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THE DEVELOPMENT OF CULTURAL-BASED MATHEMATICS MEDIA USING AUGMENTED REALITY 3D WITH ETHNOMATHEMATICS CONCEPT TO SUPPORT INDEPENDENT LEARNING

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Abstract: This research aims to develop 3D *augmented reality* mathematics learning media with ethnomathematical concepts to support the independent learning program. Mathematic SASAMBO media products that have been developed are then tested for the validity and practicality of the media. The ethnomathematical elements used in this study are traditional houses originating from 3 tribes in West Nusa Tenggara, includingBale Lumbung from the Sasak Tribe, Istana Dalam Loka from the Samawa Tribe, and Uma Lengge from the Mbojo Tribe. This research adopts *Research and Development* (R&D) refers to the 4-D development model. The 4-D development steps are definition (*define*) which contains problem analysis, task analysis, and concept analysis; The second stage is design (*design*) by designing *augmented reality* media using ethnomathematical concepts with the help of *Blender* software version 2. 93, *Adobe Illustrator artwork* 23.0, and *Unity* and *Vuforia* AR *Extension for Unity*; The third stage is the development (*DEvelop*) by conducting feasibility tests and media practicality. The research sample was 61 students taken with a *simple random sampling* technique. Based on the results of the study, the average validity score by three validators gave a score of 91.67%, which indicates that the MAMBO media developed is very valid. The results of the media practicality test showed that students gave a positive response to all components of the MAMBO media with an average practicality of 82%. Based on the data obtained, it can be concluded that the MAMBO media developed has been very valid and very practical to be used in learning activities.

Keywords - augmented reality, ethnomathematics, learning media

Introduction

Education is a very essential place to form a smart and quality generation. Education is closely related to the teaching and learning process that supports students to develop their ability to understand lessons [4]. The teaching and learning process is inseparable from various kinds of problems such as the complexity of the material. One material that is often considered to have high material complexity is mathematics. Though mathematics is one of the basic sciences that is very important in the education system throughout the country [3]. According to the *Programme for International Student Assessment* 2018 survey [2], Indonesia ranks 66th out of 73 countries in the mathematics category. This is because

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there is still a low level of students' understanding of mathematical concepts and there are still many conventional learning processes so that students do not look active, saturated, and do not provide meaningful and concrete experience from the learning passed [10].

Geometry is one of the big problems among various subjects in the mathematics curriculum. This is because to study buildings that exist on geometric materials such as rectangles, triangles, trapezoids, parallelograms, rhombuses and others, learners are faced with objects that are abstract [15]. The use of geometry is often found in everyday life, even since ancient times such as temples, palaces, traditional houses and many others. The use of mathematical concepts in culture by a particular group of people is known as ethnomathematics. One of the roles of ethnomathematics in the 2013 curriculum is to facilitate students to construct mathematical understanding concepts with initial knowledge that they already know through their own environment [10]. The presence of ethnomathematics in mathematics learning gives the nuance that learning mathematics is not only learned in the classroom but outside the classroom by visiting or interacting with local culture and can be used as a medium for learning mathematics or teaching materials, especially on geometry material. This is because in these objects there are many geometric shapes that can be seen from the form of reliefs and building structures [10].

ethnomathematics has relevance to indicators on critical thinking skills which include interpretation, analysis, evaluation and decision. Students' critical thinking skills can be improved by using ethnomathematics-based geometry material in the learning process. However, ethnomathematics learning is currently still not in demand because the media used still uses textbooks whose contents are in the form of text and still images, and still uses conventional methods (lectures, questions and answers and assignments). In addition, today's learners tend to prefer playing gadgets rather than learning [13]. Research published in 2019 stated that 53% of 1,600 children aged between 8 years to 12 years owned their own devices when they were 11 years old and children aged 8 to 12 years on average used devices for 4 hours a day [1, 2]. In addition, current students can be categorized as generation Z which is a generation with a birth year of 1995-2010 [14]. This generation is globally connected, so it can be said that generation Z "lives and breathes" with technology. Therefore, more interactive mathematics learning media is needed that can be used to demonstrate or visualize the material studied. It can be a tool to construct basic concepts that stimulate the development of students' geometric abilities using current technology.

