Instrument of Augmented Reality Technology Based Biology Practicum: Psychometrics Analysis

Abstract

Digital literation skills are student's need in nowadays modern era to refine the information accurately as an education media. Supporting the digital literation is by using the proper application by applying augmented reality (AR) technology. The purpose of the research is to analyze an implementation of AR technology as an effort to improve student's digital literation skill in Surabaya senior high schools. The method of the research is quantitative with around 500 respondents that consist of students form three non-government senior high schools in Surabaya, Indonesia. The instruments validation to measure student's acceptance towards AR technology as a teaching media is unexplored yet. This study is to evaluate the questionnaire about AR technology towards digital literation skill. The questionnaire consists of 10 items by google form and sent by online to 500 students in Surabaya. The data is processed by statistics with data analysis using Exploratory and Confirmatory Factor analysis. The whole average scores of questionnaires point that analyzed descriptively around, 60 and 2.63 with deviation standard 0.52-0.77. The scores of Pearson correlation by the whole items is around 0.08 and 0.35. The measurement of sample fairness using Kaiser-Meyer-Olkin (KMO) analysis generate 0.796 (Primely). This study identified three dimensions of total variation explains 51.28% from 10 items. The whole items generate factor loading score 0.5. However there are 2 items that eliminated that is item 1 and item 2.

Keywords: augmented reality technology, biology practicum, digital literation skills, psychometric analysis

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INTRODUCTION

The deliver of learning in senior high school is still using learning media that deliver by the teacher directly (Lindner et al., 2019; Martín Gutiérrez et al., 2015). The deliver of theory is classified into undeveloped because less of using digital literation use (Bursali & Yilmaz, 2019; Joda et al., 2019). Nowadays, the improvements of information and communication technology (ICT) is running fast and become all people needs. The role of information and technology is very affected for education(Arici et al., 2019; Fidan & Tuncel, 2019; Yip et al., 2019). The information technology nowadays is very helpful for students, because not only direct meeting to gain a knowledge but also could access the internet to gain an easy appropriate theory (Anderson et al., 2021; Sahin & Yilmaz, 2020). The existence of technology is give an advantages as a space of learning that could applied effective and efficiently in learning implementation and simplify the students to gain the aims of learning (Farrow, 2019; Garzón et al., 2020; Oranç & Küntay, 2019).

In nowadays globalization era, the improvements of ICT had spread in public. The improvements of information technology recently is growing rapidly and almost be spread evenly in whole aspects, especially in education aspects (McCarthy & Uppot, 2019; Roopa et al., 2020; Theodoropoulos & Lepouras, 2021). The improvements of science and technology, especially information technology is very influence towards composing and implementation of learning strategy (Aslan et al., 2019; Harun et al., 2020; Liagkou et al., 2019). Through the improvements, the teachers could use various media in accordance with the needs and aims of

learning (Blevins, 2018; El Sayed et al., 2011; Joda et al., 2019). The use of media not only simplify and make the learning process effective, but also make the learning process more interesting (Arulanand et al., 2020; Liono et al., 2021). At the moment the use of learning media in teachers, especially information and technology based learning media is show the significance improvements (Hincapie et al., 2021; Venkatesan et al., 2021; Zhou et al., 2020; Omurtak & Zeybek, 2022).

Improvements of technology in biology practicum is growing rapidly, in the beginning the process of learning is only implement with textbook, the students only understand the theory by read a book (Farshid et al., 2018; Lee & Lee, 2018; Weeks et al., 2021). Even though the pictures in the book is not make the students understand the theory by the teacher directly (Cai et al., 2014; Georgiou & Kyza, 2018; Yilmaz, 2016). Then learning biology is identically with practicum so that it is need a laboratory as a student's practice space in learning biology. The conventional practicum of biology is needs a long time relatively so that could not implement in short time, especially about structure and function of animals anatomy etc (Blevins, 2018; El Sayed et al., 2011; Wojciechowski & Cellary, 2013). Therefore biology practicum based learning is need a relevant media in accordance with the student's cognitive competence that is using augmented reality (AR) technology (Boeriis, 2021; Danaei et al., 2020; Huang et al., 2016).

