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IMPROVING STUDENTS' SCIENTIFIC LITERACY THROUGH DISTANCE LEARNING WITH AUGMENTED REALITY-BASED MULTIMEDIA AMID THE COVID-19 PANDEMIC

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ABSTRACT

Scientific literacy is a capability to identify problems, analyze questions, and create solutions by applying scientific knowledge and integrating science with technology and society. This literacy needs to be improved so that students can develop their skills in identifying science phenomenon and addressing various solutions. Although the learning was conducted in distance since the current situation is still amid the COVID-19 pandemic, the literacy can be taught during the learning process. This study aims to improve students' scientific literacy through distance learning with augmented reality-based multimedia amid the COVID-19 pandemic. The research included in a descriptive quantitative study with pre-test and post-test design. The distance learning was conducted in the lecture of anatomy and physiology of organism during even semester in May 2020, with 111 students from three classes in the 2018 academic year. The science content provided in online learning was supported by augmented-reality based multimedia on the topic of the human respiratory system. This multimedia was evaluated, also stated as valid and appropriate to be implemented in the learning process. Scientific literacy was measured using the online test form. The findings indicated that the students' scientific literacy improved moderately both in class A and B, but low in class C. The improvement of scientific literacy in class A reached N-gain average score of 0.31, class B reached 0.38, and class C reached 0.22. Students also gave a positive response, showed by the percentages of students' response at 89.1% in class A, 87.0% in class B, and 84.8% in class C, which was in the very strong category. Therefore, it can be concluded that students' scientific literacy improved well through distance learning with augmented reality-based multimedia amid the COVID-19 pandemic.

Keywords: augmented reality-based multimedia; distance learning; scientific literacy; COVID-19 pandemic

INTRODUCTION

Science is the organized study of the structure and process of the physical, social, and natural worlds through various investigation activities, such as observation and experiment (Costa & Araujo, 2018). Science is also the main component to create creativities, innovations, and developments since students can identify and explore world phenomenon by having science (Rusilowati et al., 2016a). Therefore, it is essential to learn science in schools and universities.

Moreover, by learning science, students can develop skills to examine questions, identify problems, collect information, organize ideas, overcome problems, apply knowledge, and make conclusions (Bertling et al., 2016; Glaze, 2018). Even more, science also compromises ways for learners to develop scientific attitudes and processes by increasing the skills in conducting science investigations and developing science skills such as responsibility, curiosity, carefulness, confidence, and communication (Rokhmah et al., 2017).

According to the observation results from the preliminary research in the previous semes-

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ter in which the students have learned in basic science lecture; it can be assumed that most students have difficulties in learning science. It also indicated that there were students who did not master the science concepts well, especially concepts related to human anatomy and physiology. They argued that science concepts are hard to remember and comprehend since the concepts are abstract. Besides, many complicated terms need to understand because if not, it can bring misconception or misunderstanding. It has also been supported by research results about difficulties in science concepts which impact on cognitive achievements (Schneiderhan-Opel & Bogner, 2020). One of the concepts that are difficult in the students' perspective is about the human organ system, for instance, the respiratory system. The reason is that this topic consists of unobservable abstract concepts and include various complicated terms. From this point of view, it is assumed that the learning process has not been conducted effectively yet, and students cannot comprehend the science concepts well (Bertling et al., 2016). If it is so, then students cannot achieve learning achievement and skill excellently (Costa & Araujo, 2018).

Outstandingly, the role of science learning process not only aims at transferring science knowledge to learners but also developing students' scientific literacy. International large-scale surveys (ILSA), such as the Programme for International Student Assessment (PISA), argued that the science learning should be provided by inquiring students in conducting science activities actively (OECD, 2018). Furthermore, it is also suggested that educators should not only focus on the students' outcomes but also the students learning progress. Students' scientific literacy is also essential to develop during the learning process.

