Al-Ishlah: Jurnal Pendidikan
Vol.14, 1 (April, 2022), pp. 877-886
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v14i1.1140

The Use of Ethnomathematics Learning Media Based on Augmented Reality for Madrasah Students

A A Abdullah[1], R Richardo[2], T Rochmadi[3], A Wijaya[4], Nurkhamid[5]

[1] Universitas Alma Ata; ahmad.anis@almaata.ac.id.
[2] Universitas Alma Ata; rinorichardo@almaata.ac.id.
[3] Universitas Alma Ata; trirochmadi@almaata.ac.id.
[4] Universitas Negeri Yogyakarta; a.wijaya@uny.ac.id.
[5] Universitas Negeri Yogyakarta; nurkhamid@uny.ac.id.

ARTICLE INFO

Keywords:

Mathematics learning;
Learning Media;
Augmented Reality.
.

Article history:

Received 2021-12-09
Revised 2022-03-17
Accepted 2022-04-19

ABSTRACT

This study presents Augmented Reality (AR) implementation for learning geometry mathematics with a cultural approach in junior high schools. The research method used was ADDIE (analysis, design, development, implementation, and evaluation) by limiting it to (1) exploration analysis, (2) design, (3) development, and (4) implementation. Applying the AR concept to the mathematics learning method with a cultural approach is hoped to create an interesting and fun mathematics learning atmosphere. This is because the application of AR concepts in mathematics learning can help students towards abstract mathematical concepts with the help of 3D objects and improvisation of appropriate sounds and images. The research results are an AR application prototype for learning geometric mathematics with a cultural approach in junior high schools, which can be used for geometry material in junior high schools for both classroom and online learning.

Corresponding Author:
A A Abdullah
Universitas Alma Ata; ahmad.anis@almaata.ac.id.

1. INTRODUCTION

The 2018 Program for International Student Assessment (PISA) survey announced in March 2019 show that Indonesian students' reading, science, and math skills are still low. PISA is an evaluation survey of the world's education systems that measures the performance of secondary school students. This assessment is conducted every three years and is divided into three main points, namely literacy, mathematics, and science. Based on the latest PISA results, 2019, Indonesia is ranked 74th. from 79 countries. As for the category of mathematical ability, Indonesia is ranked 73 out of 79 countries with an average score of 379. The PISA 2021 results will be announced in 2022. There is great hope for an increase in the achievement of Indonesian students. The OECD explains that PISA includes three major components of the mathematics domain, namely context, content, and competence (OCDE, 2019). In

accordance with the purpose of PISA to assess students' capacity to solve real problems, the problems in PISA include mathematical content related to phenomena. Problems (and their solutions) can arise from different situations or contexts based on individual experiences (Stacey, 2011). Therefore, the questions given in PISA are presented mostly in real-world situations so that the benefits of mathematics can be felt to solve problems of daily life. PISA questions that are non-routine and problem-solving problems make Indonesian children have difficulty solving them(Johar, 2012). Difficulties that are often experienced by Indonesian students in solving PISA problems include difficulty in understanding the meaning of the questions, difficulties in relating real-life aspects to mathematical problems (models), difficulties in performing mathematical operations, and difficulties in interpreting the results of mathematical solutions to real-world problems (Haji, 2018). This is because mathematics learning carried out in schools does not get used to solving non-routine and problem-solving problems (Safitri, Yasintasari, Putri, & Hasanah, 2020).

On the other hand, the COVID-19 pandemic has changed the learning model in schools (Abidah, Hidaayatullaah, Simamora, Fehabutar, & Mutakinati, 2020). This situation led to a change in learning that was originally face-to-face in the classroom to online learning at home. During online learning, many students find it difficult to implement it, especially in mathematics(Fauzy & Nurfauziah, 2021). Teachers try to maximize performance through e-learning to help students understand the teaching material(Mailizar, Almanthari, Maulina, & Bruce, 2020). COVID-19 has also become a gateway for digital learning in mathematics education. Digital learning in mathematics allows students to study at home comfortably during the COVID-19 pandemic (Mulenga & Marbán, 2020). During online learning, smartphones have become an inseparable part of student learning activities(Bahri, Kes, Sp, & Makassar, 2021). Students are accustomed to using various online media to access various knowledge. So it is impossible to separate smartphones from student learning today, even though learning is carried out face-to-face again. This is because the use of smartphones has become a habit of students at this time (Handayani & Irawan, 2020). So the challenge for mathematics teachers is how to maximize the use of smartphones for learning in schools optimally and effectively. One of the uses of smartphones in learning mathematics is Augmented Reality (AR)(Sudirman, Poppy Yaniawati, Mellawaty, 2021).