AR technology is the innovations in interaction aspects that use in recent days. The use of technology is helpful to simplify the delivery of information to the users (Cascales et al., 2013; Ke & Hsu, 2015; Poretski et al., 2021). AR is technology that combine between the real world and cyberspace (Diaz et al., 2015; Sannikov et al., 2015). AR has three characteristics, namely combination between real and virtual world, the real time interactions, the 3D object. The form and data of augmented reality is could be location data, audio, video or 3D animation model form (Iftene & Trandabăt, 2018; Layona et al., 2018; B. Sharma & Mantri, 2020). In general, the component that needed in augmented reality production is computer, marker and the last one is camera (Fonseca et al., 2013; Gargrish et al., 2020).

AR is a technology that could become a problem solving of education world (Kysela & Štorková, 2015; Perry, 2015; Weng et al., 2013). AR is a technology in the form of application that combine the real world and cyberspace in two or three dimension that projected in real time and real environment (Alalwan et al., 2020; Jamali et al., 2015; Techakosit & Wannapiroon, 2015). Augmented reality is frequently called as an obstructed reality. Because it is enhance an cyber object to the real object in real time (Loureiro et al., 2020; R. Sharma et al., 2016). The available of augmented reality could be the solution for science learning problems especially to show the learning object in the class due to make the more interactive and effective learning (Alabdulaziz, 2022; Cao et al., 2021; Lopez et al., 2021). Augmented reality could be implement extensively in various media, easy to operate and less cost production make augmented reality (AR) become the solution of learning media in new habit adaptation (Anđić et al., 2022; García et al., 2022; Go, 2022).

Based on the elaboration above that practicum of biology has an important role in learning process, because it could applying the theory in real (Liu et al., 2015; Prit et al., 2020). The obtained principles in learning theory could be review in practicum. Similarly with the development of skills may build knowledge, problem solving, critical thinking and answer recognizing (Law & Heintz, 2021; Lindner et al., 2019). Biology practicum based Augmented reality (AR) technology learning is an alternative fun learning for students due to more effective without preparing with heavy capital in implement biology practicum (Joda et al.,

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2019; Martín Gutiérrez et al., 2015). it is very recommend for teachers to use the media to improve the learning result of students (Arici et al., 2019; Fidan & Tuncel, 2019; Yip et al., 2019). In others, with augmented reality technology media it is help the students to remember and organize the information about whole learning materials and it is easy to understand (Garzón et al., 2020; Sahin & Yilmaz, 2020). Based on the elaboration to recognize the use of AR is significance affected towards student's critical thinking (Cao et al., 2021; Hincapie et al., 2021).

In practicum of biology, it is ideally to implement several types of experiment and practice by mastery of laboratory tools (Anderson et al., 2021; Farrow, 2019; Oranç & Küntay, 2019). However, the students has short time while the practicum be held with limited of teachers, so that the understanding process of practicum is also limited (Hincapie et al., 2021; Weeks et al., 2021). Therefore the AR is expected to simplify the teachers to deliver the practicum theory so that the learning process become more interesting (McCarthy & Uppot, 2019; Theodoropoulos & Lepouras, 2021). Therefore the learning media become one of the right alternative media to deliver the biology practicum theory that considered as a difficult theory so that it can be understand by students easily (Aslan et al., 2019; Liagkou et al., 2019; Roopa et al., 2020). The practicum learning not only deliver by watching but it must be could to integrate with the developments of science and technology (Arulanand et al., 2020; Harun et al., 2020).

