

## Development of Android-Based Mathematics Learning Media on Three-Dimensional Geometry for Vocational High Schools with an Ethnomathematical Approach

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**Abstract:** The purpose of this research is to produce an android-based application through an ethnomathematical approach for the scope of three-dimensional geometry material that is feasible and according to the needs of vocational students. Development research using the ADDIE model was chosen to achieve this goal, with five stages, namely analyze, design, development, implement, and evaluate. The instruments that accompany this research are the material expert and media expert validation questionnaire sheet, and the vocational school mathematics teacher response questionnaire. The results of the validation of the developed learning media obtained an expert validation value of 77.3% categorized as feasible, the teacher response value of 76% categorized as feasible. This learning media as a whole can be well received by vocational school teachers and strengthened by the validation results from experts who stated that the application was suitable for use in learning

**Keywords:** Android-Based Application, Three-Dimensional Geometry, Vocational School, Ethnomathematic

### Introduction

Education has an important role in the life of the nation and state in an effort to create quality human resources. Through education, humans are educated, fostered and developed the potentials that exist in themselves (Riyana, 2020). Mathematics is a subject that is given at all levels of education, starting from primary education, secondary education, and partly in higher education. However, behind the important role that mathematics has, mathematics is also a subject that tends to be feared by most students (Khoironi, 2019). Many students at every level of education regard mathematics as a difficult subject and often cause various problems to be solved, resulting in low student achievement (Ety, 2020).

Student learning achievement in mathematics can be known by conducting assessments using various types of assessment instruments such as tests, observations, assignments, projects, and products (Pakpahan, 2016). Based on the results of the 2018 PISA, Indonesian students are ranked 72 out of 79 test-taking countries. The test results show that the average score of the students is 371 in reading, 379 in mathematics, and 396 in science. This score is below the average of 79 PISA participating countries, which is 487 for reading ability, and 489 for math and science (OECD). , 2019). From the PISA report, it is known that the low quality of teachers and the disparity in the quality of education in Indonesia are thought to be the main causes of the poor literacy skills of students. Other causes in the learning process in schools, such as the lack of use of learning media in teaching and learning activities, so that students are less active and less interested in the material being taught. (Hadisaputra, 2020).

The determination of a learning media that is considered appropriate in a learning activity cannot only be based on the teacher's enjoyment of the media. Moreover, if the determination of a learning media is used only because it is in the school and the teacher does not try to find the appropriate one. If this is the case, then what happens is that there are obstacles in learning communication so that learning does not take place optimally. This happens because the media is a means of communication that bridges communication between teachers and students, and the way this communication can affect students' memory (Ashyar, 2021). The following table shows the influence of students' memory with verbal communication and media.

Table 1. Student's memory with verbal communication and media

Verbal communication	Media of Visual	Memory	
		3 hours	3 days
√		70%	10%
	√	72%	20%
√	√	85%	65%

Based on table 1.1, it can be seen that the communication that exists without the use of media and only relies on verbal, causes students' memory in 3 hours to only be 70% and when using visual media without verbal communication students' memory increases to 72%, while with visual media and verbal communication students' memory is able to reach 85%. With an interesting stimulus, students will be easy to process the information they receive and information can be transferred to short-term memory if the information gets special attention.

The results of the researcher's interview on initial observations with the Mutaqin creative video shooting team, a team that is quite well known in Lubuklinggau, on September 14, 2019, strengthens the evidence of a cultural shift. The evidence obtained is that in one year, in 2019, from about 50 requests by the bride and groom to document the wedding ceremony to the reception, only 10% of the bride and groom at the wedding ceremony held a cacap-cacapan oral tradition. The rest, 20% have modern concepts such as bringing in artists from the capital city, 45% use the WO concept, 20% are marriages of other ethnic groups who are not from the Malay ethnic group, such as the Javanese, and the remaining 5% do not hold receptions or traditional events, only wedding ceremony.

One of the learning media that supports visualization by utilizing technological developments is multimedia. According to the definition of experts that multimedia is seen as a "combination of the following elements; text, color, graphics, animations, audio, and video". Multimedia is a tool that can create dynamic and interactive presentations that combine text, color, graphics, animation, audio, and video (Ratnasari, 2021). Multimedia learning media also has the advantage that it can be accessed using Android mobile devices such as smartphones and tablet computers.

