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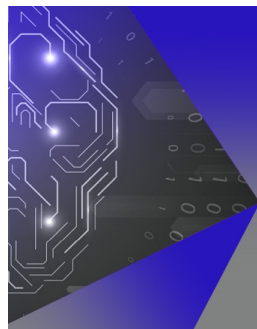
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Ethnomatematics Learning Media Based on Augmented Reality for Learning Geometry: A Needs Analysis

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Abstract. Two-dimensional and three-dimensional geometric shapes are often mathematical objects that are difficult for elementary and junior high school students to understand. Using augmented reality technology to visualize it can make it easier for students to learn geometry material. The purpose of this study was to analyze the need for developing learning media based on ethnomatematics with augmented reality. This research is quantitative research. The research subjects were 40 mathematics teachers in Yogyakarta, Indonesia. Subject determination techniques using cluster random sampling in 5 districts in Yogyakarta Province. Research data were collected by giving questionnaires to respondents. The results of this study indicate (1) most of the teachers found that their students had difficulty in learning geometry material; (2) most mathematics teachers rarely use culture as a learning context; (3) all mathematics teachers have never used ethnomatematics-based Augmented reality-assisted learning media; (4) all mathematics teachers are in dire need of learning multimedia innovations to teach geometry material, such as augmented reality; and (5) the development of ethnomatematical AR multimedia based on geometry material can be a solution to create an innovation in mathematics learning that can facilitate students in learning, so as to improve mathematical abilities, make learning more meaningful, and can increase student self-regulated learning during the pandemic.

INTRODUCTION

The quality of learning and learning outcomes are closely related to the quality of a teacher's competence [1]. The teacher is the spearhead of the success of a learning [2]. Pedagogic competence is the ability to manage student learning, with one indicator that teachers must have the ability to design of learning programs [3]. The ability of learning design is related to the teacher's ability to create and develop learning media [4,5]. This is so important, with learning media it can help students to understand concepts and materials [6]. In addition, the media can help students increase their motivation, curiosity and thinking ability and competence [7,8].

In learning mathematics, the media has a very important role to assist students in constructing a concept [9]. Media can also help students understand abstract mathematical objects into real objects [10]. Based on several studies, students' difficulties in understanding geometric material are due to abstract geometric objects so media are needed to make it easier for students to understand them [11,12,13]. Geometry is a science that studies space, studies visual patterns, and relates them to the real world [14,15]. The difficulty of students in understanding geometric concepts lies in students' difficulties in imagining spatial concepts, drawing or making illustrations, especially in

three-dimensional shapes [16]. This difficulty will have an impact on students' low understanding of geometric material [17]. Therefore, the media has a role as a real representation, manipulating spatial objects or real objects, making it easier for students to learn geometry.

One of the media that can be used in studying geometry is multimedia [18]. Multimedia is the use of computers to present and combine text, sound, images, animation, audio, and video with tools and links so that users can navigate, interact, create, and communicate [19]. The resulting images, videos or animations can be in the form of manipulating spatial objects in geometry into real objects. In its development, technology that is capable of two-dimensional and or three-dimensional virtual objects into a real environment in real time is called Augmented Reality (AR) [20]. AR is a multimedia technology that is suitable for use in geometry learning. Several research results show that AR-assisted geometry learning can improve spatial abilities and geometry learning outcomes [21,22,23].

The success of a lesson is not only measured by improving learning outcomes, but can facilitate the formation of national character to students, through culture-based learning [24,25]. Ethnomathematics is a concept in teaching mathematics by making culture a context for constructing knowledge and understanding material [26]. So that not only the achievement of learning outcomes obtained, but affective competence (character) can be formed. However, based on the researcher's search, there are still not many studies related to the development of AR multimedia for ethnomathematical-based geometry learning, especially in Indonesia. So that research on the development of Indonesian ethnomathematical-based AR geometry multimedia is very much needed. This research is in the context of developing Indonesian ethnomathematics-based AR, especially in the Yogyakarta culture. But first, it is necessary to analyze the needs of media development so that the multimedia developed is in accordance with user needs.