According to PISA, scientific literacy is defined as a skill to identify science-related problems and involve them with the ideas and thoughts of science (OECD, 2018). Furthermore, the scientifically literate one is curious to engage in science and technology, in which it requires the skills to describe phenomena scientifically, evaluate scientific problems, design scientific inquiry, and also interpret findings, facts, and evidence systematically (Knain, 2015; Rusilowati et al., 2016b). However, it is announced that students in Indonesia reached a lower score than the OECD average in science. Since 2001 to 2018, students' performance in science has fluctuated but remained flat overall in which means that students attained higher level in science from 2006 until 2012, but the improvement was not high, then in 2015 and 2018 students reached lower level but the score was still around 500, not far from the score before (OECD, 2018). Therefore, educators have to provide effective science learning process that aims not only to transfer science knowledge but also to develop scientific literacy.

Additionally, learners have to be also guided to master scientific literacy covering its scientific knowledge, processing skill, and attitudes since scientific literacy is essential in solving problems in the daily life (Pahrudin et al., 2019). Students can contribute to society by having this literacy, also to apply scientific knowledge in making a decision and offering solutions to the problems (Fakhriyah et al., 2017). It is stated earlier that scientific literacy is a skill that refers to the scientific knowledge and links to an understanding of the scientific process and the integration between science and technology (Asrizal et al., 2018; van Rensburg, 2018). Students have to be guided to develop scientific literacy since it also pertains to the application of science, technology, and society (Asrizal et al., 2018). Student's scientific literacy can be outstretched by presenting scientific knowledge, which correlated with technology and society issues (Al Mamun et al., 2020).

Besides, the development of students' scientific literacy is also based on the learning process by educators. The quality of science teaching and learning process is also linked to the structural and process, the way of educators teach, and the methods they use to provide science learning process (Asrizal et al., 2018; Tuli & Mantri, 2020). Educators have to ensure that students can achieve learning concepts easily. Therefore, educators have to provide interactive learning environments during all comprehensive learning situation. It is proved that learning in an interactive and effective learning environment is easier for students (Baratè et al., 2019; Turgut & Yakar, 2020).

However, the current condition is amid COVID-19 global pandemic so that government in many countries implements rules that limit people congregating in public places (van Rensburg, 2018; Rapanta et al., 2020). The rule also impacts on the learning process at schools and universities in which students and educators cannot attend the places and have face-to-face learning activities as usual. Moreover, the science learning process is conducted in an open online technique.

Distance learning offers new learning experiences both for students and educators. During the distance learning process, learners can study actively and responsibly (Arulogun et al., 2020). Students can also increase higher-thinking skill during online learning because it provides plenty of information as a flexible substitute for distance learning (Reimers et al., 2020). Furthermore, students can undergo the best learning practice by having distance learning that leads to concept comprehension and literacy improvement. In contrast, for educators, distance learning offers quintessential adaptive and transformative challenges, in which they should provide effective learning environments in an online form (Littenberg-Tobias & Reich, 2020).

One of the challenges for educators is to conduct fun and effective distance learning that also develop scientific literacy. It can be provided by integrating science distance learning process with new technology (Yip et al., 2019). For instance, the technology that can be used in distance learning activities is augmented reality (AR). AR is an interactive experience of a real-world environment in which the objects that reside in the real world are developed by computer-generated perceptual information with the use of visual elements, sound or other sensory stimuli that can be operated in computer and smartphone (Crider et al., 2020; Sahin & Yilmaz, 2020).

AR is proved to provide learning environments where students can build concept comprehension in a real-life three dimensions world (Garzón & Acevedo, 2019; Tuli & Mantri, 2020). Also, by using AR, educators can improve learning outcomes by increasing engagement between teacher and students (Jamali et al., 2015). AR provides various aspects to increase learning skills and motivation. Nowadays, about 80% of teenagers use smartphones only for social networking and games, and only a few who uses them for learning (Bursali & Yilmaz, 2019). Therefore, the potential of combining smartphones and AR is essential, since AR can offer students an experience in applying scientific knowledge with new technology.

AR-based multimedia during the distance learning in this study provided learners to understand human respiratory organs, consisting of upper and lower respiratory organs. This learning media was used to accomplish the learning activities during online education. Also, this media is expected to gain students' learning motivation since it contains animation, sound, and three-dimension visual model of human respiratory organs.

Furthermore, this learning media also has benefits to render objects that are hard to imagine and turn them into three-dimension model, which make it easier to comprehend (Iftene & Trandabăt, 2018; Garzón et al., 2020). Most students argue that the human respiratory system is one of the difficult concepts that is considered as abstract science content. Therefore, it is presented through augmented reality-based multimedia during distance learning so that learners can understand the concept easily and improve scientific literacy.