In general, Android is widely used by the community, especially students. The use of smartphones is currently popular in the world and is not left behind with Indonesia. However, the use of smartphones is only used for the use of social media and only a small number of them use it to assist learning activities. (Muyaroah & Fajartia, 2017). The development of android-based media is expected to increase student literacy. Learning by using learning media allows students to focus on the content. Learning media contains complete media elements which include animated audio, video, text, and graphics that allow users to interact interactively through the available features (Gunawan, 2017).

Most mathematics teachers who teach without paying attention to the approach and content listed in the book, especially in SMK still use standard books provided by the government as teaching materials (Yekti, 2019). This is not good for learning activities because it can result in a lack of interest and enthusiasm for student learning in mathematics (Ramadhani, 2020). Therefore, it is very important for teachers to develop teaching materials by paying attention to the needs of students and according to the demands of the curriculum, namely teaching materials that match the characteristics of students as targets. In this case, the characteristics of students include the geographical, cultural, social, and developmental stages of students.

In 1960, a Brazilian mathematician used the term "ethnomathematics" for the first time, namely Ubiratan D'Ambrosio (Sánchez & Albis, 2013). D'Ambrosio describes the relationship between the application of mathematics and differences in cultural groups as ethnic-national societies, certain age groups, labor groups, or professional classes. Ethnomathematics is a scientific discipline that is an alternative to updating mathematics education, in this case the novelty approach to cultural elements (Runehov & Oviedo, 2013). Culture or Tradition is part of the perspective and thoughts of individuals/groups in living life (Widiyanto, S., et al, 2021) Ethnomathematics can support the ability to apply mathematical knowledge in solving real-world problems through the application of sensitivity to numbers and numerical operations, describe statistical information, and create new forms of information (Rosa & Orey, 2007). Learning will be more meaningful that students know the benefits of learning mathematics in real life through the application of ethnomathematics. In this case, ethnomathematics is a means to raise students' enthusiasm and motivation in learning mathematics (Mahendra, 2017).

Based on the analysis of learning media needs that have been carried out by researchers at SMK Negeri 1 Singosari. Researchers obtained data through filling out a questionnaire by six mathematics teachers and

interviews with two mathematics teachers from SMKN 1 Singosari. In addition to teachers, several students also filled out a needs analysis questionnaire, namely 21 students from SMKN 1 Singosari. The results of interview questionnaires and needs analysis showed that many students lacked interest or difficulty in learning three-dimensional geometry, trigonometry and other materials based on surveys. Problems arise because of the absence of supporting learning media so that students find it difficult to visualize or understand a concept in mathematical material. In addition, before the Covid-19 pandemic they only received an explanation through conventional learning delivered by the teacher, this could make students easily bored and lazy to study the material. During the Covid-19 pandemic, learning using whatshap group and google classroom media emphasized the provision of materials and assignments, but this was still doubtful regarding the results of student understanding because based on the results of interviews, teachers assumed that some values were considered invalid because of the difficulty of controlling the class during distance learning or online learning.

Android-based applications are one of the alternative learning media during the Covid 19 pandemic that can make it easier for teachers to deliver material and can also increase student motivation in learning mathematics because it can be accessed anytime and anywhere. Therefore, to create an active, creative, effective, and fun learning atmosphere. Teachers are advised to use media in the learning process. After the researchers conducted pre-research observations at SMK Negeri 1 Singosari, information was obtained that the school fully supports the facilitation of android-based mathematics learning media applications because all students have their respective smartphones and to make more use of the facilities they have more effectively and efficiently.

Some examples of android-based learning media, for example the Development of Android-Based Mathematics Learning Media in Grade 4 Elementary School (Karim, 2020), the Development of Android-Based Mathematics Learning Media for SMP/MTs and SMA/MA Students. (Hamdani, 2021), Development of Android-Based Learning Multimedia in Basic Computer and Networking Subjects for Class X SMK Informatics Global Nusantara (Fauzi, 2021) and so on. Some examples of these learning media do not use an ethnomathematical approach. Therefore, the researcher took the initiative to develop an Android-based learning media that is complete and suitable for learning and characteristics of SMK students with an ethnomathematical approach. Based on this description, the researcher conducted research and developed this mathematics learning application with the title: "Development of Android-Based Mathematics Learning Media on Three Dimensional Geometry for Vocational High Schools with an Ethnomathematical Approach".

