Integrating Local Wisdom Forms in Augmented Reality Application: Impact Attitudes, Motivations and Understanding of Geometry of Pre-service Mathematics Teachers'

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Abstract—Many studies are related to the use of augmented reality in the process of learning geometry. However, not many people have integrated the local wisdom forms into the augmented reality application. Therefore, the focus of this study is to implement geometry learning that integrates local wisdom forms in Augmented Reality (AR) applications and analyze their impact on learning attitudes, learning motivations and understanding of geometry material concept of pre-service mathematics teachers. The participants of this study consisted of 24 Pre-service Mathematics Teachers. The instruments used were a questionnaire of attitude and learning motivation, tests of geometry material concept understanding and semi-structured interviews. Research findings show that learning geometry that integrates local wisdom forms in the AR application has a positive impact on attitudes, motivation, and understanding of the geometry material concept of pre-service mathematics teachers.

Keywords—Learning Attitudes, Learning Motivations, Local Wisdom Forms, MAR Application, Understanding of Geometry Concepts

1 Introduction

The development of information and communication technology (ICT) which continues to increase in the middle of society becomes its own challenge, especially in the field of education[1]. Use of ICT, such as Edmodo [2], GeoGebra [3], dynamic geometry program [4], sketchpad [5], augmented reality [6] have been used to help the process of Geometry learning in schools or universities. Augmented Reality is one technology mostly used in learning [7],[8] especially math learning [9],[10] for decades.

Since it was first introduced in the 1990s, the presence of AR technology provides another alternative in the learning process. Characteristically, AR technology can bridge virtual objects and the real world, the existence of user interaction with virtual objects directly and identify real objects accurately [11]. The benefits of AR technology can grow kinaesthetic, increase understanding of the material, increasing motivation and involvement of students in learning [8]. In addition, although the use of AR technology has been widely used in learning geometry, not much research has integrated local wisdom forms into AR technology to help pre-service mathematics teachers understand geometry. The Integration is limited in using AR technology to study Indonesian "Batik" in Vocational Schools [12], and introducing traditional house forms[13].

Therefore in this study, the AR application developed allows users, especially pre-service mathematics teachers to interact with objects in local wisdom forms and construct them to understand geometrical concepts. These local wisdom forms are used as markers and 3D animation objects. The 3D object of this form of local wisdom represents the existing geometrical concepts in that local wisdom forms. Besides that, the menu in AR application is designed to deepen the concept of geometry and measure the understanding of geometry concepts. Therefore, in broad outline this research applies augmented reality-based learning that is integrated with local wisdom forms and analyzes the impact of its use on learning attitudes, learning motivations and understanding the geometrical concepts of pre-service mathematics teachers.The specific research questions examined in this study are as follows:

- Does the integration of local wisdom forms into AR applications in the learning of geometry have a positive effect on the attitude of the learning pre-service mathematics teachers?
- Does the integration of local wisdom forms into AR applications have a positive impact on learning motivation of pre-service mathematics teachers?
- Does the integration of local wisdom forms into the AR application on learning geometry have a positive impact in improving the understanding of geometry concept of pre-service mathematics teachers?

2 Theoretical Background

2.1 Local wisdom

Local wisdom is one source of knowledge [14] in the form of cultural heritage, social norms, customs and values [15]. Local wisdom is important because it is related to real life and can be linked to the learning process [16]. Besides, local wisdom provides an alternative in bridging students to understand the concept of contextual material [17]. Many studies that integrate local wisdom in the learning process such as [18], integrate the values of local wisdom into the Indonesian curriculum, [19] integrate the values of local wisdom in the learning model and [20] into problem-based learning.

In addition to local values, there is also cultural heritage that is still maintained. The forms of cultural heritage are a traditional house, house of worship, a tool for calling worship "drum", traditional games, traditional food and so on. Therefore, the local wisdom form is defined as the representation of the forms of cultural heritage that are still maintained until now. The representations of local wisdom in this study are chosen from the local wisdom forms that resembled geometric shapes such as Wa Rebo traditional houses, East Nusa Tenggara, Indonesia. Wa Rebo traditional house in a conical shape. Look at picture 1.