This study is focused on the implementation of distance learning using AR-based multimedia acts as the solution to the learning process during COVID-19 pandemic. Moreover, the current science learning process ineffective in which students are unmotivated, and it impacts on the students' learning achievements and skills (Pratama et al., 2020; Reimers et al., 2020). It has been proved that if learners are less motivated during their learning process, it can impact on their learning achievements and skills (Rapanta et al., 2020). Therefore, it is expected that students can be motivated during the learning process because they can undergo fun learning experiences through AR-based multimedia. Once they are motivated in learning, it will be easier for them to comprehend the concepts (Bursali & Yilmaz, 2019). Also, the importance of this study is to provide interactive distance learning during COVID-19 pandemic. It is also beneficial since distance learning with AR-based multimedia can be used not only to provide effective learning but also to improve students' scientific literacy.

According to those previous views, this study aims at improving students' scientific literacy through distance learning with augmented reality-based multimedia amid the COVID-19 pandemic.

METHODS

This descriptive quantitative study was conducted during even semester in the 2019-2020 academic year in May 2020. The distance learning process was implemented asynchronously in the lecture of anatomy and physiology of organism with 111 students from three classes (from A to C) in the 2018 academic year from a public university in Indonesia. The research subject

decision included in non-probability sampling technique, in the type of purposive sampling. In this type of sampling, the students were chosen based on the purpose of this study, specific characteristics and criteria (Mohsin, 2016). There were 36 students in class A consisting of three boys and 33 girls, 38 students in class B consisting of six boys and 32 girls, and 37 students in class C consisted of four boys and 33 girls. All students in this study learned the concepts of the human respiratory system on the lecture of anatomy and physiology of organism.

The study was implemented referring to ASSURE instructional design. The reason was that ASSURE instructional design has detail and systematical stages (Henich et al., 1999). Furthermore, ASSURE design also aims at producing an effective teaching and learning process (Turgut & Yakar, 2020).

In this study, the first stage was conducted by analyzing learners in which the learning subjects were decided. Besides, students' learning styles were also analyzed. The learners as research subjects were 111 students from three classes in the 2018 academic year. According to the observation, students are around 20 years old and have studied general biology in the previous semester, in which the concepts are correlated with the concepts of human anatomy and physiology. Furthermore, most students also have audio-visual learning styles so that it is appropriate if the learning process is conducted with technology-based multimedia.

Furthermore, the second stage was conducted by stating objectives. In this study, the learning objectives were about learners can comprehend science concepts and improve scientific literacy. The third stage was about selecting instructional methods, media, and materials. The method in this study was distance learning in asynchronous. Besides, the media was augmented reality-based multimedia. The materials were about concepts in human respiratory organs.

The fourth stage was utilizing media and materials. In this study, the AR-based multimedia was developed in the form of .apk program for smartphone and computer. The AR-based multimedia was evaluated and validated by experts before implementation in the learning process. The media validators asked about the content and construction aspect. This media was evaluated by two lecturers and stated as valid and appropriate with a total score of 3.25. Therefore, the augmented reality-based multimedia was appropriate to apply in improving the students' scientific literacy on distance learning as one of the solutions for the learning process amid the COVID-19 pandemic.

The fifth stage was conducted by requiring learners participation in which the students were involved actively during the learning process. The learning process was implemented in the distance and asynchronously. The multimedia was shared to learners during the learning process so that they can easily comprehend the concepts of human respiratory organ. Furthermore, augmented reality-based multimedia was presented in the topic of the human respiratory system provided in the learning process is not only to support the implementation but also to increase the students' scientific literacy.

Finally, the last stage was about evaluating and revising according to the results of the implementation. The results that were measured were about students' scientific literacy and their responses toward the learning process. Data on students' scientific literacy was measured using pretest and post-test design. Online test with eight multiple-choice questions about the human respiratory system was given to students both in the initial and final of the learning process to know their improvement. The questions on the test about the human respiratory system have four aspects of scientific literacy; science knowledge, investigation about science hierarchy, science as a thinking process, and interaction between science, environment, technology, and society.