## **Research Methodology**

This type of research is research and development (R&D). The R&D method is a method used to produce a certain product, and test the effectiveness of the product (Sugiyono, 2017). This research produces a product in the form of teaching materials that discuss three-dimensional geometry with an ethnomathematical approach. The R&D model used in this study is ADDIE which consists of 5 stages, namely: analyze (analysis), design (design), development (development), implement (implementation), and evaluate (evaluation). The research was conducted based on data from SMKN 1 Singosari in June 2021 using a learning media needs analysis questionnaire. The ADDIE stages carried out in this study are as follows:

### Analyze (Analyze)

This first stage collects data that will be used to analyze needs. Analysis of learning media needs is done by giving questionnaires and interviews and observing student scores. The activities carried out generally include interviews with related teachers, collecting information about student characteristics to determine learning media that are suitable for teachers and students who are the target of research. In this study, the teaching materials used are the results of previous research and of course in accordance with the 2013 curriculum.

### Design

At this stage, the media design will be developed. The preparation of the design is done by observing the problem and then looking for a solution according to the data from the needs analysis. This is a series to prepare a blueprint or storyboard design and collect pictures. In this study, making an android-based application using Sketchware software while the animation video uses Explee. In this stage, the researchers included two elements into the three-dimensional geometry material, namely ethnomathematics and engineering elements, especially engineering in the automotive and building fields because SMKN 1 Singosari was dominated by that field.

### Development

The development stage aims to produce products in the form of android-based applications that have been repaired or revised according to the direction of experts so that they can be tested on teachers and students. The steps at this stage are as follows:

#### - Instrument Validation

Instruments that have been made at the design stage are first validated so that they can measure the validity of the product in the form of a developed mathematical application.

#### - Product Validation

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The feasibility of the application made is measured through product validation. This application was validated by 2 experts to determine whether or not the product developed was used for learning. The experts who were asked to become validators were a mathematics lecturer at Indraprasta University PGRI totaling 2 people and a mathematics teacher at SMKN 1 Singosari.

#### Implement

The product implementation phase will be tested on teachers and students, but due to an obstacle the researcher cannot conduct an empirical test so that the researcher makes a product decision that will only be reviewed by the teacher concerned. Researchers used a questionnaire to determine the teacher's response to the teaching materials developed covering aspects of practicality and product effectiveness, while the results of product trials to students empirically in order to measure the suitability of mathematics applications in learning were carried out through a questionnaire covering the effectiveness and attractiveness of the product for this stage to be followed up. in further research.

#### Evaluate (Evaluate)

This step determines the need for product revision and measures the feasibility of the final product being developed. Data from the results of the validator's assessment and teacher responses were processed by calculating the percentage (%) of the scores obtained in accordance with the criteria.

Table. Interpretation Criteria for Material Expert and Media Expert Score

Percentage	Criteria
$80\% < P \leq 100\%$	Very capable
$60\% < P \leq 80\%$	capable
$40\% < P \leq 60\%$	Capable enough
$20\% < P \leq 40\%$	Not capable
$0\% < P \leq 20\%$	not very capable

Interpretation Criteria Percentage of Questionnaire Results

Percentage	Criteria
$80\% < P \leq 100\%$	Very good
$60\% < P \leq 80\%$	good
$40\% < P \leq 60\%$	enough
$20\% < P \leq 40\%$	Not good
$0\% < P \leq 20\%$	Not very good

In this development research, carrying out several processes including needs analysis in order to narrow and cover all materials and are right on target according to the needs according to student characteristics, then design or design products that will be developed according to the data from the needs analysis, after that the development stage by making revisions according to the directions from the experts. The application or product of this research was validated by material and media experts, namely Seruni, M. Pd. as Material Validator and Aulia Masrurroh, M. Pd. as a Media Validator, and reviewed by the related vocational high school mathematics teacher through a teacher response questionnaire, namely Dedy Kurniawan, M. Pd. The results of this study are a mathematical application named "Three Dimensional Geometry for Vocational High Schools"

## Results and Discussion

### Eligibility Validation

The feasibility assessment of the ethnomathematics-based three-dimensional geometry application developed was carried out by validators, namely material experts and media experts. The results of this R&D research are ethnomathematics-based three-dimensional geometry applications for Vocational High Schools that are suitable for use in learning

Table 4. Validation Results of Material Expert Assessment

Validator	Assessment Aspect	Score Number	Percentage (%)	Criteria
Material Expert	content eligibility	42	84%	fit for use
	Serving Eligibility	40	80%	
	Language Eligibility	38	76%	
	Ethnomathematics	37	74%	
Total		157	78,5%	