Fig. 1. Wa Rebo Traditional House

2.2 Augmented reality (AR) in learning geometry and its impacts

AR is one of the important technologies for enhancing the experience of interacting with reality [21] and allows users to see additional reality through virtual objects superimposed on the real world [11]. The use of AR, especially in education, gives a new color to the process of learning interaction. Besides, the use of AR provides benefits for teachers and pre-service mathematics teachers to create an effective learning process [22]. AR characteristics bridge the abstract concepts of geometry to geometrical objects in real life. Virtual objects through the AR interface help the teacher to visualize 2D and 3D geometry objects and to understand the geometrical properties of geometry [23]. AR integration into the geometry learning process can be done through a geometry material tutorial system that helps the users to learn and improve the ability to understand geometry concepts [24]. The understanding that can be improved such as the ability determines the cube webs, surface area and volume of the cube [25].

Besides, 3D virtual geometry objects can be created into AR technology. This allows AR technology to be used to help the learning process of geometry, especially 3D geometry and indirectly affects the ability of visual spatial abilities. According to [26], AR technology can help in the process of visualizing and rearranging 3D objects into the mind. In addition, AR technology used in the geomertical learning process to makes it easy for students in understanding the concept of three-dimensional geometry objects because they can rotate three-dimensional objects freely and see the three-dimensional objects more easily from various points of view [27].

Another impact of the use of augmented reality is related to attitudes and learning motivation. According to [28], the results of his research reported the positive impact of AR applications on student learning attitudes. It is because AR applications provide an active and interactive learning environment [28]. A positive attitude toward AR can be explained by the increased interest and motivation generated by the use of AR [28]. Related to learning motivation [29], his research reported that augmented reality technology has a positive impact on the motivation of secondary school students. In terms of four motivational factors (attention, relevance, self-confidence, and satisfaction), motivational factors (attention and satisfaction) in an augmented-reality based learning environment are considered better than those obtained in a slide-based learning environment [29]. The same thing was expressed by [30] stating that students who study with augmented reality-based mobile learning approaches show significantly higher motivation in the dimensions of attention, self-confidence, and relevance than those who study with conventional inquiry-based mobile learning approaches. That is because the characteristics of AR-based mobile learning are interesting and useful to help them in learning activity [29], being able to explore material content in depth makes students' motivation increase when compared to conditions before students use AR [30].

3 Methodology

3.1 Participants

24 pre-service mathematics teachers (aged 18 to 21 years, Average (M) = 19, Standard Deviation (SD) = 1.18) from a mathematics education study program at one of the universities in Indonesia, volunteered to participate in this research. Pre-service mathematics teachers who participated were 6 (25%) male and 18 (75%) female.

Before the study began, the author had a meeting with twenty-four participants. The author explains the purpose of the study and shares the informed consent form to them. The author asked them to carefully read the form and sign with ensure that all data will be kept confidential for research purposes. They agreed to sign the consent form as a legal document for their participation in this study. They also have the right to withdraw from research.

3.2 Research instruments

Instruments of learning attitudes and learning motivation are given at the end of the seventh meeting after learning. Learning attitude questionnaire was adopted from Díaz Noguera, et al [50] for its appropriateness of the aspects assessed; relevance, satisfaction, reliability. The questionnaire consisted of 23 statement items from a 5-point interval Likert scale. In addition, for the learning motivation questionnaire using a questionnaire created by Ángela Di Serio, et al [47]. That is because aspects of learning motivation namely attention, relevance, confidence, satisfaction present learning motivation after using AR. A total of 36 statement items from the question scale in four dimensions were used and assessed using a 5-point Likert Interval scale.

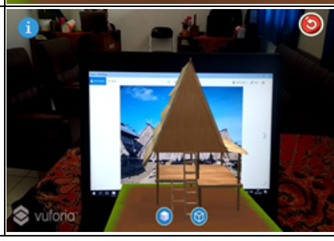
Test understanding of the concept of geometry material is given before (pre-test) and after learning (post-test). The test of understanding the concept of material geometry in this study consists of 20 questions with indicators that define the concept of the geometry of fields and spaces, able to distinguish geometry of fields and spaces based on properties, determine the webs of geometric shapes, determine the surface area and volume of geometric shapes. The lowest score from the test results is 0 and the maximum score is 100. The participants were given 60 minutes to answer the questions. The pre-test and post-test instruments were developed by two lecturers of field and space geometry who have teaching experience for 8 years.

