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AR SINAPS: AUGMENTED REALITY LEARNING MEDIA TO ENHANCE CRITICAL THINKING ABILITY

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ABSTRACT

The competitive world situation caused by globalization requires students in the 21st century to have the ability to think critically. Critical thinking ability is a thinking process that has a purpose and focuses on producing an idea to solve a problem. However, several studies show that students' critical thinking skills in biology are still in the low to medium category. Thus, several efforts are needed to improve critical thinking skills, one of which can be through the use of technology-based learning media. This study aims to improve students' critical thinking ability using Augmented Reality learning media. This research was carried out from January to July 2022 at State Senior High School 31 Jakarta (henceforth called SMAN 31 Jakarta). The research used a quasi-experimental design with a pretest-posttest control group design. The experimental class used AR SINAPS learning media to assist the learning process. The control class, on the other hand, used picture media. The research involved 44 students selected by simple random sampling. The participants were divided into experimental and control classes, each of which amounted to 22 students. The data analysis technique used was a t-test with a significant level (α) = 0.05. Based on the calculations on the average gain score for the experimental and control classes, a significance value of 0.01 was obtained, meaning that using AR SINAPS learning media might enhance high school students' critical thinking ability better than using the picture media.

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1. INTRODUCTION

The presence of globalization in the 21st century requires students to have the ability to think, formulate concepts and take action so they can compete in a competitive world (Panggabean, 2021; Syaharuddin, et al., 2022). One of these abilities is the ability to think critically (Soule & Warrick, 2015). Critical thinking skills are directed thinking processes that analyze information, either from observation or experience, to generate a logical conclusion in order to solve a problem (Ennis, 1993). Students can expand their knowledge and solve problems in their daily life through critical thinking (Dwyer, et al., 2014; Ristanto, et al., 2020; Suryanda, et al., 2020). Moreover, students can also improve their proficiency and cognitive skills by analyzing and solving a problem (Harahap, et al., 2020). In addition, Stobaugh et al. in the book entitled Assessing critical thinking in middle and high schools: Meeting the common core in 2013, also stated that critical thinking has implications for students' success in college, careers, and lives. Stobaugh et al. in the book entitled Assessing critical thinking in middle and high schools: Meeting the common core in 2013, further explained that students tend to have higher cumulative college point averages when they have critical thinking skills in college. Furthermore, employees who have good critical thinking skills are highly valued by companies because they can solve problems that arise in the workplace. Critical thinking skills can also guide students in life so they can make the right decision based on the result of their thinking.

Research conducted by Agnafia (2019) and Azrai et al. (2020) found that most students in biology learning have critical thinking abilities in the low to middle category. This categorization is based on Riduwan in the book entitled *Dasar-dasar statistika* (Fundamentals of Statistics) in 2013 critical thinking criteria, the low-category students tend to have critical thinking scores ranging from 21-40. On the other hand, middle-category students have scores ranging from 41-60. Many factors can cause low critical thinking ability. According to Suryanda et al. (2020), low variation in learning also focused on textbook learning bored students and caused low critical thinking ability. This is supported by Tasyari et al. (2021) statement that the usage of learning media in biology is not varied. Azrai et al. (2020) stated that students could not construct the knowledge, analyze and relate their knowledge to the problem. The low cognitive understanding, the inability of students to visualize the basic concept, and the lack of application of the basic concepts can also be factor that causes students' low critical thinking ability (Az-Zahra, et al., 2021; Bustami, et al., 2018; Saidin, et al., 2015). Therefore, efforts are needed to improve critical thinking ability.

Biology learning that focuses on discussing the anatomy and physiology of living things can be one way to improve critical thinking ability because students are required to be able to know the correlation between the structures of the organ and its functions (Ramdani, et al., 2020; Ristanto, et al., 2020). Critical thinking in biology learning might increase students' achievement through cognitive skills (Suparini, et al., 2020). According to Noviyanti et al. (2019), educators can develop students' critical thinking abilities through the school learning process. For example, applying the guided discovery blended learning model (Noviyanti, et al., 2019; Suparini, et al., 2020), problem-based learning model (Ennis, 2016), project-based learning (Rini, et al., 2020), and interactive learning media (Faridi, et al., 2021; Zulhelmi, et al., 2017). One of the Biology topic that is related to component structures (the organ and its tissue) and the role of these structures is the topic of the respiratory system. Students must be able to analyze the relationships that occur between organs, tissues, and their functions (as explained by Astuti et al. in the proceeding entitled The students critical thinking skill profile on respiratory system material through natural disaster and COVID-19 pandemic in 2021). Therefore, learning biology about the respiratory system may possibly develop critical thinking ability.