Source: Processed from Research Data, 2021

Table 4. Validation Results of Material Expert Assessment

Validator	Assessment Aspect	Score Number	Percentage (%)	Criteria
Media Expert	Graphic eligibility	27	77%	Fit for use
	Layout feasibility	28	73%	
	Ethnomathematics	20	80%	
Total		75	75%	

Source: Processed from Research Data, 2021

Table 5. Media Expert Assessment Validation Results

Validator	Assessment Aspect	Score Number	Percentage (%)	Criteria
Media Expert	Graphic eligibility	27	77%	Fit for use
	Layout feasibility	28	73%	
	Ethnomathematics	20	80%	
Total		75	75%	

Source: Processed from Research Data, 2021

Table 6. Analysis of the Validity of Teaching Materials

No	Validator	Number score	Percentage (%)	Criteria
1	Expert Material	157	77,3%	Fit for use
2	Media Expert	75		

Source: Processed from Research Data, 2021

Based on the table of validation results from the Material Expert assessment, it shows that the application of three-dimensional geometry based on ethnomathematics meets the criteria for the feasibility aspects of content, language, presentation, and material containing ethnomathematics of Indonesian culture, especially traditional food with a percentage score of 78.5% from the material expert validator. So that the developed application is categorized as suitable for use in learning.

Based on the results table for the validation of the media expert's assessment, it shows that the application of ethnomathematics-based three-dimensional geometry has a decent assessment with a percentage score of 75% from the media expert validator. This shows that the application meets the eligibility criteria for the supporting aspects of graphics, layout and ethnomathematical views

Based on the analysis of the application validity assessment by the validator, namely material experts and media experts, which are listed in Table 5. After the scores are accumulated, the percentage score for application validity is 77.3%. Therefore, it can be said that the three-dimensional geometry-based android application with an ethnomathematical approach that was developed was categorized as suitable for use for Vocational High School learning.

#### Teacher's Response

After making improvements according to the validator's directions, the product will be reviewed by the teacher concerned. The teacher's response in this study led to a review of the mathematics teacher at SMKN 1 Singosari on the product being developed. This is done by researchers because empirical trials cannot be carried out by researchers due to various obstacles. The teacher's response includes two aspects of the assessment, namely aspects of effectiveness and aspects of practicality as well as some related to product attractiveness. The results obtained can be seen in Table 6.

Table 7. Math Teacher Response

No	Assessment Aspect	Score Number	Percentage (%)	Criteria
1	Effectiveness aspect	80	76%	Fit for use
2	Practical aspects	72		

Source: Processed from Research Data, 2021

Based on Table 6. Mathematics teacher responses show that the three-dimensional geometry-based android application with an ethnomathematical approach has a good assessment with the percentage score of the teacher respondents is 76%. These results indicate that the application has met the feasibility of aspects of practicality and effectiveness with the criteria of "Eligible".

#### Product Evaluation

To get a decent product, it is necessary to evaluate the product. Product evaluation is carried out by making improvements or revisions according to the directions from the validator listed on the validation sheet. In this study, the product underwent several revisions related to the systematic delivery of the material, the completeness of the material and the appearance. Regarding the direction or feedback of material experts, media experts and vocational school teachers, researchers made improvements according to the instructions listed in the Notes and Suggestions column. There are several important points that must be improved, namely:

1. The writing is less sharp or unclear.
2. There are not so many examples of questions in the matter of point and plane distances.
3. It is better for each sub-material to be given an explanatory video, such as the volume-building sub-material.

After evaluating the product, a product is obtained that is ready to be used in mathematics learning on three-dimensional geometry material for vocational high schools and is named "Three Dimensional Geometry for Vocational High Schools", while the resulting application display is as follows:

Table 8. Display of the mathematics application “Three-dimensional Geometry for Vocational High Schools”