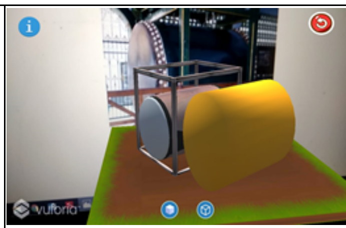
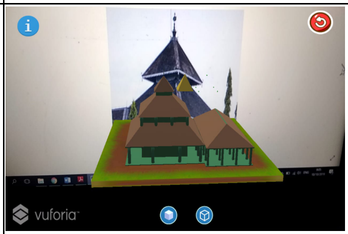
The interview aims to explore in depth information about the use of integrated learning of local wisdom forms into the AR application. Semi-structured interviews were conducted by recording the opinions of pre-service mathematics teachers for 7 meetings. Examples of interview questions such as: "what are the obstacles faced when using integrated learning of local wisdom form in AR application", "What are the benefits of using integrated learning of local wisdom forms in an AR application".

3.3 Procedure

This research uses a quantitative approach to a quasi-experimental design, which uses a one-group pretest-posttest design. The experiment lasted for 7 weeks in the even semester of the academic year 2018-2019 weighted three SKS (Semester Credit System) which is 8 hours per week. Before starting the study, the user is given a pre-test of geometry concept understanding (TPKMG). After 7 weeks, pre-service mathematics teachers were given a post-test of TPKMG and attitude, motivation questionnaire. After the post-test, a semi-structured interview was conducted to dig deeper information related to the implementation of local wisdom forms integrated into the AR application in learning geometry.

The process of integrating local wisdom forms lies in the design of markers and 3D animation objects.

The form of local wisdom	The integration in local wisdom	The Integration in 3D animation
Traditional House of Baduy from Province of Banten, Indonesia		
Traditional house of Lengge from West Nusa Tenggara (NTB), Indonesia.		

Beduk, a tool to summon to prayer, from Java Island, Indonesia		
The roof of the great mosque of Demak, from Central Java Province, Indonesia.		

3.4 Usage activity

Firstly, the user chooses the topic of geometry and its relevance to local wisdom. They launch the android and direct to the object of local wisdom marker that has been selected.

Secondly, the users understand the chosen geometry concept by clicking the button “Let’s play AR”.

Thirdly, the users will be deepening the concept of gemetro which later will be chosen by clicking the button “let’s learn geometri”.

Fourth, the user's understanding about geometry concept will be measured.

3.5 Data analysis

Data obtained from the results of the learning attitude questionnaire and learning motivation were analyzed statistically descriptive. This was done to obtain a standard score for attitude and motivation after learning. Next, the mean and standard deviation are seen to see the impact of lessons that integrate the form of local wisdom in the AR application. While the analysis of data from the results of pre-test and post-test using parametric test, paired sample t-test.

4 Results

4.1 Learning attitude

Learning attitude questionnaire given in this study adopted 5-point Likert Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The three aspects indicate learning attitudes; Relevance, Satisfaction, and Reliability. In the aspect of relevance, there are nine questions, the satisfaction aspect there are 9 decisions and the reliability aspect there are 5 agreements. The total number of questionnaires were 23 questions; there were 16 positive questions and 7 positive questions. The summary is given in the following table.

Table 1. The result of learning attitude questionnaire

	N	M	SD
Overall	24	4.47	0.62
Relevance	24	4.43	0.66
Satisfaction	24	4.56	0.51
Realibilty	24	4.39	0.71

The overall average score is 4.47, or close to the maximum score. Based on the average score, the relevance score is 4.43, indicating that learning geometry by integrating local wisdom forms in AR application relevant to the needs of pre-service mathematics teachers and can be used properly and correctly. Besides, the average satisfaction score is 4.56, indicating that preservice mathematics teachers are very satisfied and enthusiastic about learning that integrates local wisdom forms in AR applications. Furthermore, the average relibilty is 4.39, indicating that teaching that integrates local wisdom forms in AR applications is can develop capabilities in technology.

4.2 Learning motivation

The motivation questionnaire was given after learning activity. This questionnaire adopted 5-point Likert Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The four aspects indicate learning attitudes; attention, relevance, confidence, satisfaction. In the attention aspect, there are nine questions, in the relevance aspects there are nine questions, in the confidence, aspects there are 9 questions and in the satisfaction aspect, there are 9 questions. Note Table 2 summarizes the findings from the results of the learning attitude questionnaire.