Based on the description of the problem, the author realizes the importance of an update to existing learning, one of which is the development of Si MAMBO learning media (Mathematic SASAMBO): 3D Augmented Reality-based Learning Media with Ethnomathematical Concepts to Support Free Learning. Augmented Reality (AR) is an animation technology that works bydisplaying 3D objects in real-time. This can make learning more fun and is a new innovation in the digital era to

support independent learning. AR technology is an animation technology that can make learning more and is a new innovation in the digital era to support freedom of learning [1, 8]. The concept of Free Learning is in line with the goals of distance education which facilitates students to be able to study by eliminating space and time boundaries

Methods

A. Research Method

Research and Development). R&D is used to produce a product and can also be interpreted as steps or a series of processes in developing a new product [6]. In addition, the development model used is 4-D (four-D Model). This model was developed by Thiagarajan and Semmel in 1974 [1, 6]. Development using 4-D models is chosen to develop media using the basis of *augmented reality* technology. The 4-D model itself is designed systematically and coupled with activities aimed at making learning media [1, 7]. This model consists of 4 stages, namely define, *design*, *develop*, and *disseminate*. As for this study, the 4-D design used up to the development stage (*develop*). This research will develop learning media based on *augmented reality* technology with an ethnomathematical approach to support independent learning.

The first stage is *define* which consists of problem analysis, task analysis, and concept analysis. After the defining stage is carried out, the next stepis to do product design. At the *design* stage, media is designed based on *augmented reality* technology with ethnomathematical concepts. Thelast example is *develop*, which is validating the MAMBO media by three media experts. In addition, the research instruments and learning tools to be used are also validated by expert lecturers. After validating, a practicality test was then held by distributing google forms to 61 respondents who were students. For more details, the stages of development of Si Mambo learning media can be seen in Figure 1.

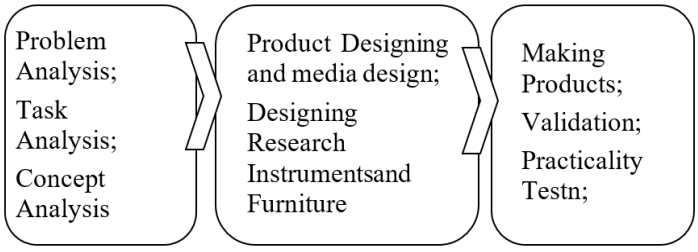

Figure 1. Stage of development of learning media Si MAMBO

B. Media Validty Test

To assess feasibility, researchers gave instruments to 3 media experts to find out their responses to the media. To further revise or improve the suggestions given. Then the researcher looked at the weight of each response and calculated the average value and score range using the following formula:

$$V - ah = \frac{TSe}{TSh}\ x\ 100\%$$

With: $V - ah =$ Expert validation; Total Score achieved; Total Expected ScoreTSe $=$ TSh $=$

Table 1. *Media Eligibility Criteria*

Shoes (%)	**Criterion**
86.00-100.00	Very valid
71.00-85.00	Valid
56.00-70.00	Quite valid
41.00-55.00	Less valid
25.00-40.00	No valid

C. Practicality Analysis

The assessment of media products si MAMBO based on questionnaires that have been filled out by students is analyzed to determine the level of practicality of the products developed. The practicality test carried out includes media attractiveness, ease of use of media, implementation time, and media benefits. Practicality can be measured by the modified Likert scale Riduwan 2017 [1, 1]. The criteria for media assessment by students for each component of the assessment can be seen in Table 2.

Table 2. *Media practicality assessment criteria*

Judging Criteria	**Shoes**
Highly Compliant (SS)	5
Compliant (S)	4
Reasonably Compliant (CS)	3
Less Suitable (KS)	2
Highly Non-Conforming (STS)	1

The practicality questionnaire analysis can be calculated by the following formula:

$$p = \frac{f}{N}\ x\ 100\%$$

Description: p = Final score; f = Score gain; N = maximum score

After the practicality value is obtained, a grouping is carried out according tothe practicality category in Tabel 3.