1. Splash screen



2. Icon



3. Home page



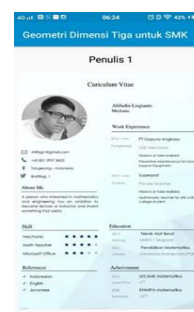
4. Material Page



5. Exercise Page

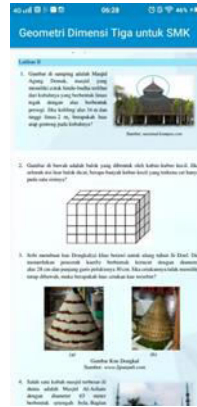


6. Profile Page

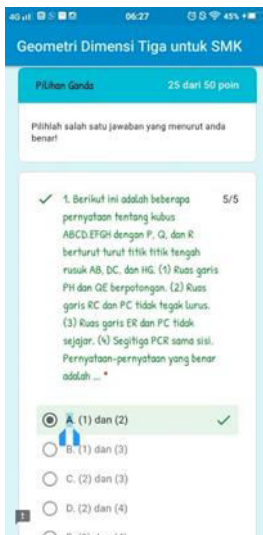


7. The menu of material volume

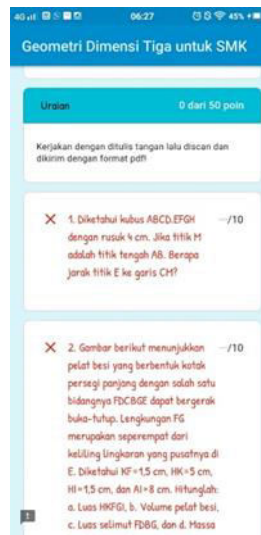
8. Exercise Menu



### 9. Multiple Choice Competency Test Menu



### 10. Competency Test Menu Description



The result of this development research is the final product in the form of a mathematical application on three-dimensional geometry material with an ethnomathematical approach that suits the needs and characteristics of students of SMKN 1 Singosari. Based on the results of the validation of the experts with a percentage of 77.3% (adequate), the teacher's response with a percentage of 76% (adequate), and several improvements according to the direction of the validators. It was concluded that the three-dimensional geometry-based android application with an ethnomathematical approach that was developed already met the criteria well and was suitable for use for vocational learning activities.

The results of the study indicate that an android-based application with an ethnomathematical approach on the topic of three-dimensional geometry can support students in increasing mathematical knowledge inductively, giving students space to create solutions in responding to problems, motivating and raising curiosity, and getting good insight by gain knowledge about the forms of cultural diversity that exist in society.

In the era of online learning (in the network), Learning Management System (LMS), is a must. LMS is an important component in the online learning journey, regardless of the various forms of presentation of the LMS, and the level of effectiveness (Wiratomo & Mulyatna, 2020). Furthermore, the means of delivering material require appropriate learning media. During the COVID-19 pandemic, online delivery (system sharing) is a must, because direct interaction is very limited. Therefore, an android-based application on three-dimensional geometry material for SMK through an ethnomathematical approach is in accordance with existing conditions. The presentation of android-based learning media allows these teaching materials to be flexibly distributed, and can be accessed easily with a smartphone or device.

Ease of disseminating information and access to teaching materials, also followed by packaging of teaching materials through cultural elements, makes students more able to explore their own knowledge. Various kinds of development of teaching materials with approaches that are closely related to the daily life of students, both in



terms of religious (Islamic), in terms of the application of daily life (contextual), as well as in terms of cultural elements (ethnomathematics), in fact have an impact positive attitude towards material delivery (Rahim & Wahyuni, 2019; Nurafni, Pujiastuti, & Mutaqin, 2020; Munandar & Rizki, 2019).

Ethnomathematics, which is actually part of strengthening student identity with cultural elements, is an added value to the plurality of the Indonesian nation (Mahendra, 2017). With direct experience through the appearance of this cultural element, it is hoped that students can explore the culture around them themselves, then be able to draw relationships with mathematical concepts. However, this developed application does not leave the character of vocational students, namely by bringing up models of forms that students often encounter in vocational practice. For example, there are illustrations related to machines, and so on.

## Conclusion

Based on the results of research and development of android-based learning media, it can be concluded that the application of three-dimensional geometry for SMK through an ethnomathematical approach was developed, based on student characteristics and can increase knowledge about the characteristics of Indonesian culture. The stages of developing teaching materials are through the ADDIE stage. The analyze stage is a needs analysis, the design stage is designing appropriate teaching materials based on data from the needs analysis, the development stage is making a design draft that is validated by media experts and material experts, the evaluate stage is evaluate and revise the product in accordance with the suggestions or input of the validator and the teacher's response. Thus, the three-dimensional geometry-based android application with an ethnomathematical approach that has been developed already meets the good criteria and is suitable for use for vocational learning activities.

Suggestions for researchers who will develop android-based applications through an ethnomathematical approach for technical vocational schools should create applications so that they can stimulate or make it easier for vocational students to understand the content of the material so that they can be applied in their fields. It is also hoped that the material provided can support students' abilities in the world of work

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