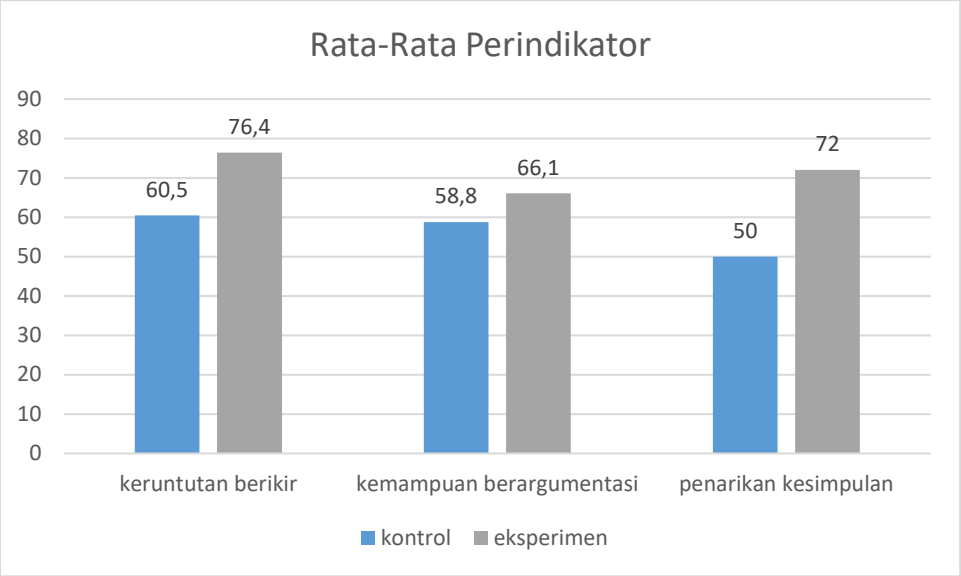

Figure 4. Average Value of Logical Thinking Ability Indikator

Based on Figure 4, it can be seen that the average value per indicator of logical thinking ability of students in the experimental class exceeded the control class in every aspect. For the first aspect, namely the sequence of thinking, the average value of the control class reached 60.5, while the experimental class reached 76.4. In the second aspect, namely the ability to argue, the average value for the control class was 58.8, while the experimental class was at 66.1. For the third aspect, namely drawing conclusions, the control class recorded an average value of 50, compared to 72 for the experimental class. The aspect of thinking ability that received the highest score was the sequence of thinking. Overall, the average value obtained for each indicator of logical thinking ability, which is divided into 3 aspects, shows that the experimental class that implemented the Case Based Learning (CBL) learning model with the quiz technique had a higher score than the control class that implemented the conventional learning model.

Next, an N-Gain test was conducted for pretest and posttest scores to assess the improvement in students' logical thinking skills after implementing the Case Based Learning (CBL) model with the quiz technique. The following are the results of the N-Gain test for pretest and posttest scores in the control and experimental classes.

Table 2. N-Gain Results of Control Class and Experimental Class

Class	Average N-Gain	Presentase (%)	Category
Control	0,28	28%	Low / ineffective
Eksperiment	0,74	74%	Moderate / quite effective

Based on Table 2, it was found that the average N-Gain value of the control class was 0.28, which is equivalent to a percentage of 28%. Therefore, the results of this N-Gain test are categorized as low and considered ineffective. On the other hand, the average N-Gain value for the experimental class reached 0.74, with a percentage of 74%. Thus, the results of the N-Gain test in this experimental class are classified as moderate and quite effective (Fauzi, Ermiana, Rosyidah, & Sobri, 2023). The N-Gain results on logical thinking skills in the experimental class indicate that the application of the Case Based Learning (CBL) learning method with the quiz technique successfully improved students' logical thinking skills.

Based on the results of the study, it was found that the average value of the logical thinking ability of the experimental class was 72.47 and the control class was 49.88. These results indicate that the average value of the experimental class is higher than the average value of the control class so that the logical thinking ability of students who use the Case Based Learning (CBL) learning model with the quiz technique (experiment) and the conventional

learning model (control) has a significant difference. The application of the problem-based learning model (Case Based Learning (CBL)) has a large influence on students' mathematical logical thinking ability (Assmarqandi, Hayati, & Hapipi, 2021). And with the existence of the Case Based Learning model, it can affect the level of problem-solving ability in students (Fiorennica Agustin, Dian Nur Antika Eky Hastuti, & Maya Kartika Sari, 2024).