Augmented reality technology media show complete observation picture with the description about the parts, and picture with interesting display, animation, video and others that show as if in real world (Blevins, 2018; Bursali & Yilmaz, 2019). Therefore it could make the students more creative, active and the student's understanding about the theory better, it is could improve the learning result of students (Liono et al., 2021; Venkatesan et al., 2021; Zhou et al., 2020). By sing augmented reality, it helps to make the practicum learning of biology nowadays is easy to gain, more efficient and easy access by students (Boeriis, 2021; Oranç & Küntay, 2019). The media is a combination between two or three dimensions virtual things to the real environment, and three dimensions to project the virtual things to the real forms (Hincapie et al., 2021; Weeks et al., 2021). Virtual reality is not entirely change the real world, however an augmented reality only enhance and complete the ungained yet about real world (Farshid et al., 2018; Lee & Lee, 2018; Moro et al., 2021).

With the augmented reality someone could gain the sensation of exploring and learning with the fun and unique way because involved in the learning process directly (Cai et al., 2014; Georgiou & Kyza, 2018; Yilmaz, 2016). Biology practicum learns a lot about the human body that students need to know, namely about the structure and function of the human body, especially in blood circulation (Blevins, 2018; El Sayed et al., 2011; Wojciechowski & Cellary, 2013). This study was to determine the conditions of learning biology during the adaptation period of new habits. Knowing the role of AR technology as a fun biology practicum learning media solution (Boeriis, 2021; Huang et al., 2016; Ke & Hsu, 2015). Implementation of AR as an alternative solution for learning media that is more effective and efficient without having to require a relatively long time like conventional biology practicum (Cascales et al., 2013; Poretski et al., 2021; Sannikov et al., 2015).

METHODS

Literature Review and Formulation of Question Items

Literature review and formulation of items in this step, the literature works about

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Augmented reality (AR) is collect by google form that submitted to the researchers related with the improvements of technology through learning media augmented reality implementation based on biology practicum due to improve student's digital literation skill. The augmented reality technology is a technology that could become solutions about problem in education aspect, especially about biology practicum process that need research materials and tools that has a relatively expensive price. The literature review generates the questionnaire about augmented reality learning media that consist of 10 items such as show on table 1. The 10 items are divided into five positive items and five negative items. Each question has 4 answer choices, that are "Very Agree", "Agree", "almost disagree", "disagree"

Table 1. Set of Items and Points in questionnaire

Item number	Statements
1	Augmented reality as interactive learning media for teaching biology practicum
2	Augmented reality technology as learning media could be implement without space and time limitation
3	Terms and language in augmented reality is more communicative and easier to understand
4	Display design of android based augmented reality technology is more interesting and simplify the biology practicum
5	3D picture can delivers new knowledge in the form of digital literation.
6	The instruction for use the augmented reality technology is clearly delivers without vagueness
7	Augmented reality could be operates easily without difficulty
8	Augmented reality improving student's digital literation towards electronics components
9	Augmented reality technology helps students to recognize about practicum tools and materials without bring in directly
10	Augmented reality improve student's spirits to learns about biology practicum

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Instrument Trials

Respondents of the research are students of senior high school in Surabaya private and public senior high school students. Data collection is using online survey. The implemented survey in the research is using google form in accordance to the clause of questions items that provided by the researchers. The minimum targets of respondents that expected by the researchers is 500 students. Then numbers of respondents have completed the minimum limitation that need to apply factor analysis.

Data Analysis

The questionnaire that provides is not on a known dimension, therefore it is still being develop. Therefore, exploratory factor analysis (EFA) is need to identify the dimensions and valid questionnaire item. The Kaiser Meyer Olkin (KMO) test to measure the our sample research adequacy. Then, the Bartlett sphericity test is applied to certain not an identity matrix. Finally, items with a factor loading < 0.5 should be removed. For further analysis, all items that were maintained were analyzed using confirmatory factor analysis (CFA). Then the

analysis was carried out to test the fit of the dimensions. Model measurement is done with statistics obtained from goodness of fit (GOF). Items that have a standard regression weight (λ) of 0.5 are omitted.

RESULTS

Descriptive Statistics

The average value of the items that have been analyzed descriptively is between 1.60 and 2.63 with a standard deviation of 0.52-0.77. None of the items has a standard deviation of 2.5, meaning that all items are eligible. In addition, the results of Pearson correlation analysis showed score between 0.08 and 0.35. It was found that one item was omitted. The other items are significant because the correlation value still meets the requirements, which means that the results of the statistical descriptive are lower than 0.80.

