Developing Ethnomathematics-Based Learning Multimedia for Junior High School Students

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Abstract

This study aims to develop and determine the feasibility of ethnomathematics-based learning multimedia in junior high school students. This research used Research and Development methods with the ADDIE model (Analysis, Design, Development, Implementation and Evaluation). This research was conducted at Junior High School 19 Purworejo. The instruments used in this study were validation sheets, student questionnaire responses sheets, and test questions. The results of data analysis obtained from the assessment of media experts, learning and material on multimedia developed obtained an average rating of 3.63 with valid criteria. The results of the questionnaire data analysis of student responses to multimedia learning based on ethnomathematics obtained very practical criteria with a percentage of 81%. Learning multimedia is declared effective based on the effectiveness of the test results using the t-test; it can be concluded that there is a difference between before and after learning multimedia based on ethnomathematics. Thus, ethnomathematics-based learning multimedia developed in this study is categorized as suitable for mathematics learning in junior high school.

Keywords: Learning Multimedia, Ethnomatematics, ADDIE Model

INTRODUCTION

Learning mathematics should begin with introducing problems through contextual learning. Mathematics is inseparable from students' daily experiences, if mathematics is seen as independent then they will quickly forget and cannot apply mathematics contextually (Astuti & Purwoko, 2017). Therefore, schools are expected to be able to use information and communication technology such as computers, teaching aids, or other media in learning mathematics. In learning mathematics, the use of media is still very much needed, especially at the elementary and junior high school levels, where students are still in the concrete operational stage and the transition to the formal operational stage (Wardani et al., 2019).

In its development, technological innovation has become inseparable from the world of education. Education will continue to develop along with the times that demand the development of technology. However, this ever-occurring development must be balanced with improving the quality of teacher ability. Teachers must use technology in learning. Schools' conditions are different, and conventional learning often dominates the learning process (Purwoko, 2017). Teachers prefer conventional learning because it does not require a lot of practical tools and materials; the teacher only needs to deliver material using the lecture method and use teaching materials from printed books (Purwoko & Santosa, 2020). Conventional learning makes students only memorize the concepts given by the teacher, causing a lack of interest in learning, and the development of students' potential is not optimal. One way that teachers can do this is to use learning media (Nasution & Hidayat, 2022). The use of learning media can generate desire and interest, generate motivation and stimulate learning activities, and affect students' psychology (Restu Ningsih et al., 2021).

Right now, the development of learning media is not only in appearance but also in its application, already using a combination of some or all of the media we call "multimedia"; therefore, learning becomes more interactive (Nugraha & Muhtadi, 2015). Multimedia learning is a new alternative to learning innovation. Multimedia learning can combine learning and technology. The use of multimedia in learning mathematics can help students present abstract mathematical concepts concretely and increase interest and motivation to learn and understand concepts and others. Multimedia learning can also provide meaningful and interesting learning experiences for students. Multimedia can present information that can be seen, heard and shown, so multimedia is very effective as a complete tool in the teaching and learning process (Astuti et al., 2021).

Learning multimedia can be developed according to the desired needs and adapted to 21st-century learning. The forms of skills in the 21st century are (1) life and career skills, (2) learning and innovation skills, and (3) media and information technology skills (Kemendikbud, 2017). In the 21st century, education is becoming increasingly critical to ensuring students have the skills to learn and innovate, use information technology and media, and work and survive using life skills. This is related to the multimedia that will be developed; Multimedia is not only for learning media but must be equipped with skills that students must have in the 21st century.

Learning multimedia is the result of technological and learning developments, which are the positive impact of the influence of globalization on education. However, globalization also has negative impacts, eroding the nation's noble cultural values. As a result, the Indonesian nation is experiencing a crisis of national identity, becoming a nation that is easily influenced and scattered. The reason is the lack of understanding and application of the importance of cultural values in society. Education and culture have a crucial role in growing and developing our nation's noble values, impacting character formation based on noble cultural values. So far, the understanding of values in mathematics learning conveyed by teachers has not touched all aspects. Cultural values need to be integrated into learning mathematics, one of which is ethnomathematics-based learning to achieve these learning objectives (Miftakhudin et al., 2019).

