Jurnal Analisa 9 (1) (2023) 22-36
http://journal.uinsgd.ac.id/index.php/analisa/index
p-ISSN : 2549-5135 e-ISSN : 2549-5143

Development of Interactive Augmented Reality Multimedia Based on Ethnomatematics

Rahayu Kariadinata, Amelia Muhibatul Milah*, and Hamdan Sugilar
Mathematics Education, State Islamic University Sunan Gunung Djati
Jl. Soekarno Hatta Cimencrang, Bandung, Indonesia
*ameliamilah24@gmail.com

Received: 4 Juni 2023 ; Accepted: 24 Juni 2023 ; Published: 30 Juni 2023

Doi: 10.15575/ja.v9i1.26032

Abstrak

Matematika disajikan dalam konsep yang abstrak sehingga diperlukan adanya fasilitas yang dapat memberikan kemudahan dalam memahami konsep tersebut salah satunya dapat melalui penerapan multimedia interaktif. Tujuan penelitian ini adalah mengembangkan multimedia interaktif *Augmented Reality* berbasis etnomatematika yang dapat digunakan pada pembelajaran materi bangun ruang sisi datar. Metode yang digunakan pada penelitian yaitu *Research and Development* (R&D) model ADDIE (*Analysis, Design, Development, Implementation, Evaluation).* Sampel penelitian yaitu kelas VIII F di salah satu SMP di Bandung sebagai kelas uji coba produk. Instrumen yang digunakan yaitu instrumen tes dan non tes. Hasil penelitian diperoleh: 1) Hasil uji validitas memiliki kriteria sangat valid dengan rata-rata persentase total sebesar 89,51%; 2) Hasil uji praktikalitas pada skala besar dengan total persentase 81,8% kriteria sangat Practical; 3) Hasil uji efektivitas pada skala besar dengan persentase 40% pada kriteria cukup efektif. Sehingga dapat disimpulkan multimedia interaktif *Augmented Reality* berbasis etnomatematika layak untuk digunakan dalam pembelajaran.

Kata kunci: *Augmented Reality*, Etnomatematika, Multimedia Interaktif.

Abstract

Mathematics is presented in an abstract concept, so it is necessary to have facilities that can provide convenience in understanding these concepts, one of which can be through the application of interactive multimedia. The purpose of this research is to develop an interactive Augmented Reality based on ethnomathematics that can be used in learning polyhedron. The method used in this research is Research and Development (R&D) with ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The research sample was 8th grade calss of junior high school in Bandung city as a product trial class. The instruments used are test and non-test instruments. The research results obtained: 1) The results of the validity test shows that the developed multimedia have a very valid criteria with total average percentage of 89.51%; 2) The results of the practicality test on a large scale with total percentage of 81.8% with very practical criteria; 3) The results of the effectiveness test on a large scale with percentage of 40% on the criterion of being quite effective. So, it can be concluded that interactive augmented eeality multimedia based on ethnomathematics is feasible to use in learning.

Keywords: *Augmented Reality, Ethnomathematics, Interactive Multimedia.*

1. INTRODUCTION

In the 21st century, technology has become an important component (Caena & Redecker, 2019: 3). In its application, technology contributes to various sectors, including business, industry, to education, and even personal life (Sugilar, 2020: 442). The application of technology in education has an important role, especially in learning mathematics (Susilawati et al., 2022: 74). Where the application of this technology has the potential to improve the teaching and learning process of mathematics (Cullen et al., 2020: 2). So that the application of technology in abstract mathematics learning makes it easy for students to understand the material. It was confirmed by Putrawangsa & Hasanah (2018: 43-44) that the application of technology to learning mathematics provides positive benefits, including increasing students' achievement through the use of technology, improving the quality of learning effectively through the use of technology, and being able to provide directions and instructions in carrying out learning process in the classroom (Simamora, 2020: 87).

However, the reality on the ground states that the use of technology in learning is still underused by teachers. This statement supported by the results of a research by Remillard et al. (2021: 1334) that in mathematics learning activities, teachers use blackboards and books more often than utilizing digital technology media. One reason is that there is still a sense of concern felt by teachers that the use of digital technology in learning mathematics will be misused by students (Ge et al., 2021: 80). Based on the results of a preliminary study through interviews at a junior high school in Bandung, it shows that even though there is a multimedia room in the school, the use of technology in mathematics learning activities has not been fully utilized, especially in the use of interactive multimedia. Sari et al (2020: 3) has views that contradict this. She stated that it is necessary to use media in learning mathematics through the use of interactive multimedia.