METHOD

This study uses a quantitative approach using a questionnaire [27]. This descriptive research aims to describe the phenomenon and reveal the value contained in the phenomenon [28]. This method is usually used in the field of education and surveys are one way to get information. Quantitative approaches are thought to be capable of producing results that are reliable, valid, objective, and generalizable [27]. Furthermore, the questionnaire, which is one of the most extensively used quantitative instruments, may be distributed to a huge number of people.

The population in this study were mathematics teachers in DIY Province. Sampling was done by cluster random sampling. Samples were taken from each of the 5 districts in the DIY province totaling 40 mathematics teachers. The instrument used in this study was an online questionnaire. Before the instrument was distributed to respondents, expert validation was carried out first. The questionnaire instrument was carried out content validity using the Index Aiken formula. If the items developed are theoretically correct, then the measurement results are seen as valid results [29]. The reason for using online questionnaires is to facilitate access and effectiveness in filling them out. In addition, there are government regulations for physical and social distancing during the pandemic. The questionnaire was created using the google form application. The questionnaire was submitted through the WhatsApp group with a message in the form of a link. The questionnaire open for one month.

The needs analysis questionnaire contains 14 questions, with 11 questions with 4 answer choices (4-scale), 3 questions with 2 answer choices (2-scale), and 1 open-ended question. Then the data from the questionnaire were analyzed using descriptive statistics. The purpose of descriptive statistics is to describe the characteristics of a data set whose presentation is in the form of tables and data diagrams, as well as measurements of central data [30].

RESULT AND DISCUSSION

This section presents descriptive results which include the results of the validity of the contents of the questionnaire instrument, as well as the results of the questionnaire analysis of teacher needs as an initial study to develop ethnomathematics-based learning multimedia in the context of Yogyakarta using AR technology.

Questionnaire Instrument Content Validity Test

The questionnaire instrument used aims to obtain data related to user needs for learning media that will be developed by researchers. This learning media is devoted to geometry material with an ethnomathematical context in Indonesia in the province of Yogyakarta. So that the questions in the questionnaire are related to the difficulty of

the teacher in teaching geometry material to students, the media used in learning, and the urgency of developing ethnomathematics-based multimedia in the context of Yogyakarta with AR technology. There are 14 questionnaire questions that the researcher uses as an instrument to obtain this needs analysis data. The questions are presented in TABLE I.

TABLE I. Items of the Questionnaire.

No	Question Items
1	Do you find students who have difficulty in learning mathematics, especially geometry?
2	Are students' mathematical abilities, especially in geometry material, very lacking?
3	Are interesting and innovative learning media needed that help in teaching geometry material?
4	Have you ever made teaching materials including multimedia learning mathematics?
5	If so, what teaching materials have you made? If not, please fill in (-)
6	Do you use Multimedia in Mathematics Learning, especially Geometry?
7	Do you think that using a cultural context in conveying mathematical concepts is an interesting learning innovation for students?
8	Do you teach mathematics concepts using the cultural context of teaching and learning activities?
9	Do you know about Android-Based Augmented Reality applications?
10	Have you ever heard of Augmented Reality (AR) Assisted Ethnomathematics-Based Learning Media?
11	Have you ever used AR-Assisted Ethnomathematics-Based Learning Media?
12	AR is a learning multimedia that develops through the combination of animation, audio, images and smartphones or computers, with effects that can make 2D and 3D virtual objects match the real ones in the real world. Is AR suitable as a learning medium, especially Geometry?
13	With animation, video images in AR, so that it can increase student learning independence. Is this suitable for AR to be used as a learning medium during this pandemic?
14	Is AR the right media and can facilitate students in the teaching and learning process?

Before the questionnaire was given to the respondents, namely mathematics teachers in the province of Yogyakarta, this instrument was validated by two validators in the field of mathematics education. Furthermore, the validation results are calculated using the Aiken Index formula as follows [31]

$$V = \frac{\sum s}{c(n-1)}, s = r - I_0$$

Keterangan:

V = item validity index

r = rater choice score category

I_0 = lowest score in scoring category

c = rater selectable category

n = number of raters

The calculation results are presented in TABLE 2 .