Augmented Reality (AR) is a technology that combines two-dimensional or three-dimensional virtual objects into a real environment and then projects them in real-time(Mustaqim, 2016). AR can also be used to help visualize abstract concepts for understanding and structure an object model. In 1990, the concept of AR was first introduced by Thomas P. Caudell. Three characteristics state that technology can be said to apply the AR concept, namely being able to combine the real world and the virtual world, being able to provide interactive and real-time information, and being able to display it in three dimensions(Aditya, Trisno, Nurwijayanti, & Fitriana, 2018). Utilization of learning media with AR is very useful in improving the learning process and students' interest in learning. AR itself has entertainment aspects that can increase students' interest in learning and playing and projecting it in real terms and involving the interaction of all of the students' five senses with technology (Mustaqim, Pd, & Kurniawan, 2017). This is because AR has characteristics and functions that are almost the same as learning media, namely the function of conveying information between recipients and senders or educators to students, can clarify the delivery of information provided by educators and students in the learning process, can provide motivational stimulation and interest in learning(W Widada, D Herawaty, 2021). The use of information technology-based learning media is in great demand and is needed in the current era (Abdullah & Rochmadi, 2020).

In this study, the content that will be used in this AR-based media is ethnomathematics. Ethnomathematics itself is one approach to learning mathematics and culture (François & Kerkhove, 2010) (Rosa & Clark, 2011). The ethnomathematical approach is very suitable to be applied in Indonesia because it is rich in cultural products, especially Yogyakarta, which is famous for its cultural city. The cultural element in learning mathematics acts as a bridge to the concept of mathematics (Herawaty, Sarwoedi, Marinka, Febriani, & Wirne, 2019). This ethnomathematical approach will stimulate students to think critically(Richardo, Martyanti, & Suhartini, 2019) and develop mathematical solving problem skills

(Imswatama & Lukman, 2018). Ethnomathematics is a constructivist theory where students build understanding and knowledge through what they have learned and been exposed to before(Brandt & Chernoff, 2015). Currently, many ethnomathematical studies have been carried out, such as batik motifs (Pramudita & Rosnawati, 2019), house shapes, and puppets (Narulita, Mardiyana, & Saputro, 2019), calendars (Syahrin, Turmudi, & Puspita, 2016), and others. Combining AR with ethnomathematics will be very interesting because culture-based mathematics learning is combined with information technology.

Based on the problems above, this study aims to describe the development of android-based mathematics learning media using augmented reality technology with an ethnomathematical approach at the junior high school level. The development of this learning media aims to invite students to build mathematical concepts from the real world, using their smartphones with an ethnomathematical approach(Richardo et al., 2019). The real-world context used in this study is the cultural context, which is a cultural heritage building in Yogyakarta. Meanwhile, the smartphone acts as a bridge between the cultural context and mathematical concepts, which in this case uses augmented reality-based applications.

2. METHODS

The technique in this study combines Research and Development with the ADDIE model. The ADDIE model has five stages, namely (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation(Sharifah & Faaizah, 2015). by limiting it to (1) exploration analysis, (2) design, (3) development, and (4) implementation. The ADDIE method is a method that is widely used in the development of AR learning media. The ADDIE model is widely used because it has several advantages, including more operational, systematic, practical, and procedural steps. The researchers conducted interviews with 41 middle school mathematics teachers in Yogyakarta to discover the problems of learning mathematics in the field. In the analysis phase, the researcher explores the literature and observes cultural heritage buildings in Yogyakarta related to ethnomathematical values. The reason for selecting objects is based on the characteristics of the forms that represent geometrical objects, like a roof that resembles a pyramid. Researchers conducted a search on cultural heritage buildings which include Yogyakarta Palace, The Great Mosque of Kauman, Taman Sari Water Castle, and Ratu Boko Temple. After finding objects related to the concept of geometry, the media development process using the ADDIE model is carried out. The second stage is the appointment of AR, which is integrated with ethnomathematics modeling; texture; 3D import; import vuphoria; upload and import of the database. The next stage is the development of integrated mobile learning ethnomathematics with AR. The trial process for implementing the AR Application prototype with an ethnomathematical approach to geometry material for Junior High Schools took a sample of students at MTs As Syalafiyah Mlangi, Sleman, Yogyakarta.

