

APPLICATION OF AUGMENTED REALITY THROUGH A SCIENTIFIC APPROACH TO STUDENTS' CRITICAL THINKING ABILITY

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Abstract: This research is motivated by the lack of learning media that can facilitate students' critical thinking skills in learning during the covid-19 pandemic. Critical thinking ability is a very important competency to be developed through a scientific approach. This ability is indispensable in everyday life. The purpose of this study was to analyze the effect of students' critical thinking skills through the application of Augmented Reality through a scientific approach. The method used in this research is Quasi Experimental with pretest-posttest control group design. The population in this study were students of class XI science at SMA Negeri 1 Cigugur which consisted of 3 science classes with a total of 78 students. The samples used in this study were two classes, namely class XI IPA 1 and XI IPA 3. The sampling technique used was purposive sampling. The instruments used are description tests, observation sheets and student response questionnaires to the application of augmented reality through a scientific approach. Based on the results of analysis and calculations with hypothesis testing, the results obtained are H1 is accepted and Ho is rejected, meaning that there is an increase in students' critical thinking skills by applying Augmented Reality through a scientific approach.

Keywords: *Augmented Reality; scientific approach; critical thinking.*

INTRODUCTION

Online learning conditions are difficult to control the learning process because it is limited in a virtual space. The change in the learning process from face to face to online is a challenge for a teacher in changing teaching strategies and the use of learning media. The interaction of teachers and students is only through the Whatsapp Group platform, Zoom Meeting, Google Classroom which has various advantages and disadvantages for each son (Permana, 2020).

Conditions like this affect the critical thinking skills of students who are required to be able to

adapt in the learning process with the new system, students are required to be skilled in using technology and be able to think critically about various information obtained through the use of information technology (Bunt & Gouw, 2020). In critical thinking, students are directed to a learning process that is able to focus their minds in processing and understanding any information (Davud Gul & Akcay, 2020).

Based on observations through interviews with biology teachers at SMA N 1 Cigugur on August 19, 2020, it was said that online learning carried out by teachers only used WhatsApp as a medium

in sharing material and sending assignments to students. In addition, the teacher only provides practice questions, there is no explanation of the material from the teacher, so students do not master it, and have difficulty understanding the material because the skills mastered are only limited to lower order thinking. As stated by Daher & Warsah (2020), the use of Whatsapp as an online learning medium is less effective in achieving learning objectives this is due to the lack of a comprehensive and simple explanation from the teacher. Students should be given the opportunity to explore and develop critical thinking skills through a scientific approach.

Critical thinking skill is very important to be mastered by students (Pujianti, 2020), because through critical thinking, students will be trained to observe the situation, raise questions, formulate hypotheses, make observations and collect data, then provide conclusions. Wahyuni in Lismaya (2021) stated that critical thinking also trains students to think logically and not to accept things easily.

The scientific approach is an approach with steps that can build knowledge through the scientific method (Asmi, 2015). This approach can also train students to think and analyze the information obtained by Wakhidah (2018).

According to Liana (2020), the 5 phases of the scientific approach can develop various skills such as critical thinking skills, communication skills, research and collaboration skills and character behavior, because of experience The learning provided can fulfill educational goals and is useful for problem solving in real life.

Augmented Reality can provide virtual learning through students' smartphones. Augmented reality has several menus containing instructions for its use. Augmented Reality that has been installed on the student's smartphone, then using the camera on the smartphone will scan the human digestive system marker, when the marker is scanned, an animation/video will appear in the form of a mechanism or how the digestive system works on the smartphone screen, so that it can stimulate students. not only how it works, there are also functions of each organ of the digestive system that appear in the Augmented Reality media. This is in the use of Augmented Reality students can also communicate ideas simply so that it can help improve students' critical thinking skills.