The first aspect of scientific literacy was about two indicators (Knain, 2015); 1) explaining facts, concepts, principles, and laws; and 2) answering questions about scientific knowledge. The second one had two indicators; 1) answering questions from graphs, tables, and figures; and 2) explaining procedural stages. Furthermore, the third aspect had two indicators; 1) analyzing a causality, and 2) presenting facts and evidence. Lastly, the fourth aspect also had two indicators; 1) describing the benefits of science and technology for society, and 2) discussing problems about science and technology. The test instrument was provided in online and answered by students through https://bit.ly/TesLSPIPA. Furthermore, the test instrument is represented in Table 1 below.

Table 1. Test of Scientific Literacy

Indicator	Sub-indicator	Number	Translated Version
Scientific knowledge	Explaining facts, concepts, principles, and laws	1	Respiration occurs as the impact of…
	answering questions about scientific knowledge	2	The respiratory organ consisted of cartilage and has a function to protect glottis is…
Investigation about science hierarchy	Answering questions from graphs, tables, and figures	3	<table><tr><th>No.</th><th>Respiration Volume</th><th colspan="2">Gender (ml)</th></tr><tr><th></th><th></th><th>Women</th><th>Men</th></tr><tr><td>1</td><td>Tidal Volume</td><td>500</td><td>500</td></tr><tr><td>2</td><td>Inspiratory Capacity</td><td>2400</td><td>3800</td></tr><tr><td>3</td><td>Vital Capacity</td><td>3100</td><td>4800</td></tr><tr><td>4</td><td>Residual Volume</td><td>1100</td><td>1100</td></tr></table> The table above explains the comparison of respiration volume in men and women. Which is the incorrect one?
	Explaining procedural stages	4	Respiration consists of internal and external. The external respiration is also known as pulmonary ventilation. Which is the correct order of external respiration system?
Science as a thinking process	Analyzing a causality	5	These statements consist of the relationship between cause and effect. Which one is true?
	Presenting facts and evidence	6	The correct statement about the human respiratory system is ….
Interaction between science, environment, technology, and society	Describing the benefits of science and technology for society	7	Pulmonology is knowledge about the way of overcoming disorders and diseases in the respiratory system. Many instrument tools are used to detect respiratory disorders and diseases. Which one is the correct about the tool and its function?
	Discussing problems about science and technology	8	The decreasing of Pulmo physiology is normal according to the increase in age. However, it can be minimized by having some stages. The ways that can be completed are ….

The test instrument also has been validated and reviewed by two lecturers before used to improve students' scientific literacy in this study. The decision of experts was based on their primary cap skills. Expert A acted as the teaching partner in this lecture, and Expert B is the coordinator of expertise field. Validation asked about the aspect of content in the instrument. This validation results revealed that the test instrument could be used to assess the students' scientific literacy. Furthermore, the test instrument was shared with all students in the first and the last meeting of this lecture to know the improvement of students' scientific literacy. Both in the first and last meeting, students filled out the test instrument through an online form for 30 minutes individually.

Data of scientific literacy were analyzed quantitatively using N-gain formula as following:

$$<g> = \quad <g> = \frac{(<Sf> - <Si>)}{(Smax - <Si>)}$$

Note:

$\langle g \rangle$: Score of N-gain $\langle Sf \rangle$: Score of post-test

$\langle Si \rangle$: Score of pre-test $\langle Smax \rangle$: Maximum score

Furthermore, the N-gain score was categorized as follows; 1) if the score is more than 0.70, then the improvement is high; 2) if the score is more than equal to 0.30 and less than 0.70, the improvement is moderate; and 3) if it is less than 0.30, the improvement is low (Balta et al., 2017).

Also, students' responses toward the implementation of distance learning with augmented reality-based multimedia were measured using an online questionnaire with Guttman scale in

which the scale is used to determine the consistent answers (Dewi et al., 2019). Questionnaire of student response consisted of eight questions that have to be filled out by students as the respondents in this study. The students' answers were valued with a score of 1 and 0. Furthermore, the percentage of student response was measured using formula below.

$$\% = \frac{\sum K}{\sum N} \text{ x } 100\%$$

Note:

$\sum K$: Number of yes answers

$\sum N$: Number of total respondents

All in all, the percentage of student response was categorized in criteria as follows: 1) If the percentage is less than 100 and more than 81, the response is very strong; 2) If the percentage is less than 81 and more than 60, the response is strong; 3) If the percentage is less than 60 and more than 41, the response is moderate; 4) If the percentage is less than 41 and more than 20, the response is weak; and 5) If the percentage is less than 20, the response is very weak (Rusilowati et al., 2016b).