Improving critical thinking skills can be assisted through technology because it can bring real-world events into classroom learning, making the information more accessible to the students and providing a clearer picture of a concept to help students in the learning process (Saidin, et al., 2015). In addition, the students can use the information as discussion material that triggers collaborative learning (Domingo & Garganté, 2016). The teacher can use Augmented Reality (AR) as one of the technologies in classroom learning (Carreon, et al., 2020). Augmented Reality is a technology that combines the virtual world in the form of three-dimensional (3D) images created by computers with the real world so that users can interact directly with both in real-time (Azuma, 1997; Duarte, et al., 2020; Fuchsova & Korenova, 2019; Kesim & Ozarslan, 2012).

Augmented Reality provides some flexibility in the learning process. For example, students can change the point of view of the image objects contained in AR media by rotating the image and enlarging it like being in front of a real object, so they can better visualize basic concepts and increase their understanding of complex topics (Bujak, et al., 2013; Faridi, et al., 2021). Augmented Reality could bring a new learning experience for students (Baabdullah, et al., 2022), and make it easier to obtain, process, and remember information to make the learning process more effective and enjoyable (as explained by Roopa et al. in the proceeding entitled Revolutionizing education system with interactive augmented reality for quality education in 2020). Augmented Reality can also increase student interest in learning and motivation (Mustaqim, 2016; Rini, et al., 2022). According to Mustaqim (2016), Augmented Reality can be used as a learning medium to stimulate students' critical thinking ability toward daily life problems. Therefore, learning media can facilitate more effective learning so that the students will have a deeper understanding (Ningsih, et al., 2019).

The use of Augmented Reality in learning to enhance critical thinking ability has been done by several researchers before. For example, as explained by Suryanti et al. in the proceeding entitled Augmented reality for Integer learning: Investigating its potential on students' critical thinking in 2020, found that using Augmented Reality on students in grade 7 junior high school would seem to improve their critical thinking skills in integer learning topics. According to Vari and Bramastia (2021), the improvement of critical thinking skills is because the students are encouraged to analyze the concepts in the worksheets. In addition, students will train their imagination skills to improve visual literacy, which helps improve critical thinking skills. In addition, Chang and Hwang (2018) found that

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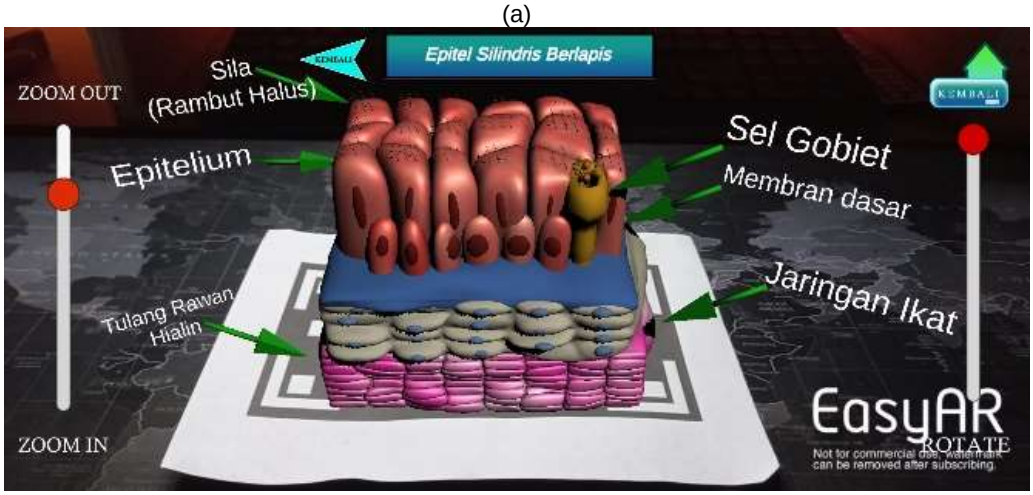
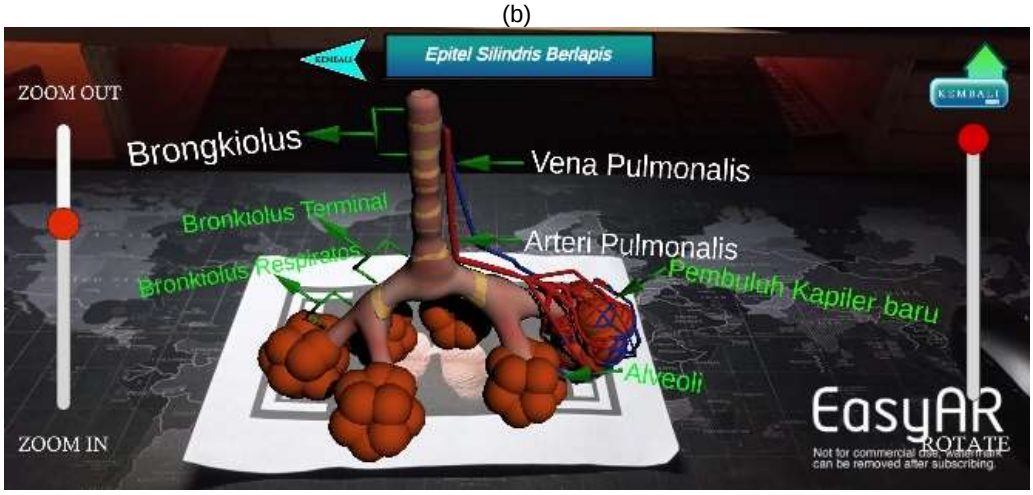
using Augmented Reality in experimental classes likely led to higher critical thinking gains than in control classes. This is because Augmented Reality allows students to learn the topic better and complete tasks more efficiently.