Table 2. The Result of Learning Motivation Questionnaire

	N	M	SD
Overall	24	4.74	1.75
Attention	24	4.66	0.49
Relevance	24	4.72	0.46
Confidence	24	4.78	0.44
Satisfaction	24	4.81	0.39

The overall average score is 4.47, or close to the maximum score. The average score of attention is 4.66, indicating that pre-service mathematics teachers pay attention during learning by integrating local wisdom forms in AR applications. The average relevance score is 4.72, indicating that learning by integrating forms of local wisdom in AR applications fulfills the need of pre-service mathematics teachers learning. The average confidence score is 4.78; indicating learning by integrating local wisdom forms in AR applications makes Pre-service Mathematics Teachers have the confidence to work on learning tasks. The average satisfaction score is 4.81, indicating that pre-service teachers of mathematics are very satisfied and passionate about learning that integrates forms of local wisdom in AR applications.

4.3 The understanding of geometry concept

The geometry concept-understanding test was given before and after learning activity. Based on the results of calculations with SPSS 21 obtained an average of pre-test is 52.58 and an average post-test 59.63 and a standard deviation of pre-test 9.37 and post-test 9.472.

Table 3. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	52.58	24	9.376	1.914
	Post-Test	59.63	24	9.472	1.934

Based on table 3, descriptively it is seen that the average pre-test is smaller than the average post-test. This indicates that there is an impact on the use of immigrated learning in local wisdom form in the AR applications. However, to prove whether the impact is significant or not, we need to interpret the results of the paired sample t-test contained in table 4.

Table 4. Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				
					Lower	Upper			
Pair 1	Pre-Test – Post-Test	-7.042	7.681	1.568	-10.285	-3.798	-4.491	23	.000

Based on table 4 it is found that the sig (2-tailed) value is 0,000 <0.05, it can be concluded that there is a significant impact on the average understanding of geometry concepts after learning that integrates local wisdom forms in AR applications.

4.4 Interviews

The interview process was conducted with 2 (two) pre-service mathematics teachers female and 1 (one) male about the experience of learning in using the integration of local wisdom forms in AR application. The Pre-service mathematics teachers give positive opinions. This indicates that the majority of pre-service mathematics teachers like IT-based learning, especially based on augmented reality. Most of them said that learning based on Android and utilizing the internet in completing learning tasks was more modern, interesting, and not boring. Some examples of pre-service mathematics teachers' opinions are as follows:

PT01: *"In my opinion, the augmented reality application is already quite good and sophisticated, because it is the latest technology in learning media, especially mathematics, with this media students understand more and are able to see visible forms (three dimensions) without imagining while in written form of questions the information was only about length and width (two dimensions)."*

PT02: *"In my opinion with this augmented reality application students will make more use and value their cellphones in learning, so the parents and teachers will indirectly be easier to supervise the use of mobile phones for junior high school students in particular who still need more supervision by parents and teachers."*

PT03: *"I can feel a new learning sensation from the application and reap a lot of curiosity about what is in the application. I can say the idea of designing an instructional media based on Augmented Reality / brilliant / Here we not only learn mathematics, but we also know about new forms of AR technology that can provide concrete examples effectively and this new knowledge can stimulate us to find out other technologies that are developing as a reference for making instructional media. I really enjoyed studying this application."*

5 Discussion

5.1 Learning attitude

The results of this study indicate the local wisdom forms into the AR application integrated in geometry learning has a positive impact on positive learning attitudes pre-service mathematics teachers. This is seen from the overall average score of three aspects score is 4.47, or close to the maximum score. This shows that the attitude of pre-service mathematics teachers is very satisfied with the learning. The most dominant aspect of a positive attitude is satisfaction with an average score of 4.56. Based on the results of interviews revealed that pre-service mathematics teachers gave positive responses and were satisfied with the learning process that integrates local wisdom forms in AR applications. That because the use of the AR application helps them better understand and be able to see 3D geometric shapes directly not only in the form of 2D visualization. In addition, because the characteristics of the AR application are able to integrate virtual aspects such as animations of local wisdom forms, 3D geometry forms into the real environment in the form of images in the form of local wisdom. In addition, 3D geometry objects, videos, animations, practice questions found in the AR application make pre-service mathematics teachers more focused, enthusiastic and enjoy the learning process. This finding is in line with several studies using AR [31], [32]. The most dominant positive attitude lies in the aspect of satisfaction. This is also in line with research [33] inferring the use of augmented reality-based education has an impact on the enthusiasm and enthusiasm in following the learning process.