RESULTS AND DISCUSSION

Distance Learning with Augmented Reality-based Multimedia

The augmented reality-based multimedia in the topic of the human respiratory system has been developed by researchers in collaboration with students in the 2015 academic year who studied the production of learning media. The view of augmented reality-based multimedia in this study is represented in Figure 1 and 2 as follows.

Figure 1. Menu View of Augmented-reality Based Multimedia

The next figure is about the content view of augmented-reality multimedia that was used in the online learning activity.

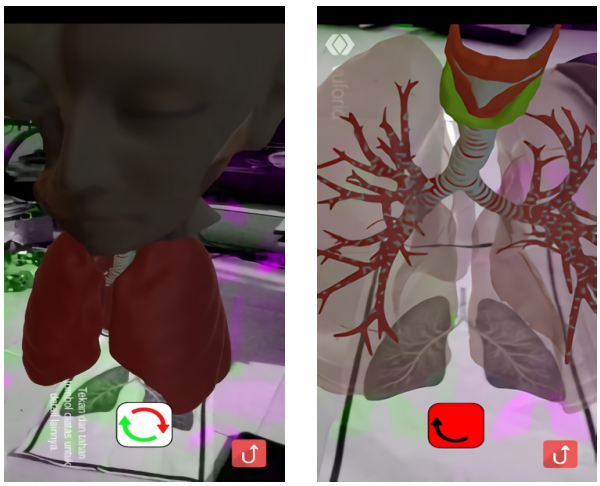

Figure 2. Content View of augmented-reality Based Multimedia

According to Figure 1 and 2, it can be known that human respiratory organ, consisting of upper and lower respiratory organs, can be observed and analyzed contextually through AR-based multimedia. The augmented reality-based multimedia was implemented during distance learning amid the COVID-19 pandemic. The learning process was implemented through online since March 2020 as the impact of COVID-19 pandemic. Therefore, various learning strategies and methods were applied to fulfil the learning aims and reach students comprehension, although they were carried virtually both in the synchronous and asynchronous ways. One of these was

implemented by having distance learning with augmented reality-based multimedia.

The developed augmented reality-based multimedia was used to improve students' scientific literacy since by utilizing this learning media in the learning process proved to make students comprehend the concepts easier (Iftene & Trandabăt, 2018). Furthermore, students can have a review of related literature on the learning environment, science learning, and components of science knowledge in which that integrates with scientific literacy (Yip et al., 2019). As it is also explained that students need to improve the scientific literacy because it is a skill that not only refers to the science knowledge but also links to understanding of scientific process and the integration between science and technology (Asrizal et al., 2018; van Rensburg, 2018).

The distance learning in this study was implemented in three virtual meetings through application of Google Classroom and Google Meet, including pre-test and post-test. The first meeting was started with pre-test to know the initial scientific literacy of students. Furthermore, the explanation of human respiratory system concepts was carried asynchronously in the form of digital sources through a platform of learning management system, and then the augmented-reality based multimedia was also shared to students during the second meeting. The third meeting was finished by having concepts review and post-test to measure the final scientific literacy on students.

As we know, education nowadays is becoming diverse, as new technologies can be easily used within the learning process as sources of learning, interaction, and communication between students to students, and students to educators (Asrizal et al., 2018; International Baccalaureate, 2020). One of the technologies that can be used in the learning activities is augmented reality (AR). AR is an interactive experience of a real-world environment in which the objects that reside in the real world (Arici et al., 2019; Uriel et al., 2020). This technology is improved by computer-generated perceptual information through the use of visual elements, sound or other sensory stimuli (Jamali et al., 2015; Tuli & Mantri, 2020).