This study uses Augmented Reality Sistem Pernapasan (AR SINAPS) learning media developed by Biology Education Study Program, Universitas Negeri Jakarta (Fig. 1). AR SINAPS runs on the Android platform, and the students can download the app from Google Play Store (here is the link to access the app: https://play.google.com/store/apps/details?id=com.PBIOUNJ.ARSinaps). AR SINAPS installed on students' smartphones use the camera to track the marker provided so the image will appear on the phone screen. The students can explore the organs and tissue found in the human respiratory system by visualizing a three-dimensional image. In addition, the image can be rotated or enlarged, so the students receive a clearer picture of the shape from another point of view. As a mobile application, students can use AR SINAPS anytime and anywhere.

(a)



(b)



(c)

Fig. 1 - Augmented reality view of AR SINAPS application. (a) lung cross-section; (b) Cross-section of trachea tissue; (c) The terminal bronchiole and alveolus.

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Broadly speaking, critical thinking skills are one of the skills that students need today because it supports their lives in the future. However, the lack of critical thinking skills of students in learning biology requires a way to improve critical thinking skills. One of them is to learn about anatomy and how it works. Learning about the respiratory system is one of the topics that can be learned. Another alternative that can help improve critical thinking skills is the use of Augmented Reality technology. Students can use the flexibility of Augmented Reality to better understand the material they are studying and improve their critical thinking. This study aims to determine the effect of using AR SINAPS learning media on the critical thinking skills of high school students. The results of the analysis of this study are expected to be a reference for teachers to be able to use AR SINAPS as a learning media. Teachers can easily access technology-based learning media through the AR SINAPS application, which can be easily downloaded from the Play Store. AR SINAPS is expected to help improve students' critical thinking skills. Furthermore, students are expected to gain new learning experiences using AR SINAPS.

2. METHOD

2.1. Research Method

This study used a quantitative approach with a quasi-experimental method and pre-test-post-test control group design. Quasi-experimental studies identify two groups, one that receives the treatment (experimental group) and one that does not (control group), to see if there is a difference when the treatment is implemented or not (as explained by White & Sabarwal in the research report entitled Quasi-experimental design and methods in 2014 https://www.unicef-irc.org/KM/IE/img/downloads/Quasi-Experimental_Design_and_Methods_ENG.pdf)). The design used in this study is displayed in Table 1.

Table 1.
Pretest-posttest control group design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Description:
O_1 : Experimental class pre-test score
O_2 : Experimental class post-test score
O_3 : Control class pre-test score
O_4 : Control class post-test score
X : Treatment with AR SINAPS learning media

2.2. Research Participants

The target population used in this research were students from 11th grade on SMAN 31 Jakarta**.** Two of five classes were obtained using cluster random sampling with a shuffle containing papers with class names. The experimental and control classes were selected based on the first and second papers resulting from the randomization. 44 students were selected from those two classes. More specifically, each of the experimental and control classes consists of 22 students.

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2.3. Experiment Design

The experimental research was conducted while learning about the human respiratory system in the classroom. Both experimental and control classes are taught by the same teacher and use the problem-based learning model. In addition, each class used a student worksheet (LKPD).

The learning process in the experimental and control classes began with a brief explanation of the human respiratory system so that students would know the topic to be studied. The learning process continues with individual pre-test questions to determine the critical thinking skills of the students before starting the learning process. Learners were given 15 minutes to complete the pre-test. Afterward, students were divided into groups to facilitate the learning process. The teacher gave each group a student worksheet to discuss a problem in the human respiratory system, such as the structure of the organs and tissues of the respiratory system, the relationship between organ structure and organ function, and diseases that occur in everyday life and relate them to the respiratory organs. Students in the experimental class used AR SINAPS to work on the student worksheet. Students in the control class, on the other hand, relied only on the pictures in the student worksheet to complete the answers. Each group was then asked to present its findings and receive corrections from each instructor. At the end of the lesson, to see the change in critical thinking scores, the students completed the same post-test questions as the pre-test questions. The post-test took about 15 minutes for the students to complete. The critical thinking score was used as the primary data for this study. In total, the learning process took about 60 minutes. The learning process implemented in the classroom is illustrated in Fig 2.