Table 3. *Categories Practicality*

No	Value	Kategori
1	80% < x ≤ 100%	Very practical
2	60% < x ≤ 80%	Practical
3	40% < x ≤ 60%	Quite practical
4	20% < x ≤ 40%	Less practical
5	0% < x ≤ 20%	Impractical

Results and Discussion

Si MAMBO (Mathematic SASAMBO) is a means for learners to learn comfortably and fun and interactively. SASAMBO itself stands for three tribes in West Nusa Tenggara (NTB), namely the Sasak, Samawa, and Mbojo tribes. This media is a supporting media to improve mathematical understanding by using ethnomathematical concepts that have the potential to help students improve their understanding of mathematics in geometry material with comprehensive ethnomathematical concepts. The Si MAMBO application is presented to provide information to simulations regarding the implementation of the independent learning policy in schools in mathematics subjects. This application contains 3 main menus, namely observing and learning from three traditional houses in NTB, including Bale Lumbung from the Sasak Tribe in Lombok, Istana Dalam Loka from the Samawa Tribe in Sumbawa, and Umma Lengge from the Mbojo Tribe in Bima. Observation and learning of this traditional house is one form of implementation of ethnomathematical concepts, namely by looking at the structure of the building that composes it to be subsequently associated with mathematics, especially in geometry material.

To increase students' interest in teaching furniture, Si MAMBO uses the basis of *augmented reality* technology. Based on references from [7] revealed that a *ugmented reality* is a technique that combines two-dimensional or three-dimensional virtual objects into a real sphere. So that students can observe the structure of traditional house buildings from NTB which are associated with building on geometry material that is visualized in reality. In addition, to support students' understanding, Si MAMBO is equipped with a description of the observed traditional house and an explanation for each building that

makes up the traditional house complete with examples of problems in solving mathematical problems. So, whilehaving literacy knowledge related to regional culture, students can understand the material taught using more interactive learning media.

Here are the steps for making Si MAMBO media based *on augmented reality*:

Define Stage

Problem Analysis:

The learning system during the pandemic has directly impacted students and teachers and faced various challenges and problems. A survey conducted by Pujiasih [2] showed that as many as 55% of 322 students expressed displeasure with online learning. This is caused by several things including students feeling bored studying at home, unable to discuss directly, difficulty understanding the material taught, feeling a lot of assignment load by the teacher, to feeling stressed with assignments given online.

In addition to students, various obstacles and similar impacts are also felt by teachers. From the impact and constraints felt by students, the teacher's perception is that there is a difference in the learning atmosphere when carrying out online learning with classroom learning so that this affects student learning motivation, besides that teachers feel not as free as in class and limited student monitoring, as well as the tendency of online learning styles that use visuals and writing [1].

For this reason, the MAMBO with an *augmented reality* base is made so that it can be an alternative learning media in the current learning system. By using Si MAMBO, learning can be done more interactively and can encourage independence and student learning motivation. *Augmented reality* 3D is a new technology that combines two-dimensional and three-dimensional virtual objects into a real-world environment.

Task Analysis

This task analysis is a collection of procedures to determine the content in a learning by detailing the tasks of the teaching material content in line in accordance with the core competencies (IC) and basic competencies (KD) in accordance with the 2013 curriculum. The subject matter specifications to be developed in AR 3D learning media are flat building material in class VII and room building material in class VIII junior high school. And added with cultural elements, namely the SASAMBO traditional house based on ethnomathematics to improve students' cultural literacy.

Concept Analysis

This concept analysis is carried out by selecting and identifying the main concepts used in the learning process. These concepts will be arranged systematically and in detail on the Si MAMBO application based *on 3D augmented reality* with ethnomathematical concepts. Sothis can make it easier for students to learn about building space with a combination of SASAMBO traditional houses.