The use of interactive multimedia has long been an option in the process of revolutionizing education (Tuma, 2021: 232). The benefits of using interactive multimedia, according to Phillips (2014: 12), is that interactive multimedia has the potential to accommodate various ways of learning and there is a multisensory environment in interactive learning multimedia to support certain ways of learning. The use of interactive multimedia in mathematics learning can be done by using Augmented Reality. Augmented Reality (AR) is a sophisticated technology that can be utilized as interactive multimedia. 2D and/or 3D objects can be projected into the virtual world directly or in real time using Augmented Reality technology (Rauschnabel et al., 2022). The main principle of Augmented Reality is to present virtual components in the form of the real world. There is interaction with three-dimensional objects, that can be operated interactively and in a real manner (Sutresna, Yanti, dan Safitri, 2020: 425).

Apart from mathematics being related to technology, mathematics can also be applied in various aspects of life (Genc & Erbas, 2019: 229). That way, mathematics can also be said to have a close relationship with culture. D'Ambrosio (2007: 26) states that learning mathematics can be adapted to culture through an ethnomathematics approach. Ethnomatematics refers to every activity consisting of calculating, determining the location, designing, measuring, playing, and explaining (Bishop, 1988: 183-184).

Through the application of ethnomathematics, students are trained to be able to use mathematical experiences from everyday experience and culture to understand how mathematical ideas are formulated and applied (Verner et al., 2019: 2). As well as with an ethnomathematics approach it is easier for students to understand a material learned through the culture that surrounds them (Kariadinata et al., 2021: 21-22). According to Rahmawati & Muchlian, (2019: 125) One way to pack so that learning mathematics is more meaningful namely by linking to the context life around students or culture that it's so entrenched that it's become a thing concrete and meaningful in the minds of students. through teaching based materials local wisdom of students can improve learning outcomes and improve communication skills student mathematics (Hidayat et al., 2021: 214).

An example of applying ethnomathematics is the polyhedron concept found on the Ratu Boko Temple site. The Ratu Boko Temple site consists of several areas including the gate, paseban, Batukapur Temple, Pembokoran Temple, Pendapa, Keputren, and Goa (M. A. Sari, 2019). One of the polyhedron concepts on the Ratu Boko temple site is found in the gate and paseban area. At the gate of Ratu Boko Temple there are geometric shapes, namely triangles, squares, rectangles, cubes, blocks, and pyramids. Meanwhile, in the paseban area, there are geometric concepts, namely rectangles and blocks.

From the previous description, researchers found opportunities where mathematics is a basic science in education, as explained by Ariyanto et al. (2020: 36), which states that both applied and reasoning aspects of mathematics have an important role in life. So that the presentation of mathematics that is contextual and interesting needs to be applied to learning mathematics, one of its applications is in polyhedron.

2. METHOD

The method used in this research is the ADDIE Research and Development (R&D) method with a series of stages, namely Analysis, Design, Development, Implementation, and Evaluation popularized by Branch (2009: 3). These stages are listed in Figure 1 below.