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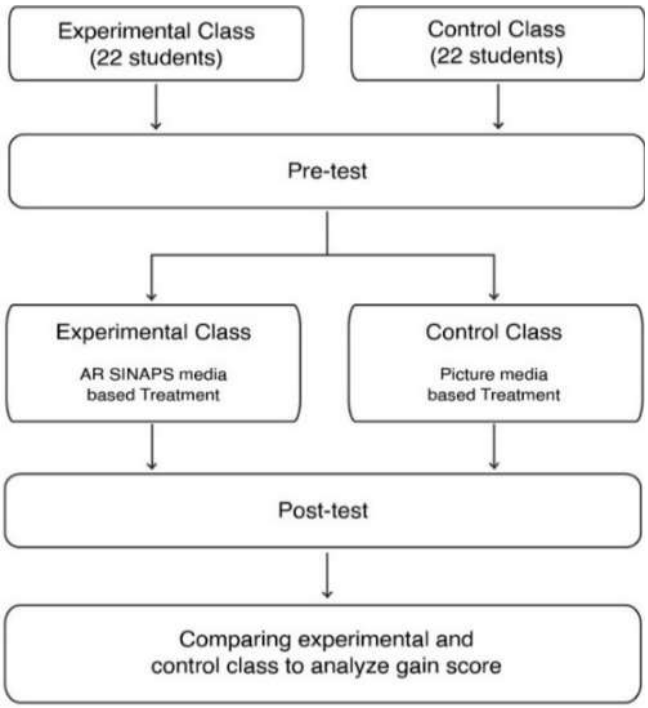

Fig. 2 – The Experimental Design

2.4. Data Collection Instrument

The instrument used to measure critical thinking skills is in the form of multiple-choice questions with a total of 20 items and uses four indicators, which consist of 1) interpretation; 2) analysis; 3) evaluation; 4) inference (as explained by Facione in the report entitled Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction in 1990). The question indicators of critical thinking ability are displayed in Table 2.

Table 2.
The indicators of the questions

Critical Thinking Indicators	Question Indicators	Question Number	Total
Interpretation	The students can explain human respiratory organs' location, structure, function, or bioprocess.	1, 5, 9, 13, 17	5
Analysis	The students can analyze the relationship between organ structure and functions or disorders in the human respiratory system.	2*, 6, 10*, 14, 18	5
Evaluation	The students can assess statements regarding the location, structure, function, bioprocess, or disturbance of the human respiratory system.	3, 7, 11*, 15*, 19	5
Inference	The students can formulate ideas to solve problems regarding the constituent structures and diseases in the human respiratory system.	4*, 8, 12, 16, 20*	5

*Invalid question

The instrument's validity was measured using point biserial and obtained 14 valid questions (the valid question are shown in Appendix). In addition, Cronbach's alpha was used to measure the reliability and obtained an alpha coefficient of 0,795. According to as Arikunto in the book entitled *Prosedur penelitian suatu pendekatan praktik* (The Research Procedure: A Practical Approach) in 2016, the results of the test were classified in the high category.

2.5. Data Analysis

The data were analyzed using descriptive analysis and treated with a Kolmogorov-Smirnov test and F-test to see the data's normality and homogeneity. The result of the test showed that the data were normally distributed and homogeneous ($\alpha > 0,05$). Hypothesis testing was also conducted using an independent t-test with $\alpha = 0.05$ to see the difference between the experimental and control classes. Students' critical thinking score is also categorized according to Riduwan in the book entitled *Dasar-dasar statistika* (Fundamentals of Statistics) in 2013 critical thinking criteria in Table 3.

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Table 3.
Critical Thinking Criteria

Score Scale	Category
81-100	Very High
61-80	High
41-60	Medium
21-40	Low
0-20	Very Low

3. RESULTS AND DISCUSSION

According to the analysis of critical thinking ability, students in the control class obtained an average value of pretest 36.36, posttest 44.16, and gain score of 7,79. On the other hand, the experimental class obtained an average value of pretest 30.84, posttest 48.70, and a gain score of 17.86 (see Fig. 3). Based on the data displayed, the control class had a higher average score on the pretest than the experimental class. But, after the learning takes place, the posttest score in the experimental tends to be higher. The gain score value of the experimental class was also higher than the control class. This data indicates that using AR SINAPS learning media could enhance the critical thinking ability of high school students.