Ethnomathematics is a form of culture-based learning in the mathematics context. D'Ambrosio, a Brazilian mathematician, introduced ethnomathematics in 1990. According to D'Ambrosio in Rosa & Orey, the definition of ethnomathematics is: The prefix ethno is today accepted as a comprehensive term that refers to the sociocultural context and therefore includes language, jargon, and codes of behavior, myths, and symbols (Orey & Rosa, 2006). The derivation of mathema is difficult but tends to mean explaining, knowing, understanding, and doing activities such as ciphering, measuring, classifying, inferring, and modeling. The suffix tics is derived from techné and has the same root as technique.

The prefix "ethno" is something comprehensive that refers to the sociocultural context, including language, jargon, code of conduct, myths, and symbols. The root word "mathematics" means explaining, knowing, understanding, and carrying out activities such as coding, measuring, classifying, inferring, and modeling. The suffix "tics" comes from techne and has the same meaning as technique. This means that ethnomathematics is a learning technique that refers to the sociocultural context. Ethnomathematics is a set of intersections of cultural anthropology and institutional mathematics and uses mathematical modeling to solve real-world problems (D’Ambrosio & Rosa, 2017).

Ethno-mathematics which combines mathematics with culture will have a dual function when applied to learning; besides making it easier for students to understand the subject matter, it can also examine the values contained in their culture (Astuti et al., 2019; Herawati et al., 2020; Inovasi & Matematika, 2021). Ethno-mathematics-based learning by incorporating local cultural wisdom in learning mathematics, students can understand mathematical concepts contextually and understand how the culture around students is associated with mathematics, and for teachers through ethnomathematics, learning can instil noble values of national culture so that it can have an impact on education character (Nuryadi et al., 2022). Another opinion states that a culture that is included in learning mathematics will create meaningful learning and improve students' cognitive domains. The cultural products that are applied in this learning multimedia are gamelan musical instruments such as the saron and xylophone in a row and series material.

The researcher is motivated to develop learning media based on the problems above. The media that will be developed is learning multimedia that can overcome students' difficulties in mathematics, increase interest and student learning outcomes, and the results of using learning technology. In addition, the researcher hopes that students have good character, understand the value of local cultural wisdom, and maintain the existence of culture in Indonesia by implementing ethnomathematics into the developed learning multimedia.

METHOD

This research is development research using the ADDIE method. This model has five stages that are interrelated and systematically structured, namely 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation (Oktafianti et al., 2019) .

Analysis Stage

The analysis phase aims to analyze the needs for developing learning media. This stage includes two things that need to be analyzed: needs analysis and material analysis. Needs analysis is focused on the field conditions to be studied. This analysis determines the need for mathematics learning media to be developed; the steps taken are interviews and observations. Needs analysis is needed to determine whether instructional media need to be developed. Interviews with math teachers and observations were conducted to determine the curriculum, learning resources and media used, and the learning model applied. Material analysis is done by reviewing the primary material to be taught. Then select materials and rearrange them systematically. The material is adjusted to the syllabus, lesson plans, and math books.

Design Stage

The second stage is to make the media design that will be made. The design is prepared by studying the problem, then looking for a solution through the identification of the analysis phase. The elements needed will be included in this learning media. The design phase includes the following activities: (a) setting learning objectives in accordance with the results of a material analysis that has been carried out previously; (b) presentation of material; (c) writing media scripts as an illustration of the steps for using and materials to be presented in the media; (d) storyboard as a layout description that users will see in the form of design templates; (e) preparation of an evaluation tool to determine the eligibility of the media.

Development Stage

The third stage is realizing the design. Supporting media elements such as animation, audio, video and images. The software used is Adobe Flash CS6. The basis for this development is the media script and storyboard that has been made. After the media is made, then an expert assessment is carried out. Expert assessment is carried out to determine the product's feasibility aspects. This is done by testing product validity by material experts, media experts, and learning experts.

Implementation Stage

The fourth stage is the implementation of learning multimedia that has been made. Multimedia that has been declared valid will be applied to users in real situations. Ready multimedia will be tested; the first trials will be conducted on a limited basis. After that, an initial evaluation is carried out to provide feedback and assessment so that the multimedia that has been produced can be improved and then tested extensively.

Evaluation Stage

After being implemented, the multimedia is then subjected to an initial evaluation to provide feedback on the multimedia that has been developed. Evaluation is a process for analyzing multimedia development and revising products based on evaluations in its implementation. The data obtained is analyzed to determine what revisions need to be made and whether the products developed are suitable for use in the mathematics learning process.