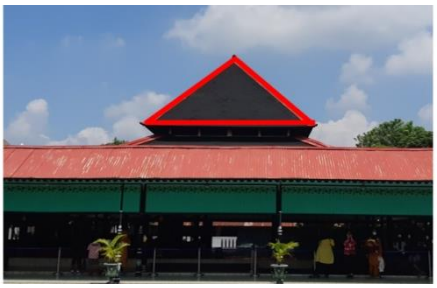
3. FINDINGS

3.1. Analysis Stage

Needs analysis in the mathematics learning process in junior high schools is carried out on planning, implementation, evaluation, and follow-up learning. Based on observations and interviews with teachers in secondary schools in several schools in Yogyakarta, several problems that often occur in the implementation of mathematics learning in junior high schools were found, including (1) most of the teachers found that there were students who still had difficulties in learning the material. Geometry; (2) most mathematics teachers rarely use culture as a learning context; (3) all mathematics teachers have never used Augmented Reality technology-assisted learning media with an ethnomathematical approach; (4) all mathematics teachers are in dire need of technology-based learning media innovations to teach geometry materials, such as Augmented Reality; and (5) the development of geometry learning media with AR technology with an ethnomathematical approach can be a solution to facilitate students in learning geometry.

Yogyakarta is a city of culture (Rif'an, 2016), with various cultural heritage buildings containing mathematical concepts (Kintoko & Jana, 2019). The exploration of Yogyakarta's cultural heritage buildings aims to identify and explain the mathematical concepts found. The results of the identification of cultural aspects in cultural heritage buildings which include Yogyakarta Palace, The Great Mosque of Kauman, Taman Sari Water Castle, and Ratu Boko Temple which, will be used as content to connect the real world to mathematical concepts obtained the following results;

Table 1. Ethnomathematics Values on Yogyakarta cultural heritage building

Ethnomathematics	Indicator tested
	Calculates the surface area of 3-dimensional shapes
	Solve problems about the area of rectangle and circle
	Calculates the volume of 3-dimensional shapes
	Calculates the volume of 3-dimensional shapes

	Calculates the surface area of 3-dimensional shapes
	Determine the diagonal length of the room

Researchers use open source tools such as Unity Version 2019.1.14f1, which can be downloaded via the unity website in the developer tools section, as the main framework for building AR applications. Unity is software that is often used to create applications on various platforms, either console, desktop, or mobile. The second application tool is Vuforia which functions to store markers into the Vuforia SDK which later the marker will display the results of 3D objects that have been created through Blender because they are free without having to use a license(Atmajaya, 2017).

3.2. Design Stage

The process flow of the developed AR application can be seen in the flowchart of Figure 1. The first stage begins with the creation of an ethnomathematical 3D object that is in accordance with the SMP material. After the 3D object is finished, the object is imported into Unity which will later be used as an object to be used appears and is matched with an existing marker.

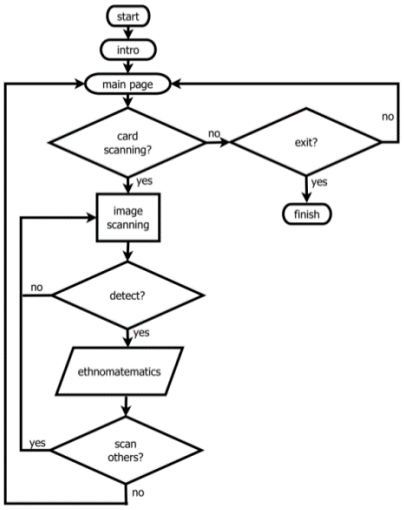


Figure 1. AR Application Flowchart

The Use Case Diagram of the AR Application, as follows:

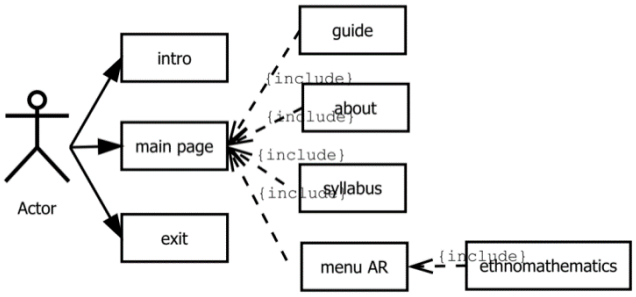


Figure 2. AR Application Use Case Diagram

Figure 2. shows the use case diagram design in an AR application. Users point the smartphone camera at the object. When the focus on the object is correct, the 3D object will appear on the screen, followed by information in the form of running text and audio according to the object selected by the user. When the AR application is run, the main interface design has three main buttons in the initial view: an introduction button containing information about the application and a summary of the material. The menu button contains the application usage guide, about (application name and author), syllabus, and the AR menu exit button to exit the AR program. Here's an initial view of the AR application;

Figure 3. AR App Initial View

3.3. Development Stage

In this section, the concept of a prototype design and development of the AR program will be explained with an ethnomathematical approach to geometry at the junior high school level. This discussion will be divided into several parts as follows;

System Function

Based on Figure 4, the running flow of the developed AR application can be seen. First, the user directs the marker object to the back camera of the cellphone. Then a 3D object will appear on the screen of the device used.

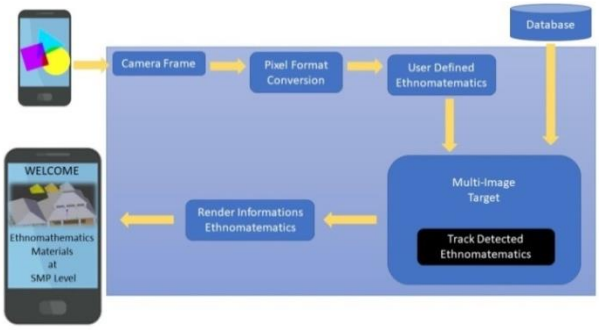


Figure 4. AR Application Architecture

Marker Reading Process

In the prototype of this application, the user will get a marker in the form of an image. The marker is directed at the camera from the device used. A 3D object will appear on the user's device screen according to the selected marker object.

Figure 5. AR application prototype concept

The marker design developed is in the form of a Student Worksheet that contains several markers, learning materials, and evaluations. In the design of this student worksheet, an explanation of information from the marker object is included. For example, for the Ratu Boko temple marker, information related to Ratu Boko Temple is explained, which includes history, location, and, most importantly, the mathematical concepts contained in it according to the material studied by students. Apart from being a marker for AR applications, the function of student worksheets also serves as a medium to bring students to mathematical concepts with an experimental learning model. Because the design of the student worksheets also includes steps toward mathematical concepts and improves students' critical thinking skills (Abdullah, Shanti, & Sholihah, 2019).

3.4. Implementation Stage

The implementation of the AR Application prototype with an ethnomathematical approach for geometry material for Junior High Schools was carried out at MTs As Syalafiyah Mlangi, Sleman, Yogyakarta, which was used as an example, the student responses that were obtained were quite good. In fact, students are more enthusiastic about using AR applications as a medium for learning mathematics with a cultural approach than conventionally taught classes. In addition, the interactions that occur between teachers and students are quite interesting. Observations made during the implementation of this AR application prototype showed students' excitement during the geometry learning process in class. As for the operation process, students did not experience problems and found it very easy. This was shown by the lack of user complaints that occurred during the testing process of the AR application prototype. In addition, students can also repeat the lessons learned at home independently. This is certainly very helpful for students during the COVID-19 pandemic because face-to-face learning hours are still very limited. With this smartphone-based AR learning media, students can learn geometry material independently with enthusiasm.