5.2 Learning motivation

In addition to learning attitudes, the use of AR also has a positive impact on learning motivation. Overall, based on the results of the pre-service mathematics teachers' motivation questionnaire on the use of integrated forms of local wisdom in the AR application had a positive impact. Such as (1) stimulating the pre-service mathematics teachers' curiosity in exploring the concept of geometry; (2) draw attention to the spirit of learning; (3) encouraging pre-service mathematics teachers to apply technology-based learning when they are already teachers. There is a positive impact on the use of AR, in line with studies [34], [35], [10]. There are 4 aspects of motivation that are given attention, relevance, confidence, satisfaction. In this study, the most dominant aspect is the satisfaction aspect. This is different from his research [34] which says that the aspect of confidence is the dominant aspect when compared with other aspects. However, there are several studies that are in line with the findings of research that have been done such as research [29] which explains that when students learn to use augmented reality-based mobile learning systems, students follow the learning process very much with greater motivation. That is because pre-service mathematics teachers' feel challenged to be able to apply technology-based learning and feel the sensation of learning new from the application and reap a lot of curiosity about what is in the application.

5.3 The understanding of geometry material concept

The impact of the use of integrated learning of local wisdom forms in AR Application on the understanding of the concept of geometry material showed a significant increase between the results of the pre-test and the post-test results. This can be seen from an increase in understanding in representing the elements and properties of cubes, beams, prisms, pyramid, tubes, cones and spheres. In addition, understanding in determining the surface area and volume of cubes, beams, prisms, pyramid, tubes, cones and spheres also increased. The results of the study, in line with previous studies. Like [24] using mobile learning to support understanding geometry. [36] Developing spatial skills using AR. [24] Assessed 3D geometry thinking skills using AR. [25]uses AR on space geometry. [37] Using AR can improve mathematical achievement and visual thinking and reflective thinking. Integration is carried out starting from detecting AR objects by using local wisdom markers in Indonesia. In addition to 3D object animation markers displayed in local wisdom animation in 3D. Integrating local wisdom forms in AR applications provides a deeper picture that local wisdom as a cultural context can be integrated with technology. In addition, the use of an AR application that displays 3D animated objects that allows pre-service mathematics teachers can construct geometric understanding independently through the help of AR technology.

Based on the results of interviews revealed that pre-service mathematics teachers provide a positive view of the use of learning that integrate forms of local wisdom in AR applications. They consciously stated that the use of AR in learning gave a different sensation that made them enthusiastic in participating in learning. They are also inspired to apply technology when they become teachers. This finding is similar to research findings by [38] finding that students who enjoy using learning with AR and can be used to design learning for children [39].

6 Conclusion and Recommendations

In this study, we integrate the form of local wisdom into AR application into learning geometry and analyze its impact on learning attitudes, learning motivation and the ability to understand the concept of geometri pre-service mathematics teachers' material. Based on the results of the analysis, we conclude that pre-service mathematics teachers have a positive attitude towards learning geometry that is integrated with the local wisdom form in the AR application. These findings are in line with international studies revealing that pre-service teachers have a positive attitude in the use of new technologies for supporting their daily teaching practices [40][41][42][43]. Furthermore, learning motivation in pre-service mathematics teachers on aspects of attention, relevance, confidence, satisfaction shows a positive impact. This finding is also in line with international research that reveals that pre-service teacher mathematics has positive interinsic motivation towards the use of augmented reality technology[44]. The understanding of test results shows significant improvement. This can be seen from an increase in understanding in determining the properties, surface surfaces, 3D geometry volume and an increase in comparing the volume of 3D geometry based on its properties. This finding is also in line with the results of other international studies which reveal that the use of new technology can help improve the understanding of mathematical concepts of pre-service teacher mathematics [45][46][47].

This study still uses limited local wisdom objects. Therefore, it allows other researchers to explore more local wisdom forms that are used to represent geometry objects. We further recommend the use of the AR application to be integrated into learning models that can make students or pre-service mathematics teachers more active. We also recommend extending the research period and looking at its impact on the ability to think in 3D geometry. In addition, the results of this study provide opportunities and alternatives for teachers and prospective teachers to implement and integrate AR applications into teaching geometry practices.

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