In accordance with the results of Mustaqim's research (2016) regarding the use of Augmented Reality as a learning medium, that is, it can stimulate a mindset in critical thinking about problems and events that occur in everyday life, because the nature of educational media is to help students in the learning process in the presence or absence of educators in the educational process, so that the use of Augmented Reality media can provide learning anytime and anywhere. In the research of Sungkar et al (2016) said that Augmented reality is proven to be able to help and understand complex concepts that the average student has difficulty in understanding.

Augmented Reality can provide virtual learning through students' smartphones. Augmented reality has several menus containing instructions for its use. Augmented Reality that has been installed on the student's smartphone, then using the camera on the smartphone will scan the human digestive system marker, when the marker is scanned, an animation/video will appear in the form of a mechanism or how the digestive system works on the smartphone screen, so that it can stimulate students. not only how it works, there are also functions of each organ of the digestive system that appear in the Augmented Reality media. This is in the use of Augmented Reality students can also communicate ideas simply so that it can help improve students' critical thinking skills.

Biology is learning in the field of science, demanding learning competencies in the realm of comprehensive high-level understanding. Science learning is closely related to phenomena or problems that exist in everyday life. According to Nainggolan, Suriani, & Sianturi (2018), essentially, biology learning is related to how to find out and understand nature systematically so that learning biology is not only mastery of a collection of knowledge in the form of concepts, facts, but also a process of discovery, so that students are required to be able to think critically and furthermore, according to Apriyani, Nurlaelah, & Setiawati (2017) argued that learning biology is a discovery process and emphasizes on providing direct learning experiences, namely by developing students' critical thinking skills, so learning must be based on appropriate problems. with the realities of life.

The concept of the digestive system in terms of structure, function and mechanism is difficult for

students to understand because the concepts are abstract and complicated, because they relate to complex mechanisms, so students need learning media to be able to deliver abstract concepts into concrete. The causal mechanism contained in the material of the digestive system makes it difficult for students to understand how the system works. So the solution is to apply Augmented Reality media in accordance with one of the competencies in the current era, namely the 4.0 era. According to Yunliono, Sarwanto, & Rintayanti (2017), the advantage of Augmented Reality in learning the human digestive system is an attractive visual display, because it can display the human digestive organs coherently and the working system in it.

Critical thinking is the result of problem solving activities or students are accustomed to problem-based learning. Problem-based learning students not only listen, take notes, and memorize material, but through problem-based learning students actively think, communicate, search and process data, which finally concludes Lismaya (2017). Students are trained in solving problems by looking for information that can solve existing problems, then efforts are made to explain the phenomenon of the problem, students can also improve their thinking skills.

Based on the background described above, researchers are interested in conducting research with the title "Application of Augmented Reality

through a Scientific Approach to Students' Critical Thinking Ability".

METHOD

The research method used is Quasy Experiment with a pre-test-post-test control group design research design (Sugiyono, 2017). The population in this study were students of class XI science at SMA N 1 Cigugur which consisted of 3 science classes with a total of 78 students. And the sample was obtained using the Purposive Sampling sampling technique, as many as two classes, namely class XI IPA 1 as the experimental class and XI IPA3 as the control class. Data collection techniques used in this study were through tests and non-tests. The instrument used in this research is in the form of standardized critical thinking essay test questions, which are given during pre-test and post-test, observation sheet and questionnaire. Observation sheets were carried out to observe the activities and implementation of Augmented Reality through a scientific approach. This observation sheet is made in the form of answer choices "Yes" or "no" by providing a checklist in the column.

In addition, a questionnaire was also used to knowing students' responses to the application of Augmented Reality through a scientific approach to the concept of the digestive system.