The research was conducted in class VIII SMPN 19 Purworejo from July to August 2019. The instruments used in this study were interview sheets, validation sheets, student response questionnaires and test questions. Data in this study were collected using interviews, questionnaires and tests. The data obtained from the research were then analyzed in terms of feasibility. Multimedia feasibility analysis was conducted to obtain valid, practical and effective criteria.

Validity analysis

The stages of validity level analysis are as follows:

1) Create and analyze evaluation instrument tables for validation by media, material, and cultural experts,
2) find the average per validator criterion with the formula:

$$Ki = \frac{\sum_{h=1}^{n} Vhi}{n}$$

Ki : average of criteria i
Vhi : the score of the h-th validator's assessment results for the i criteria
n : number of validators

3) Calculate the average of each aspect with the formula:

$$Ai = \frac{\sum_{i=1}^{n} Kij}{n}$$

Ai : i-th aspect average
Kij : average for aspect i of criterion j
n : the number of criteria in the i-th aspect

4) Calculate the average total validation with the formula:

$$RTV_{TK} \frac{\sum_{i=1}^{n} Ai}{n}$$

RTV_{TK} : average total validity of the product
Ai : i-th aspect average
n : the number of aspects

5) Matching the total average with the validity criteria uses the following table:

Tabel 1. Product Validity Criteria

Interval Mean Score	Validity Level
$3 \leq RTV_{TK} < 4$	Valid
$2 \leq RTV_{TK} < 3$	Valid Enough
$1 \leq RTV_{TK} < 2$	Invalid

Constructive revisions from experts to evaluate ethnomathematics-based learning multimedia were carried out until valid ethnomathematics-based learning multimedia was obtained.

Practical Analysis

The practicality analysis of the developed multimedia was seen from the students' responses. The steps for analyzing the data from the student response questionnaire are as follows:

1) Recapitulation of student response questionnaire results.
2) The results of the score recap from the questionnaire are then calculated to get the percentage

$$NRS = \frac{\sum NRS}{NRS\ Maksimum} \times 100\%$$

NRS : percentage of student response scores
$\sum NRS$: total student respon scores
$NRS\ Maksimum$: $\sum R \times best\ choice\ score\ (\sum R \times 4)$

3) Determine practicality criteria based on the percentage of student response scores

Table 2. The practicality criteria of a product

Category	Evaluation (%)
Very Practical	$80 < NRS \leq 100$
Practical	$60 < NRS \leq 80$
Less Practical	$40 < NRS \leq 60$
Not Practical	$20 < NRS \leq 40$
Very Impractical	$0 < NRS \leq 20$

4) Calculate the total practicality average of the product and match the total average with practicality criteria.

Effectiveness Analysis

Analysis of product effectiveness can be identified by analyzing student learning outcomes before and after using ethnomathematics-based learning multimedia. From the research results, a hypothesis test was carried out to conclude whether the learning multimedia developed had a significant or not effect. The developed media is said to be effective if it is concluded that there is a significant effect or difference after using it. Before testing the hypothesis, a prerequisite test is carried out to determine the test statistic. The prerequisite test includes the normality test and homogeneity test. If the data processing results are normal and homogeneous, then the t-test is performed.

FINDINGS AND DISCUSSION

The research procedure consists of 5 stages: analysis, design, development, implementation and evaluation. These stages are described as follows.

Analysis

Needs Analysis

Needs analysis refers to the condition of the school that will be used as a research location, namely SMP Negeri 19 Purworejo. This analysis is needed to determine the learning resources and media used, in the process of learning activities in the classroom does it require media or not? In this study, the needs analysis was based on observations of classroom activities and interviews with subject teachers.

The results of observations and interviews state that the learning media used so far are textbooks and modules. The use of IT-based learning media is still lacking, and there are no media in the form of learning multimedia. Ethnomatematics-based learning media has never been used. In addition, there are still many students who have poor character and are less active in participating in class learning. Therefore, media is needed to attract students' interest in participating in learning while simultaneously having a positive effect on student character formation.

Material Analysis

Material analysis is carried out by identifying the main material being taught, collecting and selecting relevant material and then rearranging it systematically. Material analysis in this study was based on observation of learning resources and interviews with subject teachers. The results of observations and interviews show that one of the subject matter in number patterns is still considered difficult by students. The choice of number pattern material is also based on the product that will be applied to this learning multimedia

Design

This stage aims to prepare the initial design of the developed learning multimedia.