TABLE 2. Questionnaire Validation Results

Questionnaire Items	Validator Score		s_1	s_2	$\sum s$	Index Aiken	Criteria
	1	2					
1	5	4	4	3	7	0,875	Valid
2	4	4	3	3	6	0,75	Valid
3	4	5	3	4	7	0,875	Valid
4	5	3	4	2	6	0,75	Valid
5	4	4	3	3	6	0,75	Valid
6	4	5	3	4	7	0,875	Valid
7	5	3	4	2	6	0,75	Valid
8	5	5	4	4	8	1	Valid
9	5	4	4	3	7	0,875	Valid
10	4	3	3	2	5	0,625	Valid
11	4	4	3	3	6	0,75	Valid
12	5	5	4	4	8	1	Valid
13	5	4	4	3	7	0,875	Valid
14	4	3	3	2	5	0,625	Valid

Based on the results of the Aiken Index calculation, an item can be categorized based on its index. If the index is less or equal to 0.4 then the validity is less, 0.4 - 0.8 then the validity is moderate, and if it is greater than 0.8 then it is very valid. If the instrument items that have been validated are classified in the high and medium categories, the instrument items in the form of tests can be used. If it is classified in the less category, then it cannot be used [31]. so that based on the results of table 2, it can be concluded that all the questions in the questionnaire are valid and can be used.

Result of Teacher Needs Analysis

As previously explained, the data on teacher needs in developing this multimedia is through an online questionnaire that has been filled out by 40 respondents, namely mathematics teachers in Yogyakarta Province, Indonesia via a link sent to the whatsapp group. The respondent data and the questionnaire recapitulation of teacher needs for ethnomathematics-based multimedia development in the context of Yogyakarta assisted by AR technology on geometry are presented in TABLE 3 and TABLE 4.

TABLE 3. Respondent

Total of Respondent	Educational level		Afiliation	
	Bachelor (S1)	Master (S2)	Junior High School	Senior High School
40	29	11	19	21

TABLE 4. Results of Teacher Needs Analysis

No	Question Items	Identification of problems
1	Do you find students who have difficulty in learning mathematics, especially geometry?	As many as 63% of teachers said they often and 37% said they always found students having difficulties in learning geometry As many as 90% of teachers stated that they often and 10% stated that they rarely found students having difficulty in learning geometry
2	Are students' mathematical abilities, especially in geometry material, very lacking?	As many as 89% of junior high school mathematics teachers and 86% of senior high school mathematics teachers stated that students' abilities were in the low category in learning geometry
3	Are interesting and innovative learning media needed that help	All junior high school and senior high school teachers want interesting and innovative learning media to help geometry learning

No	Question Items	Identification of problems
	in teaching geometry material?	
4	Have you ever made teaching materials including multimedia learning mathematics?	As many as 53% of teachers stated that they had never used learning media As many as 33% of teachers stated that they had never used learning media. While 67% have created and used learning media
5	If so, what teaching materials have you made? If not, please fill in (-)	A total of 9 (47%) teachers have created and used learning media in the form of powerpoints, videos and teaching aids, but have never used and made learning multimedia. While 53% have never made and used learning media. A total of 11 (52%) teachers have created and used learning media in the form of powerpoints, videos and teaching aids. While 2 of them have used and made multimedia. Furthermore, the remaining 48% have never made and used learning media.
6	Do you use Multimedia in Mathematics Learning, especially Geometry?	As many as 32% of teachers often use multimedia in learning geometry While the remaining 68% rarely and never use multimedia in geometry learning As many as 33% of teachers often use multimedia. While the remaining 67% rarely and never use multimedia in geometry learning.
7	Do you think that using a cultural context in conveying mathematical concepts is an interesting learning innovation for students?	As many as 94% of junior high school mathematics teachers and 95% of senior high school mathematics teachers stated that using cultural contexts in conveying mathematical concepts is an innovation in learning.
8	Do you teach mathematics concepts using the cultural context of teaching and learning activities?	As many as 37% of teachers stated that they often use cultural contexts in learning. Meanwhile, 63% of teachers rarely use cultural context in learning. As many as 19% of teachers stated that they often use cultural contexts in learning. Meanwhile, 81% of teachers rarely and never use cultural contexts in learning.
9	Do you know about Android-Based Augmented Reality applications?	As many as 79% of junior high school teachers and 71% of Senior high school teachers are not aware of Android-based AR applications.
10	Have you ever heard of Augmented Reality (AR) Assisted Ethnomathematics-Based Learning Media?	As many as 84% of junior high school teachers and 81% of Senior high school teachers have never heard of ethnomathematics-based AR applications.
11	Have you ever used AR-Assisted Ethnomathematics-Based Learning Media?	All junior high school teachers and 95% of senior high school teachers have never used ethnomathematics-based AR applications and never used ethnomathematics-based AR applications.
12	AR is a learning multimedia that develops through the combination of animation, audio, images and smartphones or computers, with effects that can make 2D and 3D virtual objects match the real ones in the real world. Is AR suitable as	As many as 89% of junior high school teachers and 85% of Senior high school teachers stated that AR is an innovative medium that is suitable for use as a multimedia learning geometry.