Exploratory Factor analysis (EFA) and Confirmatory Factor Analysis (CFA)

EFA and CFA through measuring the adequacy of the research sample using the KMO involving 500 respondents distributed to high schools throughout the city of Surabaya resulted in 0.796 (good). Bartlett's test resulted in 2 (45) = 2815,094, $p < 0.000$, meaning that the data can be continued into further analysis. While the results of the EFA analysis describe three dimensions of a total variance explaining 51.28% of the other 10 items. All items resulted in a factor loading value of 0.5, but from 10 items there were 2 items that were eliminated. While the anti-image correlation is more than 0.5 consisting of item 1 = 0.077, item 2 = 0.81, item 3 = 0.80, item 4 = 0.83, item 5 = 0.82, item 6 = 0 .59, item 7 = 0.78, item 8 = 0.75, item 9 = 0.87 and item 10 = 0.59. Then in detail, with a summary of the results of EFA can be presented clearly in table 2 below, among others, namely:

Table 2. EFA Questionnaire of about AR for Biology Practicum Teaching

Dimension	Items	Component		
		1	2	3
Dimension 1	Item_5	0.827		
	Item_10	0.728		
	Item_4	0.681		
	Item_3	0.670		
Dimension 2	Item_2			
		0.561		0.531
	Item_7		0.829	
	Item_8		0.808	
	Item_6		0.725	
Dimension 3	Item_9			
			0.781	
	Item_1			0.849
			0.898	

From the analysis of the analysis questionnaire about augmented reality (AR) exploratory with this rotated component matrix to determine the variables that will enter the specified factor. Determination of which factor enters the variable is determined by looking at

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the largest correlation value. Item 5 has the largest correlation with factor 1, which is 0.827, as well as item 10 factor 1, which is 0.728, item 4 factor 1 is 0.681, and item 3 factor 1 is 0.671. In item 2 removed because 1 item in 1 factor. Then item 7 factor 2 is 0.829, item 8 factor 2 is 0.808, item 6 factor 2 is 0.725 and item 9 factor 2 is 0.781. While item 1 is deleted because 1 item is in 1 factor.

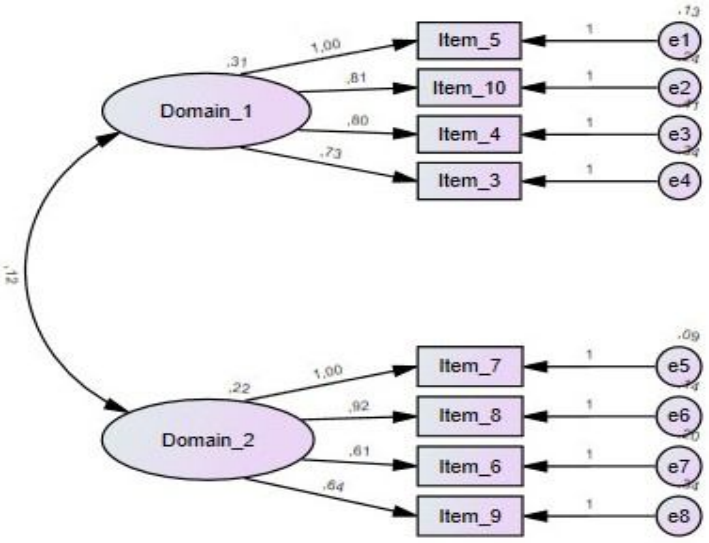

Figure 1. Correlation model that generates by confirmatory factor analysis (CFA)

Based on the picture above the readers could recognize that the variables between augmented reality (AR) technology instruments towards digital literation be found 10 indicators that are item 1-7, item 8, and item 10., item 1. Among the whole indicators there are 2 invalid indicators that are item 2 and item 1. Only 8 valid indicators that are item 4, item 5, item 7, item 8, item 6, item, item 9, and item 10.