Determine learning objectives

After studying this material, students are expected to be able to determine patterns in number sequences and object configuration sequences and solve problems related to patterns in number sequences and object configuration sequences.

Material presentation

The materials that can be collected based on the stages of analysis that have been carried out include:

To fill in the material, the research referred to the 2017 revised edition of the mathematics textbook from the Ministry of Education and Culture, the companion book for mathematics learning by the Mathematics Teacher Forum in 2019, the internet to fill in the ethnomathematics section on gamelan xylophone and saron as well as other sources related to number pattern material.

To create learning multimedia, researchers use the Adobe Flash CS6 application and supporting applications using Corel Draw X7.

Writing media scripts and materials

Media and material texts are material plans presented in multimedia learning by referring to the results of the analysis carried out in the previous stage.

Storyboard

After the script is finished, the storyboard provides a clearer picture, as seen from the display layout and the layout of the learning media.

Evaluation Tool Formulas

The preparation of assessment instruments aims to evaluate the products made. The instruments included media expert validation sheets, materials and learning, student response questionnaires, and pretest and posttest questions.

Development

Media Creation

The development of this media is based on the media script and storyboard made in the previous stage. Making media starts with making media backgrounds and navigation icons made using Corel Draw X7 supporting applications, then applying them to Adobe Flash CS6 by creating an initial home screen, entering accompaniment music, creating a home screen that contains menus, and finally filling in each appropriate menu. with media scripts that have been made. Some views of media making can be seen in the image below.

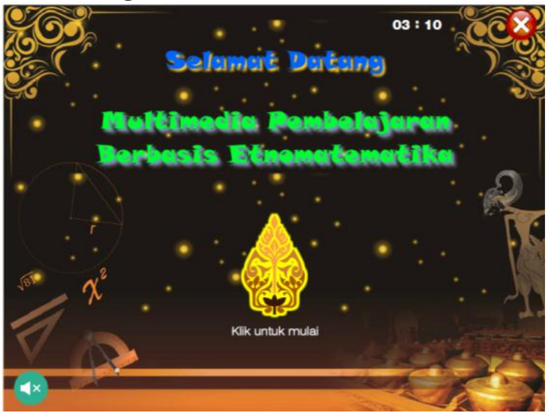

Figure 1. Home Screen

The background of this display contains Gamelan and Wayang images which symbolize that this multimedia development product introduces Javanese cultural products.The homepage display can be seen in Figure 2. This view includes a basic competition menu, teaching materials, quizzes, exercises, and developer profiles.

Figure 2. Homepage Display

Before these ethnomathematics-based multimedia is used, the expert validation stage is carried out to determine the expert's assessment of the feasibility of the media. Validation was carried out by three experts: media expert lecturers, mathematics subject teachers as material experts and learning expert lecturers. The assessment technique is carried out by giving a questionnaire which is then revised according to the suggestions and assessments of experts so that the product becomes better.

Implementation

After the learning multimedia has been revised and declared valid by the validator, the next stage is the implementation stage of the product being developed. The implementation phase aims to try out the products that have been made to be given to students and then revise the product according to user suggestions, namely teachers and students. In the limited trial implementation, learning multimedia was given to 10 students of class VIII F in one meeting. Then in a large-scale trial, learning multimedia was given to 28 students in class VIII D in two meetings.

Evaluation

At this stage, ethnomathematics-based learning multimedia was assessed from the results of validation and trials to determine the feasibility level of ethnomathematics-based learning multimedia. Evaluation is carried out by analyzing data from expert validation results to measure validity, giving response questionnaires to students to measure practicality and conducting hypothesis testing to measure effectiveness based on the results of the pretest and post-test assessments. The following are the results of the data analysis:

Validity Analysis

The assessment results are quantitative data on the score of each aspect item and a description of suggestions. Quantitative data is then converted into quality criteria for each aspect. The following are the results of media, material and learning expert assessments:

Results of Assessment by Media Experts

The expert who evaluates ethnomathematics-based learning multimedia is Dr. Heru Kurniawan. The media expert's assessment focused on visual clarity, convenience, aesthetics, learning design, consistency, and audio/music. The results of the analysis of media assessment data processing on the visual clarity aspect obtained an average score of 4, the ease aspect obtained an average score of 3.75, the aesthetic aspect obtained an average score of 3.33, the learning design aspect received an average score of 4, the consistent aspect obtained an average score of 4. The audio/music aspect obtains an average score of 4. The final assessment or score obtained from media experts is presented in the following table:

Table 3. Average Results of Ratings by Media Experts

No.	Aspect	Average value	Criteria
1.	Visual Clarity	4	Valid
2.	Convenience	3,75	Valid
3.	Aesthetics	3,33	Valid
4.	Learning Design	4	Valid
5.	Consistency	4	Valid
6.	Audio/Music	4	Valid
	Average	3,85	Valid

Based on the assessment of media experts, it can be concluded that ethnomathematics-based learning multimedia is said to be valid with an average rating of 3.85.