AR is proved to provide learning environments in which students can build concept comprehension in a real-life three dimensions world (Xiao et al., 2020). By using AR, students do not get disconnected entirely from the real environment; however, they can add any objects from the real-world (Techakosit & Wannapiroon, 2015). Furthermore, through AR, educators can improve learning outcomes by increasing engagement and interactivity between teacher and students (Garzón et al., 2020). AR in education provides various aspects that can improve the learning of skills like problem-solving, collaboration, and creativity in order learners can better prepare for the future (Pujiastuti & Haryadi, 2020).

Besides, AR has the potential to change the location and timing of studying, and also to introduce new and additional ways and methods of learning (Díaz-Noguera et al., 2019). Nowadays, about 80% of teenagers use smartphones. Most of them are active smartphone users for accessing social media platforms and games (Kumari et al., 2020). In the meantime, the much lesser part of teenagers uses phones for learning. Therefore, the potential of combining smartphones and AR is essential, since AR can grant students to experience extra digital information about any scientific knowledge, and make complex information easier to comprehend.

AR-based multimedia implemented during the distance learning in this study make learners understand human respiratory organs, consisting of upper and lower respiratory organs. This media was used to fulfil the learning activities during online education. This also can catch students' learning motivation since it contains animation, sound, and three-dimension visual model of human respiratory organs. These contents would give students a broader comprehension of concepts.

It has been proved that AR-based multimedia was able to improve learners' motivation (Videnovik et al., 2020). AR-based multimedia has also been presented only in general. Therefore, this study was conducted by implementing distance learning using AR-based multimedia since it was presented in science concepts, especially in difficult concept such as a human organ system. It also can provide an effective distance learning process and improve students' scientific literacy.

Furthermore, this learning media also has skills to render objects that are hard to imagine and turn them into three-dimension models, thus make it easier to grasp the abstract and difficult concepts (Iftene & Trandabăt, 2018; Pujiastuti & Haryadi, 2020). This is important for learners to substitute the concept into a real concept. The human respiratory system is one of difficult concept that is considered as abstract content. Therefore, it is presented through augmented reality-based multimedia so that learners can comprehend the concept easily and improve scientific literacy.

Connecting the distance learning environment with AR-based multimedia to improve

students' scientific literacy is also essential to be taught during the learning process (van Rensburg, 2018; Al Mamun et al., 2020). Since by having this, students can do a review of related literature on the learning environment, science learning, and components of science knowledge (Tuli & Mantri., 2020).

Moreover, by having this learning process, students can connect to the network to share and find out new information (Layona et al., 2018; Goodsett, 2020). Then, the learners' beliefs based on new learning will be modified, and be linked to the network to share perceptions and search for new information (Kumari et al., 2020; Widodo et al., 2020). All in all, communication between distance learning and AR-based multimedia can help learners to study in an enjoyable environment.

Students' Scientific Literacy

According to the findings of pre-test and post-test by students in class A, B and C, the students' scientific literacy can be analyzed respectively. Furthermore, students' scientific literacy level and its improvement through distance learning with augmented reality-based multimedia amid the COVID-19 pandemic are figured out in Table 2 below.

Table 2. Students' Scientific Literacy Level and Its Improvement

Class	Score			Criteria
	Pre-test	Post-test	N-gain	
A	40.6	59.0	0.31	Moderate
B	47.0	67.1	0.38	Moderate
C	40.7	53.7	0.22	Low

Findings obtained from pre-test and post-test indicated that students' scientific literacy varied in class A, B, and C. The average score of pre-test reached by students in class A was 40.6, the post-test was 59.0, and the average N-Gain score was 0.31, and categorized as moderate. Furthermore, students in class B reached an average score of 47.0 on the pre-test, 67.1 on post-test, and 0.38 in N-gain score, which was categorized as moderate. However, the average score of pre-test in class C was 40.7, the score of post-test was 53.7, and the score of N-gain was 0.22, and categorized as low.

According to those findings, it can be assumed that there were differences of improvement of scientific literacy between students in class A, B, and C. Students in class A and B reached moderate improvement of scientific literacy through the implemented distance learning. Meanwhile, the scientific literacy of students in class C only increased low.

However, it can be supposed that the distance learning process with augmented reality-based multimedia in this study improved students' scientific literacy. Students experienced a new learning environment through this kind of learning process. The augmented reality-based multimedia assisted students in building new concepts easier (Arslan et al., 2020). Scientific literacy consists of various knowledge and information in which the ways of understanding the scientific concepts and scientific process are essential in analyzing problems, identifying phenomenon, and making conclusions (Sinaga et al., 2017).