No	Question Items	Identification of problems
	a learning medium, especially Geometry?	
13	With animation, video images in AR, so that it can increase student learning independence. Is this suitable for AR to be used as a learning medium during this pandemic?	As many as 95% of junior high school mathematics teachers and senior high school mathematics teachers stated that AR was very appropriate to be used as a learning medium during a pandemic because it had several advantages including data combining animation, audio, images and being able to make 2D and 3D virtual objects according to the original in the world, real world, and can be used with smartphones
14	Is AR the right media and can facilitate students in the teaching and learning process?	As many as 95% of junior high school mathematics teachers and 90% of high school mathematics teachers stated that AR is the right medium and can facilitate students in the geometry learning process

Based on the results of the analysis of teacher needs that have been presented in table 4, it can be seen that more than 90% of mathematics teachers at the junior high and high school level always find their students having difficulties in learning geometry. This condition can be caused by the low mathematical ability of students, as well as the use of learning media (multimedia) which is still rarely used by teachers in learning geometry. In fact, good multimedia-assisted learning can help students process information well [32,33]. So that there is no pseudo thinking and even wrong concepts experienced by students in understanding the subject matter [34]. In learning mathematics, multimedia can help students to apply reasoning skills in understanding geometric problems so that they can be used as media to increase learning effectiveness [35].

Related to the ethnomathematical context, most junior high school and high school mathematics teachers rarely use culture as a context in teaching mathematics material. However, they argue that ethnomathematical-based learning is one of the learning innovations in conveying a mathematical concept. Ethnomathematics is said to be a learning innovation because through a learning culture it can be more meaningful, students are facilitated to construct their own knowledge, so they can increase students' mathematical knowledge [36,37].

In addition, based on the results of the analysis of teacher needs, all junior high and high school mathematics teachers have never been familiar with the ethnomathematics-based AR concept, although a small proportion of them know the AR concept. This means that teachers have never developed and used ethnomathematical-based AR multimedia. Whereas one of the advantages of AR is that it can combine animation, audio, images and can change 2D and 3D virtual objects according to the original in the real world. So that with this AR multimedia can form independent learning, especially during this pandemic. Therefore, based on the overall results of this analysis, it is necessary to develop ethnomathematics-based AR multimedia, as one of the learning multimedia that can help students understand concepts and be able to solve problems related to geometry.

CONCLUSIONS

The conclusion of this study is that (1) most of the teachers found that their students had difficulty in learning geometry material; (2) most mathematics teachers rarely use culture as a learning context; (3) all mathematics teachers have never used ethnomathematics-based Augmented reality-assisted learning media; (4) all mathematics teachers are in dire need of learning multimedia innovations to teach geometry material, such as Augmented Reality; and (5) the development of ethnomathematical AR multimedia based on geometry material can be a solution to create an innovation in mathematics learning that can facilitate students in learning, so as to improve mathematical abilities and make learning more meaningful.

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