Table 1. *Students' critical thinking skill test grid*

Main Material	Aspect	Indicator	Cognitive Domain	No.of question
Digestive System.	Elementary	Focusing the question	C4	1
	Clarification	Analyze arguments	C4	2
	The basis for the decision	Observing and considering observation reports	C4	3
			C3	4
	Inference	Making and evaluating inductive conclusions and arguments	C6	5
			C5	6
	Advanced clarification	Terms and consider definitions Identify definitions and identify assumptions	C6	7
			C5	8
	Supposition and integration	Combining abilities and other characters in making decisions.	C6	9
Total				9

Table 2. *Questionnaire sheet instrument grid*

No	Aspect	Indicators	No. of question
1	Observe	Ability to understand problems and Encourage students to observe	1,2,3,4

No	Aspect	Indicators	No. of question
		and identify problems with the material stimulus of the digestive system using Augmented Reality	
2	Ask	Encourage students to ask questions or formulate problems and hypotheses	5,6,7,8
3	Try	Improve students' critical thinking skills in trying or collecting information/data by using Augmented reality through a scientific approach	9,10,11,12
4	Reasoning	To determine the ability to solve problems by analyzing data	13,14,15,16
5	Communicating	Students' ability to understand the material and conclude from problem solving	17,18,19,20
Total			20

Table 3. Observation sheet instrument grid

No	Learning Stage	Item Number	Total
1	Preliminary activities	1,2,3,4,5	5
2	Core activities With the DL Model, the use of AR through a scientific approach		
	Phase 1 <i>Stimulation</i>	6,7	2
	Phase 2 <i>Problem statement</i>	8,9,10,11	4
	Phase 3 <i>data collection</i>	12,13,14	3
	Phase 4 <i>data processing</i>	15,16,17	3
	Phase 5 <i>verification</i>)	18, 19,20	3
	Phase 6 <i>generalization</i>	21,22	2
3	Closing activities	23,24,25	3
Total			25

RESULTS AND DISCUSSION

Analysis of pre-test result

To measure students' initial critical thinking skills, students are given a pretest in the form of critical thinking skills description tests that have previously been tested by instruments and contain 9 indicators of critical thinking skills. The average value of the pretest from the control class and the experimental class can be seen in the table below:

Table 4. Pre-test average

Class	N	Average	DS
Experiment	27	34,56	8,70
Control	27	34,22	8,47

Based on the table of pre-test scores for the two classes, namely control and experiment, the results were not much different. Based on the results of the pre-test given to the experimental class and the control class, the results showed that it did not show a significant difference, meaning that students had the same initial ability, the two sample classes had relatively the same critical thinking skills. The average overall pre-test scores of the experimental

class and control class students are not much different as shown in the table, namely 34,56 in the experimental class and 34,22 in the control class.

Hypothesis test (t test)

Homogeneity of variance that was carried out previously, hypothesis testing was carried out using the t test, because the data group was homogeneous. The results of the t-test on the pre-test data The results of the t-test on the pre-test data of the experimental class and control class are presented in the table:

Table 5. The result of pretest data hypothesis test

Class	tcount	Db	tTable	Conclusion
Experiment and Control	0,61	52	2,00	Nothing is better

Because the variance of the data is homogeneous, it is continued to test the hypothesis, namely the t-test and the t-value is -0,61 and t-table is 2,00. Because the value of t-count < t-table, 0,61 which is < 2,00 then H₀ is accepted and H₁ is rejected, which means that the two sample groups, both the experimental class and the control class, have no significant or equivalent initial differences in critical thinking abilities.

Analysis of posttest results

The average posttest from the control class and the experimental class can be seen in table 6.

Table 6. Posttest average score

Class	N	Average	DS
Experiment	27	81,04	7,21
Control	27	68,78	8,41

Based on the table, the experimental class has a higher average post-test value than the control class. The results of the post-test calculation of critical thinking skills in the control class and the experimental class. Based on the table, the average

value of the post-test obtained by the experimental class is 81,04 while the average value of the control class is only 68,78. This shows that application Augmented Reality through a scientific approach has a positive effect on students' critical thinking skills. In other words, students' critical thinking skills can increase because it is facilitated by Augmented Reality through a scientific approach. Furthermore, the post-test results of the two classes were used to test the hypothesis.