Also, every learner needs to master scientific literacy covering its scientific knowledge, scientific process skill, and scientific attitudes (Sinaga et al., 2017). Every learner is also invited on not only mastering this literacy but also improving this since scientific literacy development is vital in facing and solving problems in the daily life (Tuli & Mantri, 2020; Widodo et al., 2020). Scientific literacy is essential because students can contribute and interact in society by having this literacy, also apply the scientific knowledge in making a decision and giving solutions to the problems (Rokhmah et al., 2017; Ratini et al., 2018).

Scientific literacy is a skill that refers to the scientific knowledge and links to an understanding of the scientific process and the integration between science and technology (Techakosit & Wannapiroon, 2015; Dewi et al., 2019). Scientifically literate learners can analyze problems, find answers to daily life questions, predict natural phenomena, read scientific literature, and identify scientific problems (Knain, 2015; Rusilowati et al., 2016b). They also have skills in expressing positions that are scientifically and technologically informed, gauging the value of scientific information based on its source and the methods used to create it, evaluating arguments based on facts and evidence, and applying conclusions appropriately (Fakhriyah et al., 2019; Pahrudin et al., 2019).

Moreover, scientifically literate learners would have specific knowledge, principles, attitudes, and responsiveness, along with problem-solving and higher-order thinking skills (Syawaludin et al., 2019; Lampropoulos et al., 2020). Therefore, scientific literacy is greatest perceived as a continuum along which a learner's impro-

vements, not as a finale state. This continuum has two dimensions-breadth and depth (Parno et al., 2020; Rusli et al., 2020). Breadth ranges from the recognition of vocabularies to conceptual and contextual comprehension. Meanwhile, depth involves an understanding of the scientific concepts, scientific inquiry process, and scientific skills (Rusli et al., 2020).

The results also showed that students got a low score in the pre-test, while, some of them got a better score in post-test. However, some students got the same score both in pre-test and post-test. Several factors caused the difference in the improvement of students' scientific literacy. Students varied on the way of transforming knowledge and comprehending information. Besides, the factor of learning styles and health condition during the learning process could cause the difference.

It is also found that several external factors are presumed to be the cause of low scientific literacy. The learning environments can affect learners in understanding science knowledge and concepts so that learners can inhibit higher-order thinking skills in analyzing the problems and answering the questions (Costa & Araujo, 2018; López-Faican & Jaen, 2020). Therefore, various learning strategies and methods have to be implemented to improve students' scientific literacy. Although the recent learning process is amid the COVID-19 pandemic, educators have to fulfil the effective learning situations so that learners can understand the concepts and increase their literacy skills.

During the distance learning process, learners are required to study actively and responsibly. Students can also pursue higher thinking during the online education, since it offers online learning objects with many benefits, such as plenty of information literacy information as a flexible substitute for distance learning (Glaze, 2018; Reimers et al., 2020). Furthermore, by having distance learning, students can undergo best learning practice is the most appropriate under all learning circumstances, techniques, methods through many experiences to lead to concept comprehension and literacy development (Littenberg-Tobias & Reich, 2020).

Additionally, it has been proved that online learning permits for college students to figure at a time and an area that's compatible with their learning wants (Pahrudin et al., 2019; Rusli et al., 2020). The online learning process also provides the environment to utilize their comfortable and enjoyable time and place not only those even slow learners also can fasten the concepts by repeatedly listing to the online learning sources (López-Faican & Jaen, 2020; Parno et al., 2020; Rapanta et al., 2020).

Three main interactions in online learning process have to be involved: interaction between student and content, between student and teacher, and between one student and other (Gargrish et al., 2020; Jeong & González-Gómez, 2020). However, the interaction between student and educator, and between every student may be offered at minimal levels, or even eliminated, without degrading the educational experience (Jeong & González-Gómez, 2020). It is assumed that cognitive presence or the interaction between students and content only was recognized as a critical component of both in face-to-face learning process and distance learning (Littenberg-Tobias & Reich, 2020). Whereas, the interaction between one student and others, and the communication between student and teacher are also crucial in building an effective distance learning.