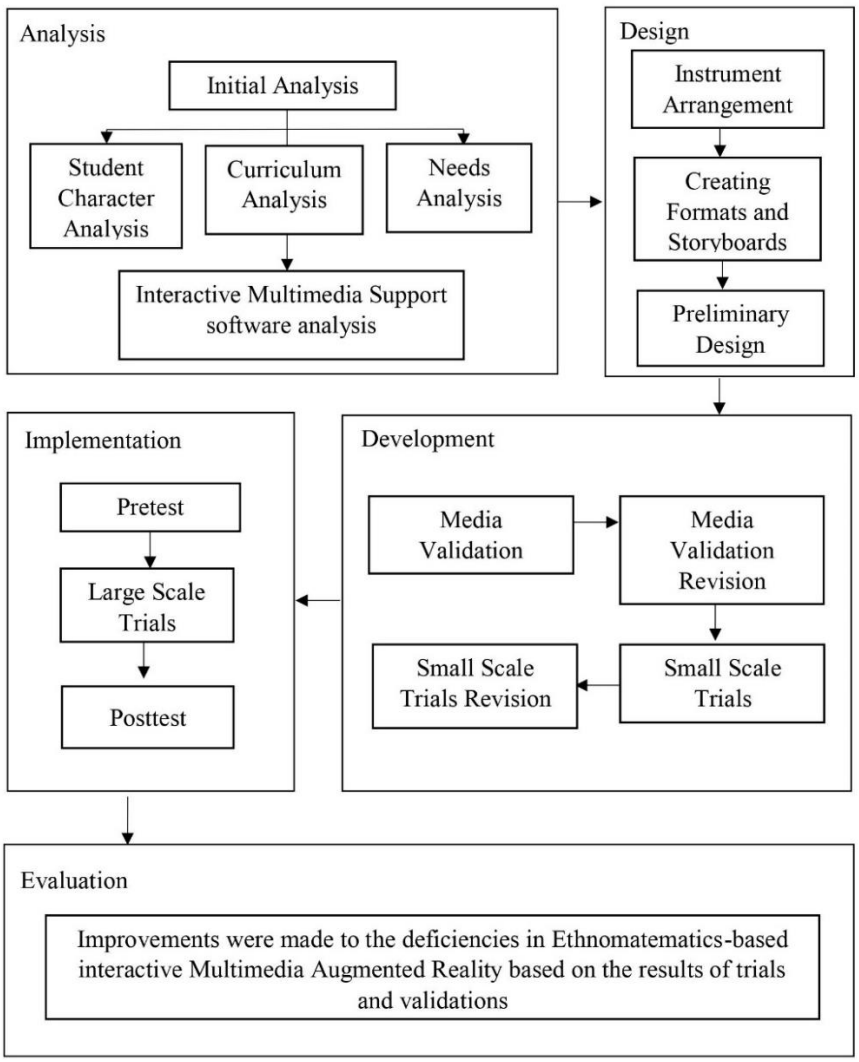


Figure 1. Stages of the ADDIE Development Model

Based on Figure 1, the flow of developing an interactive multimedia Augmented Reality based on ethnomatematics with the ADDIE model consists of the analysis phase consists of character analysis of students, curriculum analysis, needs analysis, and analysis of supporting software used in multimedia development. The design stage consists of selecting media, selecting formats, making storyboards or initial media designs and preparing instruments to test students' critical thinking skills. The development stage consists of creating or developing the interactive Augmented Reality multimedia based on ethnomathematics, small-scale trials, product validation, and revision. The implementation stage consists of a pretest, large-scale trial, and posttest to determine the level of practicality and effectiveness of multimedia. At the evaluation stage, improvements were made to Ethnomatematics-based interactive Augmented Reality multimedia.

The research instruments used include test and non-test instruments. The test instrument in this study was a test of students' critical thinking skills consisting of a pretest and a posttest consisting of five descriptive questions and identical. Meanwhile, the non-test instruments used in this study were media expert and material expert validation sheets, as well as practicality questionnaire sheets. This study used two data analysis techniques, namely descriptive qualitative analysis and quantitative descriptive analysis. Qualitative data in the form of comments and suggestions for product improvement from media experts and material experts. Quantitative data were in the form of media expert assessment scores, material expert assessment scores, student response scores to ethnomathematics-based interactive Augmented Reality multimedia, and pretest and posttest scores. Then the value that has been obtained is converted to each criterion.

To determine the level of validity and practicality of the ethnomathematics-based Augmented Reality interactive multimedia developed, the data results are concluded by conducting an analysis with the criteria in table 1 and 2 as follows.

Table 1. Validity Criteria

Value	Criteria
81% - 100%	Veri Valid
61% - 80%	Valid
41% - 60%	Reasonably Valid
21% - 40%	Less Valid
< 20%	Not Valid

Source: (Riduwan, 2011)

Table 2. Practical Criteria

Value	Criteria
81% - 100%	Very Pratical
61% - 80%	Pratical
41% - 60%	Reasonably Pratical
21% - 40%	Less Pratical
< 20%	Not Pratical

Source: (Riduwan, 2011)

To determine the level of effectiveness namely by using the results of the students' Pretest and Posttest. The results of student scores are then calculated using the N-Gain formula with the criteria in table 3 as follows.

Table 3. N-Gain Criteria

Value	Criteria
N-Gain < 0,3	Little
0,3 < N-Gain < 0,7	Currently
N-Gain > 0,7	High

3. RESULTS AND DISCUSSION

A. Development Process Interactive Multimedia Augmenetd Reality Based on Ethnomathematics

The research and development model used in this research is the ADDIE model with a series of stages, namely, Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, the researcher conducted a preliminary study and interview with one of the teachers to obtain initial data, including analysis of student character, curriculum analysis, needs analysis, and analysis of supporting software used in the development of interactive Augmented Reality multimedia based on ethnomathematics.