Based on the homogeneity of variance test that was carried out previously, hypothesis testing was carried out using the t test, because the data group was homogeneous. The results of the t-test on the post-test data of the experimental class and control class are presented in table 7.

Table 7. Posttest data hypothesis test results

Class	Tcount	Db	t-Table	Conclusion
Experiment and Control	4,62	52	2,00	H ₀ is rejected, and H ₁ is accepted

From the data above, it can be seen that the average percentage of critical thinking indicators achievement after learning in the control class and experimental class results in a t-count of 4,62 and a t-table of 2,00. Because the value of t-count > t-table is 4,62 > 2,00, then H₁ is accepted and H₀ is rejected, meaning that there is an increase in students' critical thinking skills on the digestive system material for class XI using Augmented Reality media through a scientific approach. The average learning process in the achievement of critical thinking indicators in the experimental class is greater than the control class, so when compared with the results of the pre-test, the experimental class and control class have increased the achievement of the critical thinking ability indicator.

The N-Gain calculation is carried out to analyze the magnitude of the increase in students' critical thinking skills, from the results of the analysis by comparing the results of the pretest and posttest experimental class and control class. The results of the calculation of the average N-Gain can be seen in table 8:

Table 8. Comparison of the average value of the experimental class and the control class

Class	Average score			Criteria
	Pretest	Posttest	N-Gain	

Experiment	34	81	0,71	High
Control	35	68	0,51	Medium

The results of the N-Gain analysis obtained by the experimental class and control class in table 8 show that the experimental class has improved better when compared to the control class, with the average N-Gain value in the experimental class 0,71 including in the high category and for the control class 0,51 is included in the medium category. This shows that there is a difference in the improvement of students' critical thinking skills between the experimental class and the control class.

The percentage value of each critical thinking indicator for the experimental class and the control class

The critical thinking ability description test sheet is made based on critical thinking ability indicators which consist of: (1) focusing questions, (2) analysing arguments, (3) considering the credibility of a source, (4) making inductions and considering the results of induction, (5) identifying assumptions (6), deciding an action, (7) terms and consider definitions, (8) identify definitions and identify assumptions, (9) combining abilities and other characters in making decisions (Ennis, 2016). Critical thinking indicators are applied to the description test questions which will be given to students at the pre-test and post-tests. The results of the recapitulation of the value of each critical thinking indicator are shown in Figure 1.

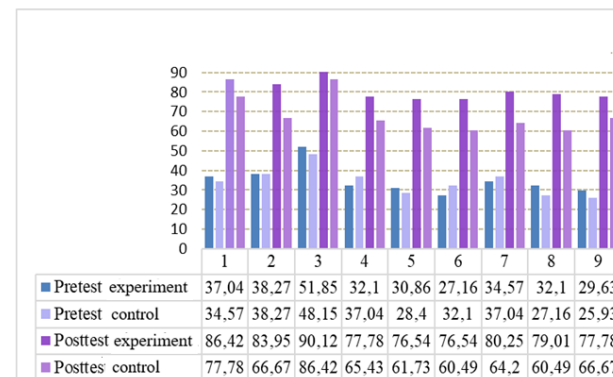


Figure 1. The percentage value of each critical thinking indicator

Based on Figure 1, it can be seen that of the nine indicators of critical thinking skills, it shows that each indicator has increased but the third indicator has the highest increase. The experimental class and control class in the indicators of observing and considering the observation report, the experimental

class is higher, namely 90.12 and the control class is 86.42 posttest scores, it can be concluded that critical thinking skills through the indicators used, after carrying out observations using Augmented reality are higher in the class Experiments that were treated using Augmented Reality with a scientific learning approach, compared to the control class that did not use Augmented Reality media even though they used the same scientific learning approach.