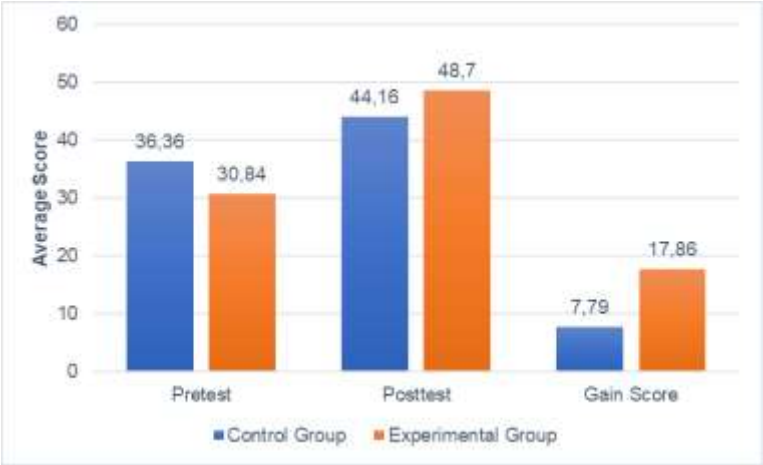

Fig.3 - Pretest-posttest,results and gain score average value

Based on the result of the critical thinking score categorization (see Table 4), there is a change in the number of students per category before and after the learning process. Most of the experimental class students on the pretest results were in a low category, and there were even students in the very low category. However, after being given treatment, most of the students were in the medium category, five were in the high category, and none were categorized as very low. On the other hand, the pretest result of most students in the control class was classified in a low category. The Posttest result shows that most students were categorized in a medium category. According to the data, experimental classes have more students classified as a high category than control classes. Also, one student was categorized as very low in control classes after the learning process. This data indicates that the student's critical thinking skills in both classes improved, but the experimental classes showed a better improvement than the control classes.

The Kolmogorov-Smirnov test the normality of gain score data and the F-test to see the data homogeneity before the hypothesis test. Based on the data analysis, the control class obtained 0.12 > 0.05, and the experiment class obtained 0.20 > 0.05 for the normality test. This result states that H0 is accepted, so the gain score data from both classes are normally distributed. Homogeneity test from both classes obtained 0.72 > 0.05. Therefore, the H0 is accepted, and it can be concluded that both groups are homogenous.

Table 4.
Grouping learners by category of critical thinking ability

Category	Total of Learners			
	Experiment		Control	
	Pre-test	***Post-test***	***Pre-test***	***Post-test***
Very low	6	0	0	1
Low	9	7	15	7
Medium	7	10	6	11

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High	0	5	1	3
Very High	0	0	0	0

The hypothesis test result on gain score value shows that the independent t-test value is 0.01 < 0.05, so H_1 is accepted, which means there is a significant difference in gain score value in the experimental class than in the control class. This significant difference also indicates that using AR SINAPS learning media can enhance the critical thinking ability of high school students compared to picture media. This study's result parallels Suryanti et al. in the proceeding entitled Augmented reality for Integer learning: Investigating its potential on students' critical thinking in 2020, that using Augmented Reality learning media could enhance critical thinking ability in integer learning. Furthermore, Syawaludin et al. (2019) also stated that using Augmented Reality media could affect critical thinking ability in learning about the earth's structure. Moreover, learning about the digestive system with Augmented Reality learning media also improves students' critical thinking ability (Lismaya, 2022).

The significant improvement in students' critical thinking skills who use AR SINAPS learning media is because they can get information more easily by visualizing the respiratory system organs in interactive 3D images. In addition, students can move the 3D image displayed on the app to get more information from another point of view. The information then can be processed by students and help them to understand the basic concept of the respiratory system, especially in learning anatomy. Furthermore, the visualization of the organ displayed by Augmented Reality in 3D images could make the image look realistic (Ozdemir, et al., 2018) and help students understand the basic concept (Kurniawan, et al., 2018). Roopa et al. in the proceeding entitled Revolutionizing education system with interactive augmented reality for quality education in 2020, also stated that using Augmented Reality learning media could facilitate students to obtain, process, and remember information.

The AR SINAPS 3D image's ability to be moved around creates interaction between students and the learning media. As a result, students are more involved in the learning process and become more interested, which can increase motivation (Faridi, et al., 2021; Rini, et al., 2022). Moreover, Fidan and Tuncel (2019) stated that the involvement of students in the learning process assisted with AR helps exchange information stored in short-term and long-term memory to improve understanding. Motivation is one of the internal factors that can also affect critical thinking ability (Erwiza, et al., 2019; Mahapoonyanont, 2012).

The 2D image used in the control class also represents the actual view of the tissue and organ in the respiratory system. But, based on the findings from Fig. 1, using 2D images only without other learning media does not support improving critical thinking ability. One of the factors is the limitation of picture media to support the improvement of critical thinking ability. One limitation is that students cannot move the picture to get another point of view like in AR SINAPS learning media. According to Parvathy et al. in the book chapter entitled Augmented reality simulation to visualize global warming and its consequences in 2016, 2D learning media often do not fully impact the learning process because of the learning media limitation. The use of 2D image media in a textbook for anatomy learning is also less able to develop students' understanding, so assistance is needed from additional learning media that shows 3D images like Augmented Reality (Duarte, et al., 2020; Küçük, et al., 2016; Kurniawan, et al., 2018). Furthermore, Lismaya (2022) stated that students in control classes gain less information, contrary to experimental classes using Augmented Reality.