4. CONCLUSION

This paper concludes that android-based mathematics learning media using augmented reality technology with an ethnomathematical approach greatly motivates students to understand geometric concepts compared to students taught by conventional learning. In addition, students are getting to know the cultural values that are located around students. This smartphone-based AR learning media helps students learn geometry independently at home during the covid 19 pandemic because face-to-face learning hours are still very limited.

Acknowledgements

The author expresses his gratitude to the Ministry of Education, Culture and Higher Education (KEMNDIKBUD DIKTI) the Republic of Indonesia for the grant that has been given to the "Penelitian Kerjasama Antar Perguruan Tinggi (PKPT)" scheme between Alma Ata University Indonesia and Yogyakarta State University Indonesia.

REFERENCES

Abdullah, A. A., & Rochmadi, T. (2020). Student Perceptions Towards Moodle and Kahoot Based e-Learning in Learning Mathematics. Proceeding International Conference on Science and Engineering, 3(April), 315–318.

Abdullah, A. A., Shanti, W. N., & Sholihah, D. A. (2019). Critical Thinking Ability Development Students Through Experiential Learning In The Calculus Class. IOP-J Series, 0.

Abidah, A., Hidaayatullaah, H. N., Simamora, R. M., Fehabutar, D., & Mutakinati, L. (2020). The Impact of Covid-19 to Indonesian Education and Its Relation to the Philosophy of "Merdeka Belajar." Studies in Philosophy of Science and Education, 1(1), 38–49. https://doi.org/10.46627/sipose.v1i1.9

Aditya, F., Trisno, B., Nurwijayanti, A., & Fitriana, L. (2018). The Use of Geometry Learning Media Based on Augmented Reality for Junior High School Students The Use of Geometry Learning Media Based on Augmented Reality for Junior High School Students. IOP Conf. Series: Materials Science and Engineering, 1–7. https://doi.org/10.1088/1757-899X/306/1/012029

Atmajaya, D. (2017). IMPLEMENTASI AUGMENTED REALITY UNTUK. ILKOM Jurnal Ilmiah Volume, 9(2), 227–232.

Bahri, A., Kes, M., Sp, K. K., & Makassar, U. N. (2021). Blended Learning Integrated with Innovative Learning Strategy to Improve Self-Regulated Learning. International Journal of Instruction, 14(1), 779–794.

Brandt, A., & Chernoff, E. (2015). The Importance of Ethnomathematics in the Math Class. Ohio Journal of School Mathematics, (71), 31–36.

Fauzy, A., & Nurfauziah, P. (2021). Kesulitan Pembelajaran Daring Matematika Pada Masa Pandemi COVID- 19 di SMP Muslimin Cililin. Jurnal Cendekia: Jurnal Pendidikan Matematika, 05(01), 551–561.

François, K., & Kerkhove, B. Van. (2010). Ethnomathematics and the philosophy of mathematics. Centre for Logic and Philosophy of Science. (October 2009), 121–154.

Haji, S. (2018). Analisis Kesulitan Siswa dalam Menyesaikan Soal-Soal PISA (Programme for International Student Assessment) di SMP Kota Bengkulu. Jurnal Pendidikan Matematika Raflesia, 03(02), 177–183.

Handayani, S. D., & Irawan, A. (2020). Pembelajaran matematika di masa pandemic covid-19 berdasarkan pendekatan matematika realistik. Jurnal Math Educator Nusantara, 6(2), 179–189.

Herawaty, D., Sarwoedi, S., Marinka, D. O., Febriani, P., & Wirne, I. N. (2019). Improving student's understanding of mathematics through ethnomathematics. Journal of Physics: Conference Series, 1318(1). https://doi.org/10.1088/1742-6596/1318/1/012080

Imswatama, A., & Lukman, H. S. (2018). The Effectiveness of Mathematics Teaching Material Based on Ethnomathematics. International Journal of Trends in Mathematics Education Research, 1(1), 35.