Analysis of the students' character was obtained through interviews and pre-tests. Based on the results of an interview with an 8th grade mathematics teacher, it was found that students' critical thinking skills and understanding of concepts at the school still needed to be improved. In addition, the results of the initial test showed that there were some students' answers that were not in accordance with the indicators of critical thinking skills. This can be seen from the way students' answer that they are still confused about finding solutions and final conclusions in solving mathematical problems related to ethnomathematics. Based on the results of the character analysis of the students, the researchers found that the ability of the students to provide answers related to indicators of critical thinking ability and understanding of the concept of flat-sided geometric shapes needed to be improved.

Curriculum analysis was obtained through interviews with mathematics teachers. Based on the results of the interviews, it was found that the school implemented the Kurikulum 2013 for 8th grade class. Based on the results of the analysis of the applicable curriculum, it is known that the core competencies (KI) that are determined so that 8th grade students can achieve are KI 3 and KI 4. Based on the results of curriculum analysis that one of the 8th grade mathematics subject matters refers to the Kurikulum 2013, namely the polyhedron that is studied in even semesters according to Core Competencies and Basic Competencies.

Needs analysis obtained through direct observation. The results of the needs analysis show that the availability of technological media that can be applied in learning in schools is quite complete. However, technology-based mathematics learning media is still lacking and cannot be utilized optimally. The process of delivering polyhedron only uses the lecture or discussion method with explanations from textbooks without using multimedia, even though studying this material requires learning media that displays the three-dimensional shape of the flat sided shapes. So that with the available facilities, it is necessary to develop learning media on polyhedron.

The results of the analysis of supporting software that can be used in developing interactive Augmented Reality multimedia based on ethnomathematics are Unity 3D and Vuforia SDK. Both of these softwares can help researchers in developing applications because Unity 3D has features that can display images in three dimensions and Unity 3D is used as a medium in making interactive multimedia that can be used on Android. While the Vuforia SDK is used by researchers as a link and database of Augmented Reality features.

The next stage is the design stage. This stage consists of making storyboards and preparing instruments for testing students' critical thinking skills consisting of a pretest and a posttest consisting of five descriptive questions and identical, as well as the preparation of media expert validation sheets, material expert validation, and practicality questionnaire sheets. Making storyboards aims to provide information on the multimedia development process. The example storyboard as follows:

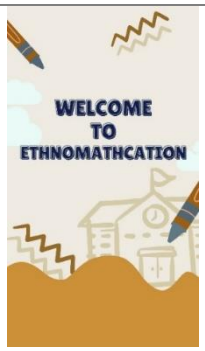
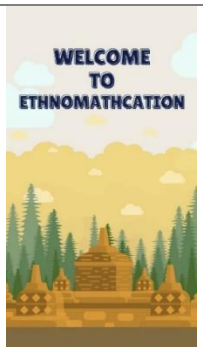
Table 4. Storyboard Interactive Augmented Reality Multimedia Based on Ethnomatematics

Scene Title	**Scene 1 of 13**	**Information**
Menu		
		In scene 1 there is the main menu, in which there are several buttons to navigate to the material page, the history of the Ratu Boko temple site, Augmented Reality features, Quiz, information, instructions for use, and setting the music volume.
Scene Title	*Scene* 2 of 13	Information
Menu		
		In scene 2 there is a material menu, in which there are several buttons to navigate to the cube material page, block material, competencies, and the home button to the main page

After the storyboard was designed, then the development of interactive Augmented Reality multimedia based on ethnomathematics was carried out. After the multimedia is developed, expert validation is then carried out. Expert validation aims to determine the feasibility of the developed multimedia. Expert validation involves 2 experts, namely media expert validation and material expert validation. The results of the assessment from the validator are used for revision guidelines so that media that is feasible to operate will later be produced.

In the first phase of media validation, the media expert validator gave a feasibility of 69.27% with the criteria of interactive Augmented Reality multimedia based on ethnomathematics that can be used with improvements. In the second stage of media validation, the media expert validator gives a feasibility of 96.2% with the criteria of interactive Augmented Reality multimedia based on ethnomathematics that can be used without improvement. Material validation by material experts was carried out once and obtained a feasibility result of 96.875 with very valid criteria. The material validator conveys suggestions for adding sample questions along with their discussion. The results of improvements to interactive Augmented Reality multimedia based on ethnomathematics after being validated by media experts and material experts are presented in Table 5 and Table 6.