The critical thinking test is made based on critical thinking indicators and consists of 1) interpretation; 2) analysis; 3) evaluation; and 4) inference (as explained by Facione in the report entitled Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction in 1990). The average value of each indicator forms the pretest and posttest results in Fig. 4. Based on Fig. 4, the interpretation, analysis, and inference indicators show a higher gain than the control class. The greater improvement of the interpretation indicator in experimental classes than in control classes indicates that using AR SINAPS learning media could assist students in understanding the basic concept of respiratory system organs through 3D visualization and the interactivity from the students. Furthermore, using AR learning media supports the student in acquiring visual information, so they can easily imagine and understand the image through visual literacy and then improve their interpretations skills (Kędra & Žakevičiūtė, 2019; Vari & Bramastia, 2021).

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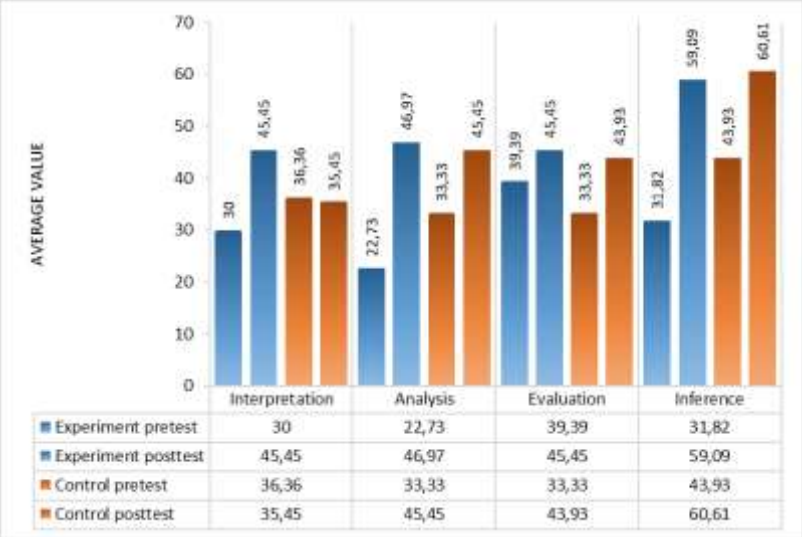

Fig. 4 - *The average score of critical thinking indicators*

The improvement of interpretation indicators average score affects the analysis and inference indicators in the experimental class. The simulation provided by AR SINAPS learning media is one factor that can affect analysis indicators in experimental classes. AR SINAPS media can provide a simulation experience because students can interact with the images contained in the learning media. This interaction will provide students with an experience that can trigger active learning. Active learning will encourage students to analyze the relationship between the constituent structures and bioprocesses or disturbances in the human respiratory system. These findings are also encouraged by Herliandry et al. in the proceeding entitled Improve critical thinking ability through augmented reality assisted worksheets in 2021 , that the use of worksheets assisted by AR media can encourage students to analyze physics concepts so that, in the end, it can trigger students to learn actively and practice critical thinking skills. Active learning will encourage students to use higher-order thinking skills such as analyzing (Jesionkwska, et al., 2020). Duarte et al. (2020) stated that learning anatomy using AR media could help improve memory retention so that they can understand more information. The information that has been understood will form knowledge that can then be used in the analysis process (Dwyer, et al., 2014).

Students who understand the basic concepts well through AR SINAPS media in the experimental class can trigger a better analysis process to produce conclusions or solutions to solve the problems. The results of research support this by Lismaya (2022), which states that using AR learning media in the learning process can support students to investigate, collaborate and ultimately improve critical thinking skills as measured by several indicators. One of them is an inference indicator. As explained by Herliandry et al. in the proceeding entitled Improve critical thinking ability through augmented reality assisted worksheets in 2021, also stated that using AR media can support students in developing indicators of critical thinking skills such as inference.

Biology is one of the more difficult disciplines to study due to the large amount of material to understand. Human Respiratory System as a Biology topic requires students to understand and analyze the structure and function of each organ (Az-Zahra, et al., 2021; Paidi & Jumadi, 2023). Analysis is one of the indicators included in critical thinking skills, and students must be able to make the connection between the course content and everyday life (Virtanti & Yuniastuti, 2021; Widita, et al., 2018). According to Ndae and Widyaningrum (2020), having critical thinking skills in biology learning can help students get used to facing challenges and solving problems with their own thinking. In addition, Saputri et al. in the proceeding entitled Critical thinking skills profile of senior high school students in Biology learning in 2018 noted that biological science will continue to evolve rapidly, and future students will need to be able to solve increasingly complex problems.