Data Analysis of Questionnaire Result

The questionnaire sheet instrument was used to determine student responses to learning using Augmented Reality media through a scientific approach carried out in the experimental class, namely class XI IPA 3. The questionnaire sheet for each indicator consisted of twenty questions from five indicators of the student response questionnaire. the percentage of the questionnaire for each statement has a different response. The results of the calculation of the questionnaire sheet which can be seen in the appendix, obtained a percentage showing the response of the experimental class during the learning process. The results of the calculation of the questionnaire sheet are adjusted to the score of each questionnaire item that is used to determine student responses to Augmented Reality through a scientific approach during the learning process in the experimental class.

The following is a diagram of the questionnaire percentage to reveal student responses to the implementation of Augmented Reality through a scientific approach.

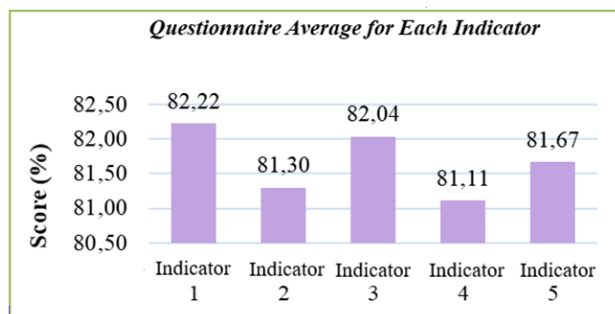


Figure 2. *Questionnaire average for each indicator*

Description:

Indicator 1: Ability to understand problems and encourage students to identify problems with the material stimulus

of the digestive system using Augmented Reality

Indicator 2: Encouraging students to ask questions or formulate problems and hypotheses

Indicator 3: Improving students' critical thinking skills in trying or collecting information/data by using Augmented Reality through a scientific approach

Indicator 4: To determine the ability to solve problems by analyzing data

Indicator 5: The ability of students to understand the material and conclude from problem solving.

Data analysis of observation result

The observation sheet is an evaluation technique used to determine the process carried out by the teacher containing the steps of augmented reality through a scientific approach, so the analytical technique is only used in the experimental class. This observation sheet is used to determine whether the steps of Augmented Reality through a scientific approach and on the material of the digestive system are in accordance with the steps that have been prepared in the lesson plan.

The results of observing teacher activities by applying Augmented Reality through a scientific approach in the experimental class.

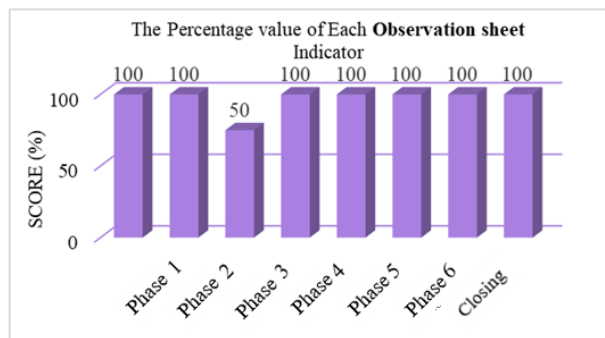


Figure 3. *The percentage value of each observation sheet indicator*

The average critical thinking of students in the experimental class is in the high category, meaning that overall students have been able to use their critical thinking skills well and the average thinking of students in the control class in the medium category means that overall students use their critical thinking skills quite well. Also supported by Syarifuddin's research (2018), there is a significant

influence of the scientific approach through critical thinking in science. In line with Deshpande & Kim's (2018) research, the use of Augmented Reality can improve problem solving skills, 3D objects in real time through Augmented Reality cameras can help students solve problems.

Although the control class experienced a significant increase in critical thinking skills, it was not in accordance with the expected critical thinking abilities of students. This is in line with the analysis of improving critical thinking skills in the experimental class which is better than the control class, because when conducting learning in both learning classes they are treated the same, but in the experimental class it is added or assisted by the existence of learning media, namely Augmented Reality as a student support tool. Through a scientific approach to be more critical in responding to the problems presented. In Augmented Reality media students are presented with material, animation and stimulation, students are invited to explain the data that has been obtained in observations after interpreting the animations and simulations in the Augmented Reality content, the problem is through discussion with friends.