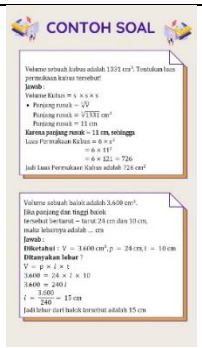
Table 5. Improvements According to Advice from Media Experts

No	Before revision	After revision
1.		
Changing the appearance of the start page to better display the ethnomathematics side		
No	**Before revision**	**After revision**
2.		
Changes in the appearance of the menu page so that it better displays the ethnomathematics side and builds flat side spaces as well as changes in the appearance of the information button from round icons to writing		
No	**Before revision**	**After revision**
3.		
Added reference buttons and sample questions		
No	Before revision	After revision

4.	Not yet added	
Added material and historical reference pages		
No	Before revision	After revision
5.		
Changes in the display of information from written form to a flowchart		
No	Before revision	After revision
6.		
Adding ethnomathematics pictures to the quiz questions according to the buildings listed in the questions		

Table 6. Improvements according to suggestions from material experts

No	Before revision	After revision

1.	Not yet added	
Added sample question pages along with discussion on the material menu		

Based on Table 5, media expert validators provide suggestions and input for improving interactive Augmented Reality multimedia based on ethnomathematics which are developed including: a). Improved display on some pages. b). Adding a reference page in the material section. c). Adding pictures to quizzes. d). Editorial fixes on some pages. Meanwhile, Table 6 shows suggestions and input from material experts to add examples of questions and discussion in the material section.

At the implementation stage, product trials are carried out. The product testing phase consists of small-scale trials and large-scale trials. The small-scale trial was carried out by 10 students independently for 4 days from 03 – 06 May 2023. After the small-scale trial was carried out, students were given a practical questionnaire. The result of a small-scale practicality questionnaire was 80.8% which was included in the practical criteria. The large-scale trial phase was carried out on Monday, 08 May 2023 in class and continued independently. After the interactive Augmented Reality multimedia based on ethnomathematics was given to the large class, the practicality questionnaire score was 81.8% in the practical category and the posttest results combined with the pretest results were 0.4 in the moderately effective category.

The following is the evaluation stage. The results of the analysis, evaluation, and student responses are used as a reference for whether or not the final stage of media revision is necessary. Based on the stages of analysis, design, development, and implementation, the results of the evaluation show that interactive Augmented Reality multimedia based on ethnomathematics is feasible to use polyhedron without the need for repair.

B. Analysis of the Validity of Development Interactive Augmented Reality Multimedia Based on Ethnomatematics

Learning media validation analysis was carried out 2 times, namely before and after the implementation of small-scale trials. This interactive Augmented Reality multimedia based on ethnomathematics validator consists of two people, namely one material expert validator and one media expert validator. The results of the media assessment by media experts in the first stage, the results are presented in Table 7 and the second stage is presented in Table 8.

Table 7. Media Expert's First Validation Analysis

Aspect	Indicator	Score	Percentage
Appearance	Colors	3	75%
	Graphics	3	
	Design	3	
	Animations	2	
Language	Choice of words	2	62,5%

Aspect	Indicator	Score	Percentage
	Terms, symbols and icons	3	
Convenience and Practicality	Convenience	3	66,6%
	Practicality	2	
overall percentage			**68,05%**
Category			**Valid**

Based on Table 7, the percentage results for all aspects of the media expert's assessment were 69.27% with valid criteria. From the first stage of validation, the validator provides suggestions and input, namely: a). Improved display on some pages; b). Adding a reference page to the material section; c). Adding pictures to quizzes; d). Editorial fixes on some pages. The results of the second validation are presented in Table 8.

Table 8. Validation Analysis of the Second Media Experts

Aspect	Indicator	Score	Percentage
Appearance	Colors	3	95%
	Graphics	3	
	Design	3	
	Animations	2	
Language	Choice of words	2	93,75%
	Terms, symbols and icons	3	
Convenience and Practicality	Convenience	3	100%
	Practicality	2	
Overall Percentage			**92,25%**
Category			**Very Valid**

Based on Table 8, the percentage results for all aspects of the media expert's assessment were 96.25% with very valid criteria. Subsequent validation does not need to be carried out because the developed multimedia has obtained very valid criteria. Material validation was carried out once by material experts. The results of the material validation are presented in Table 9.