https://doi.org/10.33122/ijtmer.v1i1.11
Johar, R. (2012). Domain Soal PISA untuk Literasi Matematika. Jurnal Peluang, 1(1), 30–41.
Kintoko, & Jana, P. (2019). Development of Mathematics Module on the Material of Flat Side Space Building in DIY Culture-Based. Journal of Physics: Conference Series, 1254(1). https://doi.org/10.1088/1742-6596/1254/1/012072
Mailizar, Almanthari, A., Maulina, S., & Bruce, S. (2020). Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: The case of Indonesia. Eurasia Journal of Mathematics, Science and Technology Education, 16(7). https://doi.org/10.29333/EJMSTE/8240
Mulenga, E. M., & Marbán, J. M. (2020). Is covid-19 the gateway for digital learning in mathematics education? Contemporary Educational Technology, 12(2), 1–11. https://doi.org/10.30935/cedtech/7949
Mustaqim, I. (2016). PEMANFAATAN AUGMENTED REALITY SEBAGAI MEDIA PEMBELAJARAN. Jurnal Pendidikan Teknologi Dan Kejuruan, 13(2), 174–183.
Mustaqim, I., Pd, S. T., & Kurniawan, N. (2017). AUGMENTED REALITY. Jurnal Edukasi Elektro, 1(1), 36–48.
Narulita, D., Mardiyana, M., & Saputro, D. R. S. (2019). Ethnomathematics in Traditional Wayang Performance in Surakarta as a Source of Mathematics Learning in Junior High School. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal, 2(2), 115–122. https://doi.org/10.33258/birle.v2i2.281
OCDE. (2019). PISA 2018 Results (volume i): what students know and can do. Paris: OECD Publishing.
Pramudita, K., & Rosnawati, R. (2019). Exploration of Javanese culture ethnomathematics based on geometry perspective. Journal of Physics: Conference Series, 1200(1). https://doi.org/10.1088/1742-6596/1200/1/012002
Richardo, R., Martyanti, A., & Suhartini. (2019). Developing ethnomathematical tasks in the context of yogyakarta to measure critical thinking ability. Journal of Physics: Conference Series, 1188(1). https://doi.org/10.1088/1742-6596/1188/1/012063
Rif'an, A. A. (2016). Tourism Components and Tourists Characteristic of Prambanan Temple As the World Culture Heritage Site in Yogyakarta, Indonesia. International Journal of Tourism and Hospitality Study, 1(1), 1–10.
Rosa, M., & Clark, D. (2011). Ethnomathematics: the cultural aspects of mathematics. Revista Latinoamericana de Etnomatemática, 4(2), 32–54.
Safitri, P. T., Yasintasari, E., Putri, S. A., & Hasanah, U. (2020). Analisis Kemampuan Metakognisi Siswa dalam Memecahkan Masalah Matematika Model PISA. Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang, 4(1), 11. https://doi.org/10.31331/medivesveteran.v4i1.941
Sharifah, R., & Faaizah, S. (2015). The Development of Online Project Based Collaborative Learning using ADDIE Model. Procedia - Social and Behavioral Sciences, 195, 1803–1812. https://doi.org/10.1016/j.sbspro.2015.06.392
Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. Journal on Mathematics Education, 2(2), 95–126. https://doi.org/10.22342/jme.2.2.746.95-126
Sudirman, Poppy Yaniawati, Mellawaty, R. I. (2021). Augmented reality application : What are the constraints and perceptions of the students during the covid 19 pendemic ' s 3D geometry learning process ? Augmented reality application : What are the constraints and perceptions of the students during the co. Journal of Physics: Conference Series, 1783(012007), 1–7. https://doi.org/10.1088/1742-6596/1783/1/012007
Syahrin, M. A., Turmudi, T., & Puspita, E. (2016). Study ethnomathematics of aboge (alif, rebo, wage) calendar as determinant of the great days of Islam and traditional ceremony in Cirebon Kasepuhan Palace. AIP Conference Proceedings, 1708. https://doi.org/10.1063/1.4941172
W Widada, D Herawaty, K. U. Z. N. and A. F. D. A. (2021). Augmented Reality assisted by GeoGebra

3-D for geometry learning Augmented Reality assisted by GeoGebra 3-D for geometry learning. Journal of Physics: Conference Series, 1731(012934), 1–10. https://doi.org/10.1088/1742-6596/1731/1/012034