In line with Usada's research (2014) that Augmented Reality aims to simplify things for users by bringing virtual information into the user's environment to improve user perception and interaction with the real world. This is in accordance with what Mantasia and Jaya (2016) stated that Augmented Reality can provide a learning experience that makes it easier to understand a material because Augmented Reality is made interactively which can involve students directly in the learning process.

As in Abbas's research (2015), Augmented Reality as a learning medium can improve students' understanding because 3D objects, text, images, videos, audio can be displayed to students in real time. So that students can be interactively involved in the learning process, Augmented Reality also provides an illustration or illustration to students about the mechanism of the digestive system into a learning medium that can provide feedback to students, students can construct their own knowledge so that the experimental class indicates that critical thinking skills can be trained and taught. grow and develop through the use of Augmented Reality. As stated by Bower, Howe, Mccredie, Robinson, Grover (2014), Augmented

Reality can be used by teachers to develop students' higher order thinking skills that encourage learning by design that requires skills such as analyzing, evaluating and being creative that contribute to the final growth of students.

In contrast to the learning control class which applies a scientific approach without the help of Augmented reality media, students are only faced with the stages of learning contained in the scientific approach and in searching for data they only focus on book sources and the internet. So that students are less able to develop their critical thinking skills. In addition, the learning process in the control class does not emphasize students to play an active role in finding solutions or solving problems. On the other hand, the contribution of Augmented Reality media through the scientific learning approach shows that science is superior to learning without media in improving students' critical thinking skills.

Augmented reality through a scientific approach teaches students to analyze what they learn through a scientific approach allowing students to be directly involved in learning. The scientific approach is proven to improve students' critical thinking skills. This is also in line with Chen & Wang's research (2015) that the use of scientific discovery learning with integrated scientific reasoning has proven to be effective in increasing the ability to test hypotheses, justify hypotheses, and understanding based on correct evidence.

The results of this study are also in line with Izzudin's research (2019) which stated that the scientific approach is very effective in improving students' critical thinking skills. As stated by Liana (2020), the scientific approach provides opportunities for students to find their own thoughts, using a scientific approach, information about the problems given regarding the material of the digestive system, can be obtained anywhere, anytime and does not depend on the teacher, and encourages students to find out from various sources through observation and not just being told. Students can easily understand the material delivered with Augmented Reality media. Students are actively involved in learning. So that students are more motivated and can cause curiosity in the learning process, students can solve problems and then present their results.

Augmented Reality in learning makes it easier for students to remember new information related to

the concept of the digestive system. This is in line with Gilang's research (2016) that in the learning process using Augmented Reality media students are given the opportunity to experience themselves or do it themselves, follow the process, observe an object, analyze, prove and draw their own conclusions from a particular object, state or process. Learning with Augmented Reality students can freely communicate with their friends. So that the learning process supported by Augmented Reality will encourage students to investigate, collaborate, and improve critical thinking skills. Based on the results of the analysis of critical thinking skills on each indicator obtained.

The indicator of critical thinking ability that has the highest improvement is observing and considering observation reports. In this indicator facilitates and is trained with the use of Augmented Reality media, the results of the analysis show an increase in the average pretest and posttest scores of 50.62 and 90.12. In the experimental class and the control class, the scores both experienced the highest increase, but the experimental class had a greater increase than the control class because it was also supported by the use of technology, namely Augmented Reality. The use of Augmented Reality is dominated by this indicator because the activities in observing and considering observation reports directly involve students in finding and making observations to answer the problems given by the teacher. Students become more active in seeking and finding their own answers by using Augmented Reality media as a source of information to solve predetermined problems without relying on the teacher as a source of information.

