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THE EFFECT OF CASE-BASED LEARNING WITH AUGMENTED REALITY ON BIOLOGY LEARNING OUTCOMES AND CRITICAL THINKING AT SMAN 14 SAMARINDA

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ABSTRACT

This study aims to determine the effect of case-based learning model with augmented reality media on cognitive learning outcomes and critical thinking skills in biology learning material on environmental change and preservation of class X students of SMAN 14 Samarinda. The research method used was quasi experimental design in the form of non-equivalent control group with a total sample of 54 students from 2 different classes. Data analysis techniques using N-Gain test and independent sample t-test. The results of data analysis showed that on learning outcomes with the N-Gain test the control class had an average of 0.45 with a moderate category and the experimental class with an average of 0.61 with a moderate category. The results of the independent sample t-test test showed a sig value. (2-tailed) 0.001 for critical thinking skills, the value is smaller than 0.05 so it can be concluded that there is an effect of the case-based learning model with augmented reality media on learning outcomes and critical thinking skills in biology learning material on environmental change and preservation of class X students of SMAN 14 Samarinda.

Keywords: case-based learning; augmented reality; learning outcomes; critical thinking skills

INTRODUCTION

Education has a very crucial role because it can improve the quality of thinking, perspective, skills, ability to remember, ability to reason, and solve problems, thus potentially improving the quality of life both individually and globally (Widyastuti et al, 2022). The educational process is carried out through learning activities that involve the dynamics involving teachers, students, and their educational surroundings (Salamah, 2020). To inspire students to be excited in the learning process, a learning model is required. A learning model can encourage students to think critically, stay focused, interested, and creative in participating in learning activities is needed (Sholekah, 2020). A learning model is a systematic method that facilitates the implementation of learning through the application of specific concrete steps so that the learning process can take place effectively and achieve certain goals, such as creating positive changes in students (Soesilo et al, 2021).

Case-based learning is a teaching model focuses on real cases relevant to the material studied by students, so that students are expected to actively participate in learning by analyzing these cases in depth (Ibrahim, 2023). The cases presented through this model encourage students to take responsibility for their learning, as well as require interaction

between students and teachers, collaboration, exchange of opinions, more active learning, teaching time management, and fostering respect for different arguments (Puri, 2020). The CBL model prepares students for work in small groups, assists in peer education, and applies knowledge to real-world problems with guidance from mentors. This helps to improve the quality of clinical case management since the beginning (Burgess et al, 2021). Case-based learning reduces the gap between the academic and real worlds and provides meaningful learning, which in turn improves academic outcomes and student satisfaction (Blázquez et al, 2022).

According to Ariska et al. (2022), the steps or syntax applied in the case-based learning (CBL) model are as follows:

a. Determine the case to be studied
b. Analyze the case in depth
c. Identifying relevant supporting data
d. Develop steps to resolve and respond to the case
e. Summarize the case based on the analysis that has been done.

Learning media functions as a tool or means that bridges between teachers and students in the process of delivering learning materials (Nurhasana, 2021). One of the media that uses advanced technology and is increasingly popular is augmented reality. This technology combines virtual objects so that they appear more real through electronic devices (Tamam, 2023). Wilsa et al. (2023) define augmented reality as the idea of merging the virtual and physical worlds to make two- and three-dimensional virtual items appear more realistic. This advantage makes AR widely applied in learning as a medium that supports teachers in teaching in class. According to Cahyana et al. (2023) and Chen (2019), technology is also very helpful in improving learning efficiency and motivation, helping students understand abstract concepts, and enhancing their cognitive and academic performance.

Learning outcomes are achievements obtained by students after completing a certain learning package, which can be measured in various forms through a certain evaluation process. The results achieved can include cognitive, affective, and psychomotor domains (Nugroho, 2019). Learning outcomes have a close relationship with the learning process itself. To understand the extent of changes that occur in a person, both in behavior and skills, can be seen from the learning outcomes (Romlah, 2022). According to Yanti (2021), the implementation of a case-based learning paradigm in Grade XI SMK Negeri 1 Sigli has successfully increased learning outcomes significantly, with an increase rate of 93.3%.

Critical thinking is generally considered as a set of abilities that allow a person to produce arguments, induction, deduction, conclusions, and judgments based on the information collected (D'alessio, 2019). Facione (2015) identifies six dimensions of critical thinking: analysis, interpretation, evaluation, inference, self-regulation and explanation. Wale (2020) states that improving students' critical thinking skills through integration of critical thinking into the learning process is crucial for enhancing problem-solving abilities, expression of opinions, and student communication.

The observational study in Samarinda's senior high schools revealed a lack of implementation of case based learning and augmented reality as

educational tools. SMAN 14 Samarinda was selected based on its technological readiness and to address challenges such as ineffective conventional teaching methods that fail to engage students, particularly in complex subjects like environmental change and conservation. Additionally, the school lacks experience in applying innovative teaching models like case based learning, which could significantly enhance students' critical thinking and analytical skills in biology learning. This study aims to determine the effect of case-based learning model with augmented reality media on cognitive learning outcomes and critical thinking skills in biology learning for class X students at SMAN 14 Samarinda.