Table 3. Consistency Internal of Questionnaire

Dimension	Items	Λ	Criteria		
			CR	AVE	α
Dimension 1	Item_5	0,827			
			0,90	0,70	0,80
	Item_10	0,728			
	Item_4	0,681			
	Item_3	0,670			
Dimension 2	Item_7		0,88		
		0,829		0,65	0,76
	Item_8				
		0,808			
	Item_6				
		0,725			
	Item_9				
		0,540			
Total					0,78

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To evaluate the validity of the discriminant, it can be perform the AVE (Average Variance Extracted) analysis for each construct or variable. Based on table 3 above, it shows that the AVE value for all constructs has a lambda > 0.50. Therefore, there is no convergent validity problem in the model being tested. While CR (Composite Reliability) measures the real reliability value of a variable, while Cronbach Alpha measures the lowest value (lower bound) of the reliability of a variable so that the CR value is > 0.6 and the Cronbach Alpha value is > 0.60. CR values for all constructs are above 0.60. Therefore, it can be concluded that all constructs have good reliability.

DISCUSSION

The use of conventional media in biology practicum is difficult to provide convenience to students' understanding quickly and effectively (Lindner et al., 2019; Martín Gutiérrez et al., 2015). In this era, learning requires innovative media and makes it easier to empower students' digital literacy skills (Bursali & Yilmaz, 2019; Fidan & Tuncel, 2019; Yip et al., 2019). Thus, it shows that this research is very important to do in an effort to improve students' digital literacy (Arici et al., 2019; Sahin & Yilmaz, 2020). In this case, it is necessary to develop a good instrument to be able to measure the level of student confidence in using Augmented Reality (AR) technology (Anderson et al., 2021; Farrow, 2019; Garzón et al., 2020). Therefore, this research examines an instrument that measures respondents' confidence in AR using psychometrics analysis (Oranç & Küntay, 2019; Theodoropoulos & Lepouras, 2021). The results showed that all items had met the standard deviation, there were only two that had an insignificant correlation. After eliminating the items, an EFA was performed to determine the dimensions.

The results of the Exploratory Factor Analysis (EFA) revealed that 8 questionnaire items had loading factors that met the requirements, but two items were omitted without not meeting the requirements. Then, it is categorized into three dimensions. The first dimension consists of five items that indicate the level of acceptance of respondents towards Augmented Reality (AR) technology. The second dimension consists of four items that state digital literacy skills using Augmented Reality (AR). The three dimensions contain one item that represents the respondent's level of trust in educators who use Augmented Reality (AR) technology learning media. After giving EFA, CFA was conducted to determine the level of GOF on the proposed model. On the one hand, the correlated model produces a GOF value

Therefore, the first and second dimension remains four items. The instrument developed in this research will be useful as a data collection tool in the future related to research that tests respondents' beliefs in the implementation of Augmented Reality (AR) technology in empowering high school students' digital literacy (Liagkou et al., 2019; McCarthy & Uppot, 2019; Roopa et al., 2020). Future research, especially in biology practicum learning, requires more effective media without having to prepare relatively expensive tools and materials in conducting practicals (Aslan et al., 2019; Harun et al., 2020). The sophistication of information technology as it is today is needed to make it easier for students to learn, especially in practical learning. Students need facilities that can improve their digital literacy skills or skills (Arulanand et al., 2020; Liono et al., 2021; Zhou et al., 2020).

The habit of empowering students' digital literacy can make students more adaptable to the current developments in science and technology (Cai et al., 2014; Farshid et al., 2018; Venkatesan et al., 2021). Learning using Augmented Reality (AR) technology has an impact on students' digital literacy (Georgiou & Kyza, 2018; Yilmaz, 2016). This is because, through

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learning media, Augmented Reality (AR) technology can visualize abstract concepts to understand and the structure of an object model, as well as provide a more attractive appearance through application features (Blevins, 2018; El Sayed et al., 2011). Then this technology learning media as a more effective media in accordance with the objectives of learning media that can increase students' enthusiasm for learning and digital literacy. The success of the application of Augmented Reality (AR) technology can also be seen from the activities of students in participating in learning (Huang et al., 2016; Wojciechowski & Cellary, 2013). This is because in participating in the learning process, most students participate well in conducting practical learning (Boeriis, 2021; Danaei et al., 2020; Ke & Hsu, 2015).