The implementation of this research found several obstacles. These constraints, among others, are based on calculating the posttest average value (see Fig. 4). It can be seen that the critical thinking ability of the experimental class students is still in the medium category. Lack of time using AR SINAPS media can be one of the factors which cause less than optimal use of media. Learning is only carried out in one meeting for 60 minutes. In this case, the use of AR SINAPS media is less than optimal, so students have not been able to explore all the features of the learning media and organs of the respiratory system displayed on the media. According to Garzón et al. (2020), learning using AR media can be maximized if it is carried out within one to four weeks. Thus, to maximize the learning process using AR SINAPS media, teachers can design learning by giving students time to explore the learning media before classroom learning. Teachers can also create learning to be carried out in two to four meetings

4. CONCLUSION

This study result shows better improved critical thinking ability in experimental classes that assisted with AR SINAPS learning media than in control classes that used picture media. Furthermore, the calculation with an independent t-test also indicates the significant gain score difference between experimental and control classes. These findings suggest that using AR SINAPS could enhance critical thinking ability. Moreover, the information

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provided by AR SINAPS learning media helps students to acquire more information, so they can easily understand the basic concept of the respiratory system. Their understanding could affect the interpretation indicators and force them to analyze the problems, and they can enhance their inference. Based on the research conclusions, as a practical recommendation, biology teachers can use AR SINAPS as an alternative learning media in respiratory system topic to help students improve their critical thinking skills. In addition, using AR SINAPS as a learning tool will increase students' motivation and interest in learning. However, due to the lack of time to implement the learning media, the students in the experimental class are unable to explore the organs of the respiratory system in depth, resulting in an average post-test score categorized as medium. As a result, the students do not seem to take full advantage of the features contained in AR SINAPS. For this reason, the teacher can give an introduction to the respiratory system and at the same time introduce the AR SINAPS media in the first meeting. Teacher can also assign students to learn and explore AR SINAPS before the next meeting. Researchers can further optimize the use of AR SINAPS in the learning process by giving students more time to learn the application. In addition, further research is expected to measure students' activity, motivation, and interest in learning with AR SINAPS in order to see a clearer relationship between AR SINAPS media and students that causes active learning.

5. ACKNOWLEDGEMENT

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APPENDICES

The valid pre-test and post-test instrument

No	Indicators	Question	Answer
1	Interpretation	The itchy throat disease experienced by Sinta is most likely to occur in the human respiration system. The organs and tissues that are experiencing disorders that cause the disease are ...	a. Nasal cavity, cartilage tissue b. Alveolus, ciliated flat epithelial tissue c. Pharynx, striated muscle tissue d. Bronchioles, cartilage tissue e. Trachea, ciliated cylindrical epithelial tissue
3	Analysis	The statement below that can explain the process of Sinta's illness is ...	a. Sinta was exposed to cigarette smoke, causing cigarette smoke residue to enter and get stuck in the pharynx. b. Sinta accidentally choked when swallowing food so that food got stuck in the trachea c. Sinta inhaled air contaminated with bacteria, causing an attempt to expel it by the trachea. d. Sinta sings too much for a long time causing pain in the larynx and vocal cords e. The drink consumed by Sinta contained bacteria, causing her throat to hurt.
5	Interpretation	The difficulty in breathing is the result of a *mucus plug* found in the organ ... thus blocking air from entering the lungs.	a. Nasal cavity b. Bronchioles and alveoli c. Nasopharynx

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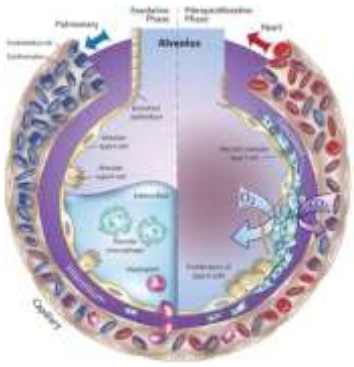
		The correct answer to fill in the missing part of the above statement is ...	d. Oropharynx e. Trachea and bronchi
6	Analysis	One of the reasons doctors can find fluid in the respiratory tract of patients with COVID- 19 is ...	a. Leakage of equipment used by the hospital b. Excessive saliva production to suppress the number of viruses c. The high number of COVID-19 viruses causes changes in the function of goblet cells d. Excessive mucus production due to infection from the COVID-19 virus e. The body's natural response to urgency when infected with a virus
7	Evaluation	The correct and credible statement to explain the reason for death in patients with COVID- 19 disease is ...	a. Patients with COVID-19 disease have a history of other diseases that are active when the virus is attacked. b. Excessive saliva production will collect in the pharynx, blocking the airway. c. Excessive mucus production in the nasal cavity causing breathing difficulties d. Excess mucus will close the respiratory tract, preventing gas exchange in the alveolus. e. Excess mucus production will speed up the metabolic process, hence accelerating death.
8	Inference	 Based on the picture above, the right conclusion to describe the difference between normal and abnormal alveolus after being exposed to COVID-19 disease is....	a. The COVID-19 virus causes epithelial cells to loosen, allowing blood to enter the alveolus b. Damage to immune cells leading to viral diseases c. The appearance of swelling due to infection with the COVID-19 virus, and disrupting the air exchange process d. Fluid that appears due to viral infection causes disruption of the air exchange process e. Damage to stratified flat epithelial cells by the COVID-19 virus causes swelling
9	Interpretation	The correct explanation to describe the difference in the shape of the right lung and left lung based on the answer below is ...	a. The left lung has a smaller size with two lobes because it is located close to the heart. b. The left lung has three lobes with three branching bronchus main trunks. c. The right lung has a smaller size because it is located close to the heart. d. The right and left lungs have the same number of branching