Student-content interaction can stimulate a learning environment in which students can commit more to be independent and self-regulated learning (Reimers et al., 2020). Students in an online learning environment acquire a degree of independence for successful learning (Arulogun et al., 2020). The skill of learners to engage in learning by themselves is an essential factor to consider. However, educators have to ensure that students can learn actively without any mistakes and misconceptions (Jufrida et al., 2019; Primasari et al., 2020). Also, educators have to provide effective communications between one student and the others. All in all, even though the learning process is implemented through online way with the synchronous and asynchronous method, educators have to provide learning environments that can improve concept comprehension, scientific literacy, and communication.

To sum up, the online learning process is required or even desirable in order to support effective and interactive learning. Online learning provides opportunities for learners to study more independently, expand their skills, and learn to use strategies that they otherwise might not have. As the current condition, it is supposed that distance learning has to be implemented in which it is discovered that they need to be adaptive and fast-thinking in order to ensure that learning continues in a good way.

Students' Response toward Distance Learning with Augmented Reality-based Multimedia

Students shared the opinions and arguments toward the implementation of distance

learning with augmented reality-based multimedia in the aspect of the learning environment, the use of augmented reality-based multimedia in the learning process, and also the content. This response is represented in Table 3 as follows.

Table 3. Students' Response toward Distance Learning with Augmented Reality-based Multimedia

No.	Students in Class	Total percentage (%)	Criteria
1	A	89.1	Very strong
2	B	87.0	Very strong
3	C	84.8	Very strong

According to the finding of students' response toward distance learning with augmented reality-based multimedia, it indicates that students gave positive opinions toward the learning process. Students in class A gave response with a total percentage of about 89.1%, which is categorized as very strong. Class B showed a total percentage of response about 87.0% that is lower than class A. Lastly, students in class C gave the lowest total percentage, with 84.8%. However, all the total percentage from class A, B, and C are categorized as very strong responses. Those positive arguments showed that students were having fun and interactive learning, also motivated during the process. If the learning process is interesting, and then it can make it easier for students to understand the concepts. High learning motivation also can impact on concept comprehension.

Additionally, it also shows that distance learning with the augmented reality-based multimedia assisted students to understand the concepts of the human respiratory system. This learning activity also helped students to identify and solve the problems while strengthening scientific literacy. It also guided students to experience self-study by applying scientific knowledge and concepts.

Also, by implementing distance learning with the augmented reality-based multimedia, students are easy to learn actively whenever and wherever they want. Students can operate the learning sources by themselves and have a review of the concepts more than once. Length of time on learning is one of the crucial factors that can affect students' achievement (Iftene & Trandabăt, 2018). It also can improve students' motivation since they can access the learning materials that they need to study whenever, for instance, during their break time (Syawaludin et al., 2019).

Furthermore, students also can monitor and manage their learning activities by having distance learning and augmented reality-based multimedia. It shows that open online learning can help students to learn more. This links to the benefits of learning science concepts through distance learning and learning media, which can be used anytime and anywhere (Parno et al., 2020; Rusli et al., 2020).

However, it is suggested that educators need to improve the quality of the learning process and multimedia contents. This effort has to be conducted to provide more effective learning environments, improve students' scientific literacy, and overcome problems of the learning process amid the COVID-19 pandemic.

CONCLUSION

This research aims to improve students' scientific literacy through distance learning with augmented reality-based multimedia amid the COVID-19 pandemic. According to the findings of this study, it can be concluded that students' scientific literacy improved well through the learning process. However, it also showed that students in class A, B, and C got a different score of improvement in scientific literacy. Even though the students have done the same condition of the learning process, however, they have different ways to understand the concepts and transform the knowledge related to human anatomy and physiology. Also, the internal factor from every student varied, in which students have different learning styles.

Nevertheless, the students have experienced new learning environment through this kind of learning process. They gave a positive response toward the learning since they argued that the learning process was new and interactive for them. Therefore, it can be assumed that the distance learning with augmented reality-based multimedia could improve the students' scientific literacy well. Besides, it is suggested that the learning process should be conducted more effectively and continually. Lecturers also should provide interactive learning media in order that students can understand the concepts well.

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