Table 9. Material Expert Validation Analysis

Aspect	Indicator	Score	Percentage
Compatibility of Material with SK and KD	Material completeness	4	100%
	Material scope	4	
	Material depth	4	
Material Accuracy	Concept and definition accuracy	4	100%
	Facts and data accuracy	4	
	Priciple accuracy	4	
	Example accuracy	4	
	Graphics accuracy	4	
	Notation accuracy	4	
Learning Material Support	Reasoning	3	87,5%
	Relation	4	

Aspect	Indicator	Score	Percentage
	Communication	3	
	Application	4	
	Material attractiveness	4	
	Encouraging	3	
Novelty	Encouraging	4	100%
	Actual diagrams and illustrations	4	
	Case examples related to ethnomathematics	4	
	Case examples are close to students	4	
Overall Percentage			**96,875%**
Category			**Very Valid**

Based on Table 9, the results of the percentage of all aspects of the material expert's assessment were 96.875% with very valid criteria. Subsequent validation does not need to be carried out because the developed multimedia has obtained very valid criteria. Based on the results of validation by media experts and material experts, it can be concluded that interactive Augmented Reality multimedia based on ethnomathematics has a very valid validity level with an average total percentage of 89.51%.

The learning device is said to be valid if expert judgment shows that the development of the device has internal consistency between every aspect that is assessed is the relationship between the components in the learning device (Ramadhan et al., 2019). Further stated by Fitra and Maksum (2021), that if all aspects of the assessment have reached validity criteria, then the developed media is declared fit for use in research.

C. Practicality Analysis of Development Interactive Augmented Reality Multimedia Based on Ethnomatematics

Practicality questionnaires were filled in by students when they finished carrying out learning using media during small-scale trials and large-scale trials. The results of the practicality questionnaire analysis on a small-scale trial totaling 10 students are presented in Table 10.

Table 10. Practicality Analysis of Small Scale Interactive Augmented Reality Multimedia Based on Ethnomatematics

No	Aspect	Score	Percentage	Criteria
1	Appearance	0,781	78.1%	Practical
2	Material Presentation	0,833	83.3%	Practical
3	Language	0,825	82.5%	Practical
4	Convenience and Practicality	0,792	79.2%	Practical
Overall Percentage			**80,8%**	**Practical**

Based on the results of the Practicality questionnaire analysis on a small scale, it was obtained that the Practicality Score of interactive Augmented Reality multimedia based on ethnomathematics by students was 80.8% which was included in the Practical criteria. Furthermore, the results of the practicality questionnaire analysis on a large-scale trial totaling 34 students of 8th grade class at one of the junior high schools in Bandung are presented in Table 11.

Table 11. Practicality Analysis of Large Scale Interactive Augmented Reality Multimedia Based on Ethnomatematics

No	Aspect	Score	Percentage	Criteria
1	Appearance	0,798	79,8%	Practical
2	Material Presentation	0,84	84%	Practical
3	Language	0,834	83,4%	Practical
4	Convenience and Practicality	0,799	79,9%	Practical
Overall Percentage			**81,8%**	**Practical**

Based on the results of the Practicality questionnaire analysis on a large scale, it was obtained that the Practicality Score of interactive Augmented Reality multimedia based on ethnomathematics by students was 81.8% which was included in the Practical criteria. This is in line with research conducted by Nugraha et al (2021: 139) states that through Augmented Reality teachers can make learning media fun, interactive, and easy to use.

D. Effectiveness Analysis of Development Interactive Augmented Reality Multimedia Based on Ethnomatematics

Analysis of the effectiveness test results in the use of interactive Augmented Reality multimedia based on ethnomatematics polyhedron was obtained through the Pretest and Posttest Scores. After the test is carried out, the results of students' answers will be calculated using N-Gain. Following are the results of effectiveness tests in large-scale trials presented in Table 12.

Table 12. Average N-Gain Increase

Category	Score
Pretest	50,12
Posttest	70,2
Average Difference	20,08
N-Gain Class (100%)	0,4
Criteria	**Medium**

Based on Table 12, it can be seen that the average posttest result has an increase compared to the pretest average result. The test of increasing the average N-Gain score obtained by students experienced an average increase of 0.4 with moderate criteria and an average difference of 20.08 with a fairly effective criterion interpretation. Refer to the criteria stated Kariadinata (2007: 72) multimedia-based mathematics learning software can be used as an effort to develop students' mathematical thinking skills. In line with this the results of Andriani's research (2021: 64) state that the use of Android based media shows there is significant increase in learning outcomes.

Overall, the research findings show that the development of ethnomathematics-based Augmented Reality interactive multimedia on polyhedron material is very valid, useful, practical, and effective for use in the learning process in the classroom. According to research Arifin, the created Augmented Reality media is valid and practical, hence it is appropriate for usage in the educational process (Arifin et al., 2020: 71-72).