Using Augmented Reality media students can describe the mechanisms that take place in the digestive organs that cannot be observed with the sense of sight. Searching for data by linking the structure of functions, as well as disorders of the digestive system. Students are directed to record the required data such as answering reports by direct observation using Augmented Reality. The ability to consider reports on observations is the ability of students to provide correct evidence based on the results of observations of a data.

According to Hayati, Loka, & Anwar (2019), the indicator of observing and considering a report is the ability to involve a few guesses based on the facts obtained and use the correct evidence to be

reported. Students are said to have the ability to make and determine the results of considerations in critical thinking if students can express a consideration that is believed and is able to determine actions based on the facts that have been collected (Purwanto & Winarti, 2016).

Through observation, students can prove the truth of their theory so that their knowledge of related concepts becomes more mature. The results of these observations can also be used as a basis for answering related problems that will be faced by Fernanda, Haryani, Prasetya, & Hilmi (2019).

The experimental class students have been trained to collect data from the information they have obtained independently to solve problems in the worksheet provided. while the control class does the LKS by looking for sources only from books or the internet, not using Augmented Reality. This is what makes students in the experimental class have more information than the control class. So that the skills to build basic skills in the two classes experienced significant differences.

In accordance with the research of Pujianti (2020), basic skills can be significantly improved if a person is accustomed to finding information independently and choosing the right information to solve a problem. Students will make their own decisions about what direction to take in an investigation, what information to collect, and how to analyze and evaluate that information.

Based on a series of learning processes carried out in the experimental class, it shows that learning activities using Augmented Reality media through a scientific approach to the human digestive system can facilitate students' critical thinking skills, such as in activities carried out with the stages of a scientific approach which is a means to achieve thinking ability indicators. critical, so Augmented Reality through a scientific approach can develop students' critical thinking skills, especially on the material of the human digestive system. Students are more active in finding the required information. This is in accordance with research conducted by Mantasia & Jaya (2016), the development of Augmented Reality technology in the implementation of learning activities using the Scientific Approach method can meet the needs of improving students' cognitive, affective and cognitive skills, and make it easier for students to understand abstract and complex things.

The results of the student response questionnaire analysis showed student interest in the learning process which reached a percentage of 81.67%, which means that Augmented Reality media can help him understand the material more quickly and develop his critical thinking skills. In addition, the assessment of the teacher's observation sheet is to show the implementation of the learning process with the application of augmented reality through a scientific approach in the experimental class where almost the entire learning phase is carried out well as shown in the picture.

As a result, both the control class and the experimental class both experienced an increase because both classes were treated with the application of a scientific approach. However, the increase in critical thinking in the experimental class is actually higher than the control class because of the use of Augmented Reality media. This is supported by Mustaqim's research (2016), the use of Augmented Reality can stimulate students' mindsets in critical thinking about problems and events that exist in everyday life, because the nature of the existing learning media educational media is to help educators in the educational process, so that the use of educational media with Augmented Reality can directly provide learning wherever and whenever students want to carry out the learning process.

CONCLUSION

Based on the research that has been done, it can be concluded that there is an effect of applying Augmented Reality through a scientific approach to students' critical thinking skills on the material of the digestive system of class XI. The highest indicator is generated on the observing indicator and considering the observation report because it facilitates or is trained with the use of Augmented Reality media.

The results of N-Gain in improving critical thinking skills there are differences between the experimental class and the control class, namely the average N-Gain result in the experimental class is 0.71 with high criteria, and the average N-Gain in the control class is 0.51 moderate criteria. , it can be interpreted that there is an increase in the critical thinking ability of students of class XI IPA 3, on the material of the human digestive system.

Based on the results of questionnaires or student responses in the use of Augmented Reality which is

used during the learning process, the results are 81.67%. So that overall students by using Augmented Reality media more easily understand the material and improve critical thinking skills.

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