Design Phase

To create media Si MAMBO, some of the software used include AdobeIl lustrator artwork 23.0, Blender version 2. 93, Unity and Vuforia AR Extension for Unity. This application is made to be used using devices with iOS and Android operating systems. After the design is completed on the storyboard, the next stage is the creation of 3D imence (3D) objects from the traditional house Bale Lumbung, Istana Dalam Loka, and Umma Lengge by applying a mathematical concept, namely geometry to find out the constituent structure of the traditional house as shown in figure 4. The creation of 3D designs is made using Blender software version 2. 93.

After the 3D design of the house theret is made, then the object is dieksport to then besaved in .fbx format. After that, an image is determined to be used as a marker to display the 3D shape of the traditional house. Markers that have been registered are then downloaded in the format unitypackage.

In supporting the material and ease of use of the application, for that added villagein display and explanation of the material using Adobe Illustrator artwork 23.0. The design results are then exported in jpg format. More details, the appearance of the application can be seen in Figures 2, 3, and 5. Some things that are considered and considered in this stage are the aesthetics of the appearance and ease of use.

3D model with fo rmat .fbx, Qcard library, application display with jpg format. and markers with unitypackage format that have been downloaded imported into unity 3D software. Next, the application is built using the Android SDK and saved in .apk format.

To improve interaction with users, audio was added at the time of making observations that explained the description of the observed custom house.

Figure 2. Logo,Initial Display and Menu si MAMBO

Figure 3. Display Description and Structure of the Constituent Fields of Bale Granary, Palace in Loka, and Umma Lengge

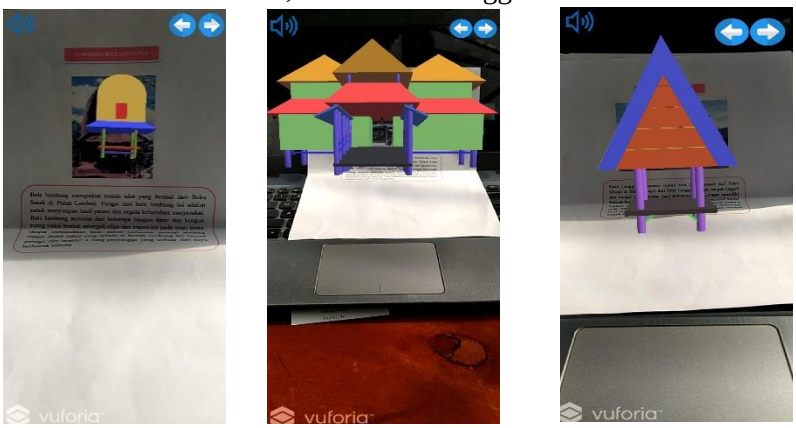

Figure 4. Display of Observations using Si MAMBO

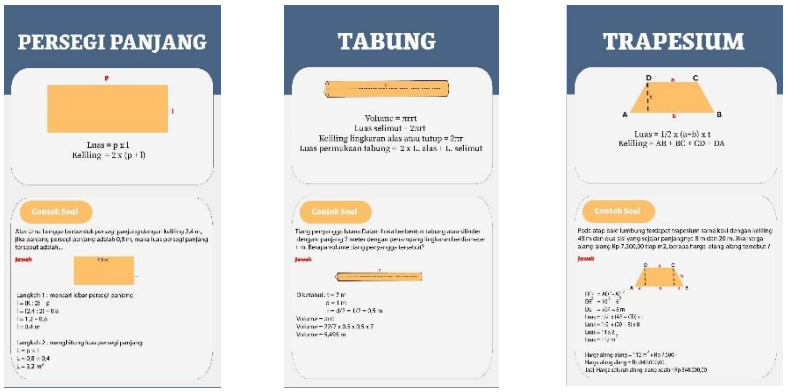

Figure 5. Explanation Display of Each Building of a Traditional House

Develop Stage

The Development Phase carried out is to develop 3D augmented reality-based learning media with ethnomathematical concepts and using SASAMBO traditional house objects that have been designed at the 3D augmented reality application design stage. Thereneeds to be an evaluation so that interactive learning media based on augmented reality with ethnomathematical concepts can run optimally. The steps at this stage are: a) compiling an initial model of the application; (b) examine augmented reality applications; (c) performinstrument validation; (d) mrevision of validation results; (e) conducta

practicality test of the application; (f) analyze the practicality test of the application; dam (g) produce products in the form of 3D augmented reality-based learning media applications.