Implementation of teaching and learning activities using interactive multimedia Augmented Reality based on ethnomathematics can train students to think critically and increase student interest in learning. By utilizing cultural values in Ratu Boko temple which is associated with mathematical concepts, it provides new experiences and trains students to be able to think critically about how mathematics and culture are related. Therefore, these findings show how useful interactive multimedia Augmented Reality based on ethnomathematics is as a learning tool. Moreover, according to Suryanti's research (2020: 6) states that the use of educational media using Augmented Reality can stimulate the mindset of students in thinking critically about a problem and events that exist in students' daily lives. In line with this, according to Aditama (2019: 181) the application of

Augmented Reality technology in the education sector can stimulate the mindset of students to think critically about problems and events that occur in the environment or daily life. Learning through Augmented Reality media can make learning activities in the classroom fun, interactive and easy to use .

4. CONCLUSION

This research has produced an interactive multimedia product Augmented Reality based on ethnomathematics on the material Flat sided space with cultural values at the Ratu Boko temple site. The findings of this study lead to the conclusion that the ethnomathematics-based Augmented Reality interactive multimedia made in this study is very valid, practical, and effective enough to be used in the learning process. Based on the results of the validity assessment of 89.51% and results practicality assessment by students with a percentage of 80.8% percent for small groups and 81.8% for large groups, the quality of interactive multimedia is developed based on the development of the ADDIE model which consists of analysis, design, development, implementation, and evaluation. Furthermore, based on the results of the pretest and posttest carried out by students, it shows that interactive multimedia Augmented Reality based on ethnomathematics is quite effective in learning mathematics with an effectiveness percentage of 40% in the criteria of being quite effective.

Reference

Aditama, P. W., Adnyana, I. N. W., & Ariningsih, K. A. (2019). Augmented reality dalam multimedia pembelajaran. *SENADA (Seminar Nasional Manajemen, Desain Dan Aplikasi Bisnis Teknologi)*, *2*, 176–182.

Andriani, R., & Suratman, A. (2021). Media pembelajaran berbasis andrioid untuk meningkatkan motivasi dan hasil belajar siswa. *Jurnal Analisa*, *7*(1), 56–65.

Arifin, A. M., Pujiastuti, H., & Sudiana, R. (2020). Pengembangan media pembelajaran STEM dengan augmented reality untuk meningkatkan kemampuan spasial matematis siswa. *Jurnal Riset Pendidikan Matematika*, *7*(1), 59–73.

Ariyanto, L., Rahmawati, N. D., & Haris, A. (2020). Pengembangan mobile learning game berbasis pendekatan kontekstual terhadap pemahaman konsep matematis siswa. *JIPMat*, *5*(1), 36–48. https://doi.org/10.26877/jipmat.v5i1.5478

Ariyatun, A., & Octavianelis, D. F. (2020). Pengaruh model problem based learning terintegrasi stem terhadap kemampuan berpikir kritis siswa. *Journal of Educational Chemistry (JEC)*, *2*(1), 33–39.

Bishop, A. J. (1988). Mathematics education in its cultural context. *Educational Studies in Mathematics*, *19*(2), 179–191.

Branch, R. M. (2009). *Instructional design: The ADDIE approach* (Vol. 722). Springer Science \& Business Media.

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369.

Cullen, C. J., Hertel, J. T., & Nickels, M. (2020). The roles of technology in mathematics education. *The Educational Forum*, *84*(2), 166–178.

D'Ambrosio, U. (2007). Peace, social justice and ethnomathematics. *The Montana Mathematics Enthusiast, Monograph*, *1*(2007), 25–34.

Fitra, J., & Maksum, H. (2021). Efektivitas media pembelajaran interaktif dengan aplikasi powntoon pada mata pelajaran bimbingan TIK. *Jurnal Pedagogi Dan Pembelajaran*, *4*(1), 1–13.

Ge, J., Smyth, R. E., Searle, M., Kirkpatrick, L., Evans, R., Elder, A., & Brown, H. (2021). Perspectives from students: How to tame the chaos and harness the power of technology for learning. *Brock Education Journal*, *30*(1), 74.

Genc, M., & Erbas, A. K. (2019). Secondary mathematics teachers' conceptions of mathematical literacy. *International Journal of Education in Mathematics, Science and Technology*, *7*(3), 222–237.