In the case-based learning (CBL) model, grades on logical reasoning tend to be higher than those on argumentation and conclusion-drawing for several key reasons. CBL inherently trains students to organize their thoughts logically and structured, which is the core of logical reasoning. CBL places students in complex, real-world case scenarios. To solve these cases, students must go through a systematic analysis process, such as:

1. Collecting and filtering information
   Students need to identify relevant facts from the presented case, sorting them from unimportant information.
2. Identifying the problem
   Based on the available facts, they must formulate the core problem accurately.
3. Developing a hypothesis
   Students will formulate various possible solutions or causes of the problem.
4. Analyzing and evaluating
   Students need to review each hypothesis in light of the available data, assessing the pros and cons of each option (Fisk, 2019).

This gradual and logical process directly trains logical thinking. They cannot jump to conclusions without going through these steps. As a result, the ability to organize a train of thought from beginning to end becomes highly practiced. Although argumentation and drawing conclusions remain important in CBL, these two aspects are often not the primary focus of the learning process itself. Here's an explanation:

a) Argumentation: In CBL, argumentation often occurs in the context of group discussions. However, the primary focus is not on "winning" the debate, but rather on defending the analysis that has been developed. The arguments constructed often center on justifying the diagnostic steps taken, rather than on developing broader, more persuasive arguments that might be found in formal debates.
b) Drawing Conclusions: Conclusions in CBL are usually the end result of the diagnostic process. These conclusions are often specific and tied to the context of the case. The process of arriving at these conclusions is valued more than the final conclusion. In other words, the logical process is prioritized over the conclusions themselves.

Thus, the sequence of thinking becomes the main foundation that must be mastered, while argumentation and drawing conclusions become complementary parts that are built on this foundation.

Previous research has shown that the Case-Based Learning (CBL) model accelerates learning, increases student engagement, and enhances their problem-solving and critical thinking skills. This suggests that combining various stages of CBL can enhance learning. This integrated method not only accelerates learning but also significantly increases student engagement. It also enhances students' logical thinking and problem-solving abilities. These findings provide educators or teachers with the opportunity to create a more vibrant and efficient learning environment (Agustina & Ro'isatin, 2024).

Furthermore, the Quiz technique has tremendous potential to improve the quality of mathematics education. This engaging and demanding competition structure enhances the enjoyment of learning while encouraging the holistic development of students' cognitive abilities, including critical thinking, problem-solving, and decision-making. Furthermore, Quiz can increase learning motivation, student engagement, and foster a healthy educational environment. This strategy requires careful planning, adaptation to student characteristics, and reinforcement through diverse questions and ongoing assessments to increase its effectiveness.

Therefore, Quiz can serve as an effective instrument in equipping students to face future obstacles (Siti Qotrunnada, Imswatama, & Balkist, 2023).

The Case-Based Learning (CBL) model offers advantages in revealing and analyzing cases, both of which are important indicators in assessing students' logical thinking. The research material was then reinforced using quiz games to strengthen and foster logical thinking in students. This quiz competition represents a form of recognition from educators and the government for students who demonstrate excellence. In addition to serving as a means of disseminating knowledge, quiz competitions can serve as an evaluative instrument for the educational material provided by instructors to students (Sutrikanti et al., 2018).

CONCLUSION

Based on the research results, it can be concluded that:

1. The implementation of learning using the Cased-Based Learning (CBL) model with quiz techniques on logical thinking skills successfully improved the quality of learning and resulted in more optimal learning outcomes for students.
2. Based on observations, the average activity of students in class VIII C of SMPN 5 Ponorogo (Experimental Class) was 83%. Through the Cased-Based Learning (CBL) model with quiz techniques, students actively participated in a series of lessons that supported the improvement of logical thinking skills.
3. The effectiveness of the Cased Based Learning (CBL) learning model with the quiz technique to improve logical thinking skills based on the results of the average N-Gain value for the experimental class reached 0.74, with a percentage of 74%. Thus, the results of the N-Gain test in this experimental class are classified as moderate and quite effective. The N-Gain results on logical thinking skills in the experimental class indicate that the application of the Case Based Learning (CBL) learning method with the quiz technique successfully improved students' logical thinking skills. This is supported by the results of research showing that the Cased Based Learning (CBL) model with the quiz technique (experiment) is better than without CBL and the quiz (control) on logical thinking skills. In addition, the value of students' logical thinking skills in the experimental class after the implementation of the Cased Based Learning (CBL) model with the quiz technique is higher than before being given treatment.

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