SI MAMBO Egibility

To assess feasibility, researchers gave instruments to 3 media validators to find out their responses to the media. Then researchers looked at the weight of each response and calculated the average value and score range. From the results of data processing (Table 4), 92.67% of categories are very valid and very good to use.

Table 4. Media Si MAMBO eligibility score

No	Assessment Aspect	Expert Value	Max Value	%	Ket
1	Display Design	32	36	89%	Excellent
2	Software Engineering	36	36	100%	Excellent
3	System Feasibility	43	48	89%	Excellent

The practicality of Si MAMBO media

Application practicality tests include 3D augmented reality-based learning media applications and research instruments conducted to determine the shortcomings of 3D augmented reality-based learning media with ethnomathematical concepts. The research team took data by looking at the responses of 61 respondents using a google form, and obtained the following results.

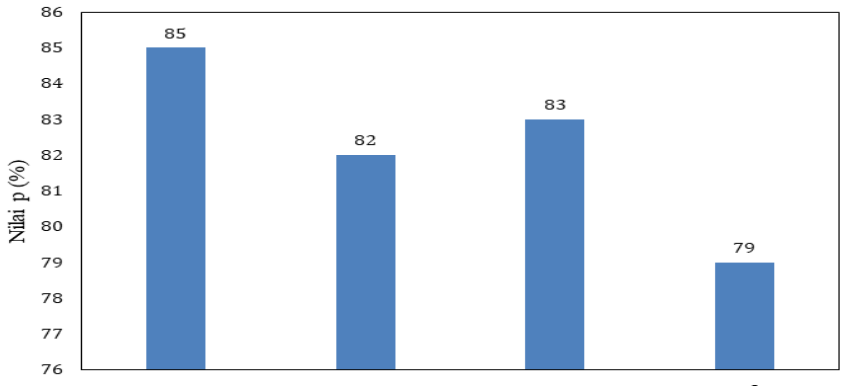

Figure 5. The practicality of Si MAMBO media

Based on Figure 5, it is concluded that each assessment component can be categorized as vulnerable practical and very practical. This can be seen from the values indicated by each component. Based on the table of practicality categories in the media attractiveness component, media ease of use component,

and implementation time component, the final value (p) was obtained respectively by 85%; 82%; 83% who showed the media component in the very practical category, while the media benefit component obtained a final value *(p)* of 79% which showed the media component in the practical category. The average total final score *(p)* for the practicality of the developed media obtained a value of 82% which shows that the developed media is in the very practical category

The results refer to research conducted by [8] their research shows that the use of interactive learning multimedia positively affects the attractiveness and involvement of students in learning. However, Si MAMBO media not only focuses on attractiveness but also how the media can educate and increase student literacy about the existing culture related to the traditional houses of 3 tribes in West Nusa Tenggara. In addition, the observed traditional house is associated with geometry by looking at the structure of the building that makes up the traditional house and is connected with building in mathematics.

Conclusions

Media Si MAMBO (Mathematic SASAMBO) for 3D augmented reality-based mathematics learning with ethnomathematical concepts to support the independent learning program has been successfully developed. The ethnomathematical elements used in this study are traditional houses originating from 3 tribes in West Nusa Tenggara, Indonesia. The validity test showed a value of 91.67% which means that the developed Si MAMBO media is a very valid category. The results of the media practicality test showed that students gave a positive response to all components of the MAMBO media with an average practicality of 82%. Based on the data obtained, it can be concluded that the MAMBO media developed has been very valid and very practical to be used in learning activities. Testing the effectiveness of Si MAMBO media is being carried out and will be published in the next scientific paper.

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Declaration of Interest Statement

I do not have money or other personal interests, directly or indirectly, in any way that creates or may conflict with my duties as a researcher in developing this media.

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