Hidayat, D. W., Pujiastuti, H., & Mutaqin, A. (2021). Pengembangan bahan ajar matematika berbasis kearifan lokal untuk siswa SMP kelas VII. *Jurnal Analisa*, *7*(2), 207–215.

Kariadinata, R. (2007). Desain dan pengembangan perangkat lunak (software) pembelajaran matematika berbasis multimedia. *Jurnal Pendidikan Matematika*, *1*(2), 56–73.

Milah, A. M., Susilawati, W., T Tutut Widiastuti, A., & Ariany, R. L. (2022). Technology Adaptation in Mathematics Learning. *Gunung Djati Conference Series*, *12*, 73–79.

Ningsih, A. K., Kariadinata, R., & Nuraida, I. (2021). Peningkatan kemampuan komunikasi matematis siswa dengan pembelajaran berbasis etnomatematika. *Lentera: Jurnal Ilmiah Kependidikan*, *16*(1), 20–35.

Nugraha, A. C., Bachmid, K. H., Rahmawati, K., Putri, N., Hasanah, A. R. N., & Rahmat, F. A. (2021). Rancang bangun media pembelajaran berbasis augmented reality untuk pembelajaran tematik kelas 5 Sekolah Dasar. *Jurnal Edukasi Elektro*, *5*(2), 138–147.

Phillips, R. (2014). *The Developer's Handbook of Interactive Multimedia*. Routledge.

Putrawangsa, S., & Hasanah, U. (2018). Integrasi teknologi digital dalam pembelajaran di era industri 4.0. *Jurnal Tatsqif*, *16*(1), 42–54.

Rahmawati, Y., & Muchlian, M. (2019). Eksplorasi etnomatematika rumah gadang minangkabau Sumatera Barat. *Jurnal Analisa*, *5*(2), 123–136.

Ramadhan, S., Mardapi, D., Prasetyo, Z. K., & Utomo, H. B. (2019). The development of an instrument to measure the higher order thinking skill in physics. *European Journal of Educational Research*, *8*(3), 743–751.

Rauschnabel, P. A., Babin, B. J., tom Dieck, M. C., Krey, N., & Jung, T. (2022). What is augmented reality marketing? Its definition, complexity, and future. In *Journal of Business Research* (Vol. 142, pp. 1140–1150). Elsevier.

Remillard, J. T., Van Steenbrugge, H., Machalow, R., Koljonen, T., Krzywacki, H., Condon, L., & Hemmi, K. (2021). Elementary teachers' reflections on their use of digital instructional resources in four educational contexts: Belgium, Finland, Sweden, and US. *ZDM--Mathematics Education*, *53*(6), 1331–1345.

Riduwan, S. (2011). Pengantar Statistika untuk penelitian pendidikan, sosial, ekonomi, komunikasi

dan bisnis. *Cetakan Ke-4 Bandung: Alfabeta*.

Sari, I. P., Nurtamam, M. E., & Hanik, U. (2020). Pengembangan multimedia interaktif berbasis game 2d flash pada pembelajaran matematika materi pecahan sederhana untuk siswa kelas III UPTD SDN Banyuajuh 4 Kamal. *Widyagogik: Jurnal Pendidikan Dan Pembelajaran Sekolah Dasar*, *7*(2), 83–91.

Sari, M. A. (2019). *Pesona Candi Ratu Boko di Yogyakarta*.

Simamora, R. M. (2020). The Challenges of online learning during the COVID-19 pandemic: An essay analysis of performing arts education students. *Studies in Learning and Teaching*, *1*(2), 86–103.

Sugilar, H. (2020). Multimedia matematika di era digital. *Prosiding-Seminar Nasional Teknik Elektro UIN Sunan Gunung Djati Bandung*, 442–451.1

Suryanti, S., Arifani, Y., & Sutaji, D. (2020). Augmented reality for integer learning: investigating its potential on students' critical thinking. *Journal of Physics: Conference Series*, *1613*(1), 12041.

Sutresna, J., Yanti, F., & Safitri, A. E. (2020). Media Pembelajaran Matematika Pada Usia Dini Menggunakan Augmented Reality. *JUSTIN (Jurnal Sistem Dan Teknologi Informasi)*, *8*(4), 424–429.

Tuma, F. (2021). The use of educational technology for interactive teaching in lectures. *Annals of Medicine and Surgery*, *62*, 231–235.

Verner, I., Massarwe, K., & Bshouty, D. (2019). Development of competencies for teaching geometry through an ethnomathematical approach. *The Journal of Mathematical Behavior*, *56*, 100708.