METHOD

The quasi-experimental design is the research methodology used. The purpose of quasi-experimental research is to obtain information that is an estimate of the true effect, although under conditions where it is impossible to control all relevant variables (Sugiono, 2019). This study employs a quasi-experimental design, specifically a non-equivalent control group design, featuring pretest and posttest measurements conducted on two separate groups: the experimental group and the control group.

This research was conducted in the second semester of the 2023/2024 school year in March-July 2024 on biology learning material on environmental change and preservation. The research place was held at SMA Negeri 14 Samarinda. The sampling technique employed in this study was purposive sampling, which selects participants based on specific criteria or similarities. The population consisted of grade X students at SMA Negeri 14 Samarinda in the 2023/2024 school year, with 27 students in class X-5 as the experimental group and 27 students in class X-6 as the control group chosen as the sample. The experimental group will be given treatment, namely learning case-based learning model assisted by augmented reality media. The control group did not receive any treatment and using the lecture and discussion method.

Students' critical thinking skills will be measured using homogeneity, normality, and hypothesis tests on all pretest and posttest data using the help of SPSS statistical software 25. The instrument of description questions was developed based on six indicators of critical thinking from Facione's (2015) opinion as shown in table 1.

Table 1. Indicators and Components of Critical Thinking Skills

No.	Indicators	Components
1.	Interpretation	a. Categorize
		b. Deciphering meaning
		c. Clarifying meaning
2.	Analysis	a. Checking for ideas
		b. Identifying arguments
		c. Identifying reasons and claims
3.	Inference	a. Proof of inquiry

		b. Alternative conjecture c. Make a conclusion that makes sense or is reasonable
4.	Evaluation	a. Evaluate the veracity of the assertion b. Evaluate the standard of arguments presented using inductive or deductive reasoning
5.	Explanation	a. State the result b. Justifying the procedure c. Presenting an argument
6.	Self-Regulation	a. Self-observation b. Self-correction

Based on the answers that have been done by students, the data will be calculated percentage. The percentage value of the score that has been obtained then categorized based on the criteria for critical thinking ability categories in accordance with Rahmawati's opinion (2023) in table 2. below

Table 2. Critical Thinking Skills Category Criteria

Score (%)	Category
80-100	Very good
61-80	Good
41-60	Fair
21-40	Deficient
0-20	Very poor

Student learning outcomes were measured using a description test instrument in the cognitive domain of higher order thinking on Bloom's taxonomy levels C4, C5, and C6. After that, the N-gain test is required with the criteria as stated by Hake (1999) in table 3.

Table 3. N-Gain Criteria

N-Gain Score (g)	Criteria
N-Gain > 0,70	High
0,30 ≤ N-Gain ≤ 0,70	Medium
N-Gain < 0,30	Low

RESULTS AND DISCUSSION

Normality Test Results

As a prerequisite for hypothesis testing, a normality test was conducted to assess whether the data distribution in the study follows a normal distribution. The Shapiro-Wilk test method was used to analyze all data from both the control group and experimental group. Considering the following factors can help you assess whether research data is normal. Data is considered normally distributed if the obtained significance is ≥ to 0.05, but not if it is < to 0.05. Table 4 below displays the data from the normalcy test findings.

Table 4. Shapiro-Wilk Normality Test Results

KELAS	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRETEST KELAS EKSPERIMEN	.141	27	.177	.958	27	.333
POSTEST KELAS EKSPERIMEN	.177	27	.029	.941	27	.130
PRETEST KELAS KONTROL	.130	27	.200*	.941	27	.131
POSTEST KELAS KONTROL	.158	27	.083	.939	27	.117

The results of the normality test using the shapiro-wilk test showed that the pretest and posttest data of the control group and experimental group had a sig value > 0.05. This shows that the experimental group's and the control group's pretest and posttest results based on critical thinking abilities indicators are regularly distributed.

Homogeneity Test Results

The homogeneity test is conducted to determine if the variance of samples taken from the same population is homogeneous. It employs Levene's test, where a significance value of ≥ 0.05 indicates homogeneous variance across samples, while < 0.05 indicates non-homogeneous variance.

Table 5. Homogeneity Test Results Levene's Test

	Levene Statistic	df1	df2	Sig.
Based on Mean	.559	1	52	.458
Based on Median	.553	1	52	.461
Based on Median and with adjusted df	.553	1	47.994	.461
Based on trimmed mean	.543	1	52	.465

The results of the homogeneity test using Levene's test based on mean in both the control and experimental groups show a significance value of 0.458. This indicates that the variance in data based on critical thinking skills indicators is homogeneous between the groups.

Hypothesis Test Results

T-test

This hypothesis test uses independent sample t-test which is conducted to knowing the effect of the case-based learning model with augmented reality on students' critical thinking skills. The criteria for hypothesis testing is sig. (2-tailed) <0.05 then Ha is accepted and Ho is rejected, which means there is an effect of using CBL model assisted by AR media on critical thinking skills in biology learning of class X students of SMAN 14 Samarinda. This data can be seen in table 6 below.