Assessment Results by Material Experts

The expert who evaluates ethnomathematics-based learning multimedia is Drs. Bambang Setiawan. The material expert assessment focused on presentation, language, and content feasibility. The analysis of media assessment data processing results on the presentation aspect obtained an average score of 3.5, the linguistic aspect received an average score of 3, and the content feasibility aspect obtained an average score of 3.4. The final assessment or score obtained from material experts is presented in the following table:

Table 4. Average Results of Assessment by Material Experts

No.	Aspect	Average value	Criteria
1.	Presentation	3,5	Valid
2.	Language	3	Valid
3.	Content Feasibility	3,4	Valid
	Average	3,3	Valid

Based on the assessment of material experts, it can be concluded that ethnomathematics-based learning multimedia is said to be valid with an average rating of 3.3.

Assessment Results by Learning Experts

The expert who evaluates ethnomathematics-based learning multimedia is Erni Puji Astuti, M.Pd. The assessment of learning experts is focused on ethnomathematics aspects. The following is the average value of the ethnomathematics aspects:

Table 5. Average Result of Assessment by Learning Experts

No.	Aspect	Average value	Criteria
1.	Ethnomatematics	3,29	Valid
	Average	3,29	Valid

Based on the assessment of learning experts, it can be concluded that ethnomathematics-based learning multimedia is valid, with an average rating of 3.29. This shows that ethnomathematics-based learning multimedia has valid criteria by learning experts. The total average of media expert assessment results, materials and learning will be presented in the following table:

Table 6. Average Results Total Assessment Results

No.	Aspect	Average value	Criteria
1.	Visual Clarity	4	Valid
2.	Convenience	3,75	Valid
3.	Aesthetics	3,33	Valid
4.	Learning Design	4	Valid
5.	Consistency	4	Valid
6.	Audio/Music	4	Valid
7.	Presentation	3,4	Valid
8.	Language	3	Valid
9.	Content Feasibility	3,5	Valid
10.	Ethnomatematics	3,29	Valid
	Average	3,63	Valid

Based on the assessment of media, material and learning experts, it can be concluded that ethnomathematics-based learning multimedia is valid, with an average rating of 3.63.

Practicality Analysis

Limited trials and extensive trials were carried out to see the practicality of using ethnomathematics-based learning multimedia. Ethnomathematics-based learning multimedia is practical if the results of student responses to ethnomathematics-based learning multimedia are obtained by more than 60%. In the limited trial conducted by 10 class VIII F students of Junior High School 19, Purworejo obtained an average response value of 83%. Based on the practicality criteria, the developed ethnomathematics-based learning multimedia is included in the very practical criteria.

The large field trial involving 28 class VIII F students of Junior High School 19 Purworejo obtained an average rating of respondents with a percentage of 81%. Based on the practicality criteria, the developed ethnomathematics-based learning multimedia is included in the very practical criteria.

Effectiveness Analysis

Product effectiveness can be identified by analyzing student learning outcomes before and after using ethnomathematics-based learning multimedia. Then from the learning outcomes, a hypothesis test is carried out to conclude whether the developed learning multimedia has a significant influence. The results of the pretest assessment are as follows:

Table 7. Pretest Assessment Results

KKM	75
Average	67,634
Standard deviation	20,313
The highest score	100
Lowest score	21
Students who pass KKM	10
Percentage of students who pass the KKM	35,71 %

After the pretest was carried out, students were given treatment with ethnomathematics-based learning multimedia and after using the product, students were given a posttest. The results of the post-test assessment are as follows:

Table 8. Posttest Assessment Results

KKM	75
Average	81,116
Standard deviation	15,428
The highest score	100
Lowest score	43