Augmented Reality technology learning media is useful for students because it makes students more active in the learning process and easily understands the biology practicum given by the teacher (Cascales et al., 2013; Poretski et al., 2021). Student activity in the learning process can help improve students' digital literacy (Diaz et al., 2015; Iftene & Trandabăt, 2018; Sannikov et al., 2015). In accordance with the theory put forward by (Layona et al., 2018) which states that Augmented Reality (AR) technology learning media can be accepted by all students, and is considered capable of being used as well as possible in learning biology practicum at school (Fonseca et al., 2013; Gargrish et al., 2020; B. Sharma & Mantri, 2020). Then Augmented Reality (AR) technology has good sustainability for use in the long term in the future according to use in the learning scope (Kysela & Štorková, 2015; Weng et al., 2013). The use of Augmented reality (AR) technology learning media is also a pleasure for students because it makes learning more active and effective (Jamali et al., 2015; Perry, 2015; Techakosit & Wannapiroon, 2015).

Augmented reality become the one of new innovation that use in recent days in biology learning aspect (Alalwan et al., 2020; Loureiro et al., 2020). The use of AR is very helpful in deliver information to the students easily and effective (Cao et al., 2021; Lopez et al., 2021; R. Sharma et al., 2016). AR is combining the real and virtual world for students. In AR there are three based characteristics that are combination between real and virtual world, real time interactions, and the last characteristic is an object in the form of 3 dimension or 3D (Alalwan et al., 2020; Weng et al., 2013). The form of data in augmented reality could be data location data, audio, video in the form of animation or 3D. generally the components that need in making augmented reality firstly is computer or laptop, second is marker and the last is camera (Kysela & Štorková, 2015; Loureiro et al., 2020).

AR allows perspective to be enriched by displaying virtual objects are part of the real world (Anđić et al., 2022; Go, 2022; Loureiro et al., 2020). AR is a crossover between the real and virtual worlds. The methods developed in augmented reality are currently divided into two, namely, Marker Based Tracking and Marker less Augmented reality (García et al., 2022; Liu et al., 2015; Lopez et al., 2021). The results of implementing the use of AR media in biology practicum learning show that the AR media developed is quite effective in helping students understand the concept of the nervous system (Cao et al., 2021; Go, 2022; Prit et al., 2020). In the opinion of (García et al., 2022) one of the factors that makes students interested in researching biology using AR is the use of 3D animation to make it easier for students to visually represent the biology practicum. complex becomes easier to describe visually (Alalwan et al., 2020; Law & Heintz, 2021; Lopez et al., 2021).

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CONCLUSION

Based on the production that conduct through augmented reality (AR) technology learning media, based on biology practicum in empowering student's digital literation skill, it could be concluded that using 10 validations instruments that implemented to measure the students trustworthiness for using augmented reality in biology practicum learning process. The instrument at the initial stage consists of 10 items with statements that are in accordance with students' understanding.

In the analysis process the validation process EFA and CFA. Measurement of sample adequacy using KMO of Sampling Adequacy involving 500 respondents resulted in 0.796 (good). The Bartlett test resulted in 2 (45) = 2815,094, $p < 0.000$, indicated that the data can be continued for further analysis. While the results of the EFA describe three dimensions of a total variance explaining 51.28% of the other 10 items. All items resulted in a loading factor of 0.5, but there were 2 items that were eliminated. So, from the results of the validation of this instrument as a first step to give a positive response to students in AR. The results of observations through this research by distributing questionnaires to students became the basis for reformulating learning media that could facilitate students in facing the digital era.

Limitation

We did not reach the stage of implementing the instrument by using several variables but rather developing the instrument and giving it to students as respondents. Therefore, others researchers to continue studies or analyzes into aspects of instrument implementation according to relevant topics.

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