Table 6. Independent Sample T-Test Results

	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	3.709	.060	3.474	52	.001
Equal variances not assumed			3.474	48.544	.001

The results of the independent sample t-test hypothesis test on critical thinking skills indicate a significance value (2-tailed) of 0.001, which is less than 0.05. This implies that Ha is accepted, and Ho is rejected. Therefore, it shows that there is an effect of using the CBL model assisted with AR on critical thinking skills in biology learning among class X students at SMAN 14 Samarinda.

N-Gain Test

The N-Gain test assesses the increase in student learning outcomes following treatment. It calculates the score difference between the experimental and control groups from pretest to posttest. Table 7 presents the N-Gain data on learning outcomes.

Table 7. Data of N-Gain Value of Control Group and Experimental Group

Data	Control Group	Experimental Group
Highest	0,74	0,82
Lowest	0,20	0,26
Average	0,45	0,61
Category	Medium	Medium

The N-Gain data above demonstrates that, in both the experimental and control groups, student learning results in biology have increased with regard to environmental change and preservation. Drawing conclusions from the data presented in the above table, it is evident that the experimental group's average N-Gain value is greater than the control group's, with the former group's average N-Gain value falling into the moderate category at 0.45 and the latter group's average N-Gain value falling into the same category at 0.61. Therefore, compared to learning through lecture and discussion approaches, it is evident from these statistics that learning results rise when utilizing the case-based learning model with augmented reality media.

Figure 1 compares the percentage values for six critical thinking skill markers between the experimental and control groups.

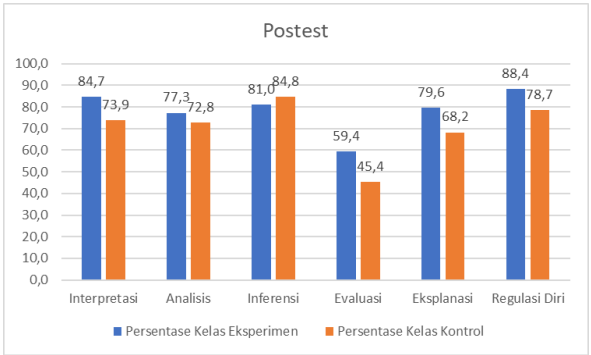

Figure 1. Percentage of Critical Thinking Skills Indicators

Figure 1 displays the percentage of critical thinking skills indicators from both the experimental and control groups. In the experimental group, the highest percentage is observed in the self-regulation indicator at 88.4%, which falls into the very good category, while the lowest percentage is in the evaluation indicator at 59.4%, categorized as sufficient. In the control group, the evaluation indicator has the lowest percentage at 45.4%, categorized as sufficient, whereas the inference indicator has the highest percentage at 84.8%, categorized as very good.

The variation in the percentage of critical thinking skills markers between the experimental and control groups can be attributed to the different learning models used. The experimental group used a more interactive model, namely case-based learning, which encouraged students to be more involved and organize their own learning process, thus improving self-regulation skills. However, the experimental group had more developed skills in areas like appraisal compared to the control group, which utilized a more conventional and less participatory model. Other influencing factors could be student motivation and characteristics, as well as the quality of feedback and evaluation provided by the teacher.

Based on the test results, it can be concluded that the experimental group, which utilized the case-based learning model with augmented reality media, showed an improvement in students' learning outcomes and critical thinking skills. Students are encouraged to discuss and solve cases so that their critical thinking skills become increasingly honed by discussion activities, presenting arguments, analyzing, and solving these cases. This supports Alt's (2019) assertion that case-based learning enables students to participate in discussions that provide them with the chance to analyze, suggest ideas, assess viable options, solve problems, or make judgments. This approach actively engages students in the learning process, promoting the development of higher-order thinking skills and enhancing their understanding of the subject matter.

The use of augmented reality media in the form of pollution images that occur in the surrounding environment and the condition of human lungs exposed to air pollution can make students able to have an overview of the case, understand and relate the material to other cases. This aligns with Oktaviani et al. (2023), who state that augmented reality learning media is crucial for school students as it effectively integrates the virtual world with the real world. Augmented reality can transform objects into 3D form, so that learning methods become more varied and not monotonous. This also encourages students to be more interested and encouraged to learn further learning materials. In addition, Wilsa et al. (2023) also said that augmented reality learning media is able to visualize abstract concepts and object model structures, making it a more effective media in accordance with learning objectives.

CONCLUSION

Based on the research and discussion results, it can be concluded that the case-based learning model assisted by augmented reality media positively impacts the learning outcomes of class X biology students at SMAN 14 Samarinda. This is evidenced by the average N-Gain value of 0.45 for the control group and

0.61 for the experimental group. Therefore, utilizing case-based learning models in combination with augmented reality media results in higher learning outcomes compared to traditional lectures and discussions. In addition, the case-based learning model assisted by augmented reality media also enhances students' critical thinking skills, as evidenced by the t-test results, with a significance (2-tailed) value of 0.001, which is less than 0.05.

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