Students who pass KKM	18
Percentage of students who pass the KKM	64,28 %

The pretest and posttest results were then tested for normality and homogeneity. If the data processing results are normal and homogeneous, then a t-test is performed. However, if the results of data processing are not normal or not homogeneous, then the Wilcoxon test is carried out. The results of the pretest and posttest data normality tests will be presented in the following table:

Table 9. Calculation Results of Pretest and Posttest Data Normality Tests

Data	Amount of Data	Average	Standard Deviation	L_{count}	L_{table}
Pretest	28	67,634	20,313	0,093	0,167
Posttest	28	81,116	15,428	0,110	0,167

Statement H_0 data is normally distributed, and H_1 data is not normally distributed. The basis for concluding is that H_0 is rejected if $L_{obs} > L_{table}$ and H_0 is accepted if $L_{obs} < L_{table}$. These calculations show that the value of L_{obs} in the pretest and posttest data is smaller than that of L_{table}, so H_0 is accepted, and it can be concluded that the data is normally distributed. The next test is the homogeneity test. The results of homogeneity will be presented in the following table:

Table 10. Homogeneity Test Calculation Results

Data	Amount of Data	Standard Deviation	Varians	F_{count}	F_{table}
Pretest	28	20,313	412,626	1,733	1,90
Posttest	28	15,428	238,031		

In Statement H_0, the pretest and posttest group data variances are homogeneous, and H_1, the pretest and posttest data variances are not homogeneous. The basis for concluding is that H_0 is accepted if $F_{obs} < F_{table}$ and H_0 is rejected if F_{obs} > Ftable. These calculations show that the F_{obs} value is smaller than the F_{table} value, so H_0 is accepted and it is concluded that the pretest and posttest group data variants are homogeneous. The data is said to be normal and homogeneous from these two tests. Therefore, the t-test is then carried out. The results of the t-test will be presented in the following table:

Table 11. Test Results t Test

Data	Amount of Data	Average	Standard Deviation	Varians	Correlation	t_{count}	t_{table}
Pretest	28	67,634	20,313	412,626	0,666	-4,673	2,052
Posttest	28	81,116	15,428	238,031			

Statement H_0, there is no difference between before and after the use of ethnomathematics-based learning multimedia and H_1 there is a difference between before and after the use of ethnomathematics-based learning multimedia. The basis for concluding is that H0 is accepted if $-t_{table} \leq t_{obs} \leq t_{table}$. The results of these calculations show that the value of t_{obs} is not in the interval $-t_{table} \leq t_{obs} \leq t_{table}$ then H_0 is rejected and it can be concluded that there is a difference between before and after the use of ethnomathematics-based learning multimedia. In other words, there is a significant difference between before and after using ethnomathematics-based learning multimedia so that the product can be said to be "effective". Based on the overall analysis results, the developed multimedia learning meets all the established criteria so that the product meets the feasible criteria. This statement is in accordance with research which states that the media or teaching materials developed are feasible if they meet valid, practical and effective criteria (Purwoko & Santosa, 2020; Wardani et al., 2019).

In addition, ethnomathematics-based learning multimedia has a potential effect on developing students' understanding of mathematics, especially in understanding contextual mathematics. Students can actively make discoveries of mathematical concepts through activities that are arranged in the stages of activities in the multimedia that has been developed. This is in accordance with research which states that students can make discoveries of mathematical concepts with appropriate and contextual activity stages (Laurens et al., 2018; Nuryadi et al., 2022). Thus, ethnomathematics-based learning multimedia can be used in junior high school mathematics learning, especially in number pattern material, because, as a whole, it meets the eligibility aspects and follows the references used as initial references.

CONCLUSION

Based on the results of research, processing and data analysis carried out through the development stage of ethnomathematics-based learning multimedia, it was concluded that this development resulted in ethnomathematics-based learning multimedia which was carried out according to the development stage, namely the ADDIE stage. The ethnomathematics-based learning multimedia developed and tested based on stages is declared to meet valid, practical and effective criteria. The product gets valid criteria based on the assessment of media experts, materials and learning with an average of 3.63. The results of the ethnomathematics-based learning multimedia assessment got a percentage response of 81% with very practical criteria. The hypothesis test concluded that there was a significant difference between before and after using ethnomathematics-based learning multimedia so that the product was effective. The product has the potential effect of increasing students' understanding of mathematics. Therefore, ethnomathematics-based learning multimedia has the criteria of "appropriate" to be used as learning media in junior high schools.

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