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			bronchi, but the number of lobes is different. e. The number of branching bronchi in the right lung is less than in the left lung
12	Inference	Read the following statements correctly! • This organ is composed of three parts • One of the tissues that make up this organ has a fine hair-like structure that functions to filter small particles from the air. • This organ is traversed by two systems: the respiration system and the digestive system. The correct answer for this organ is	a. Trachea b. Pharinx c. Larynx d. Bronchioles e. Alveolus
13	Interpretation	The alveolus is the organ at the very end of the respiratory tract. In order for the alveolus to increase its ability to maximize air exchange, the structure of the alveolus can be...	a. The alveolus is composed of a sac-like shape with a layered flat epithelium as its wall b. The alveolus has a direct connection to the bronchioles, maximizing air supply. c. The gas exchange process will be carried out through active transport between the alveolus and blood vessels d. The alveolus is filled with blood so that gas exchange can occur directly without passing through diffusion e. The alveolus has a sac-like shape with ciliated cylindrical epithelium as its wall.
14	Analysis	When breathing, air can enter through the nasal cavity as well as the oral cavity. The event that will occur if air enters the body through the oral cavity is...	a. More air can enter than through the nasal cavity b. Air can still be filtered using the fine hairs of the pharynx c. Respiratory system organs can filter out larger particles d. Interference occurs due to the influx of large particles not being filtered out e. No interference occurs because the body can breathe normally
16	Inference	Breathing performed by our body is divided into two, namely external breathing and internal breathing. One of the appropriate explanations to conclude the reason for the external breathing process in the body is....	a. In order for the air exchange process consisting of various types of gases to occur b. So that the body is able to expel metabolic waste gas and input O_2 gas c. As a sign that the person doing the breathing process is still alive d. Because the body needs CO_2 gas from outside the body for metabolic processes e. The body cannot contain all the gas that is present, so it needs to be expelled
17	Interpretation	The correct explanation of the process of exchanging O2 and CO2 from outside the body into the body during inspiration is....	a. O_2 gas in the alveolus will exchange with CO_2 in the blood vessels through the process of osmosis. b. Gas transfer is triggered by the absence of pressure difference in the alveolus and blood vessels

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			c. The presence of other gases besides O_2 and CO_2 triggers gas transfer from the alveolus to the blood vessels d. In blood vessels, the pressure is higher so that CO_2 can enter through diffusion. e. The pressure of O_2 gas in the alveolus is higher than that of blood vessels so that diffusion occurs
18	Analysis	One day there was a fire in the house where Romi lived. It took about 5 minutes for the fire brigade to get in and rescue Romi. When she was found, she had burns, shortness of breath and was unconscious. Based on the case, the correct statement regarding the reason why Romi was short of breath and found unconscious is ...	a. The cartilage in Romi's trachea was broken, narrowing the airway. b. Romi was poisoned by CO gas which exchanges faster than O_2 gas in the alveolus. c. Romi suffers from lack of air as the fire uses up all the gas. d. Romi suffered lung damage, due to accidental inhalation of fire e. Romi was poisoned by O_2 gas, because the fire triggered a higher level of O_2 gas.
19	Evaluation	When studying the human respiration system, Ratih was asked by the teacher to explain the sequence of organs that make up the human respiration system. Based on the results of her thinking, the organs of human respiration are composed of the nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles and alveolus. At the same time, she explained that bronchioles are divided into several types, and the diameter of bronchioles will get bigger as they approach the alveolus. Based on this statement, is her argument correct? The argument below that is appropriate to correct or strengthen Ratih's argument is....	a. Correct, as all the respiratory organs have been mentioned correctly b. Incorrect, as the pharynx should come after the trachea. c. Correct, because the large diameter size can facilitate the breathing process d. Incorrect, because the closer you get to the alveolus, the smaller the diameter of the bronchioles. e. Incorrect, as the largest diameter bronchioles should be near the trachea.

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