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The Development of Ethnomathematics-Based Learning Devices of Sulur Godong Batik Using Digital Manipulatives on Geometry Transformation to Improve Students Creative Thinking Abilities

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ABSTRACT: The research conducted aims to create learning devices that can be declared valid, practical, and effective, especially on the subject of Geometric Transformation. The development of this learning device is carried out with the aim of improving students' creative thinking skills. This research is a type of research and development with the 4-D Thiagarajan development model. The stages of 4-D Thiagarajan include define, design, develop, and disseminate. Data collection is carried out using observation, test, and questionnaire techniques. The results of the Ethnomathematics-based development research using digital manipulatives are classified into valid, practical, and effective. The level of validity can be seen from the validity value of each teaching module of 3.78, LKPD of 3.87, and test of 3.92 which are included in the valid category. The practicality value is obtained from the results of observations of the implementation of learning devices and the results of observations of student activities of 92.25% and 93.08%, respectively. The effectiveness value is seen from the learning outcome data obtained 83.0% completed classically with the category of very creative and creative thinking and the student response questionnaire has a positive value of 88.2%. Suggestions for teachers are expected to use learning devices more often because they can train students' creative thinking skills and can be used as a guideline in a more varied and innovative learning process. Not only that, other researchers can reach wider research subjects and different materials in the development of further learning devices.

KEYWORDS: Creative Thinking, Ethnomathematics, Geometry Transformation.

INTRODUCTION

Education is a necessity for human life. Education plays a very important role in life today and in the future. One branch of science in the world of education is mathematics. Mathematics is one of the fields of science that is very much needed to develop other fields of science. Mathematics as a basic science that plays a very important role in the development of science and technology, because mathematics is a means of thinking to develop reasoning power, logical, systematic, and critical thinking (Hobri, 2010). Mathematics is very influential in everyday life, not only related to scientific matters but almost all aspects of human life are inseparable from mathematics. One of the mathematics lessons in the independent curriculum is geometry, including knowledge about geometric transformations. In Indonesia, geometric transformations have been considered in the independent curriculum for junior high schools and high schools (Curriculum Standards and Education Assessment Agency, 2022). Geometric transformation is the process of changing from each other coordinate point in a particular plane. Transformation does not only lead to a point, but can also be found in a particular plane (Walle et al., 2008). The concept of geometric transformation includes translation, reflection, rotation, and dilation.

The learning of geometry transformation is considered and felt difficult to understand by most students. Students need help to understand geometric transformations thoroughly. Most students are taught geometric transformations directly through a formal approach, which causes them to be less able to interpret situationally or informally. Ada & Kurtuluÿ (2010) found that students had difficulty understanding the meaning of translation and rotation due to the lack of geometric meaning. However, there was no problem with the algebraic meaning. Another example is that students who have graduated from grade nine have unsatisfactory basic geometry knowledge because they lack strategic knowledge about drawing (Rellensmann et al., 2020). According to Mbusi (2015) stated that students fail to visualize certain transformations and do not have enough opportunities to practice visualization skills during class. The examples mentioned above show how the formal approach used in learning geometric transformations has

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resulted in a lack of informal geometric meaning. Therefore, in order for students to explore further, it is necessary to create real observations.

One way is with an approach that is able to connect mathematics with everyday culture, namely ethnomathematics. D'Ambrosio (1985) defines ethnomathematics as a step to know how to think to recognize mathematical forms that exist in culture. This shows that mathematics and culture are interconnected and related to each other. However, most people think that mathematics and culture are not related to each other. Therefore, efforts to advance culture also mean efforts to advance education (Rowlands et al., 2016). The purpose of linking culture and mathematics is to build students' perceptions that mathematics learning can be linked to a cultural context approach (Ditasona, 2018). Mathematics can be used as one of the concrete fields of science. Ethnomathematics is an important study to bring out cultural wisdom so that it can motivate students in learning mathematics (Fajriyah, 2018). Students' contextual experiences in learning mathematics can be found in everyday life that is based on culture. Culture that is in accordance with mathematics learning broadens students' perspectives. Thus, students' perspectives can increase and broaden their knowledge of mathematics as embedded in the social and cultural environment (Orey & Rosa, 2008). Thus, ethnomathematics is a science used to understand how mathematics is adapted from a culture (Hardiarti, 2017).

Indonesia is a country that has a diversity of noble cultural heritage, one of which is batik cultural heritage. Batik is a product of the original culture of the Indonesian nation that has high value (Istiqfarna, 2018). On October 2, 2009, UNESCO designated batik as Intangible Cultural Heritage (ICH). So Batik deserves to be recognized by the world because it is made with techniques, has symbolism, and cultural identity that is very attached to Indonesian culture. This study takes advantage of this opportunity to help students develop an understanding of geometric transformations differently than before. Previous studies have discussed learning transformation geometry using batik, such as that conducted by (Khofifah et al., 2018) who discussed the idea of the four applications of the concept of transformation geometry in making typical motifs of the Osing Banyuwangi tribe, namely the Gajah Oling motif, the Kangkung Setingkes motif, the Gedegan motif, the Kopi Pecah motif, the Sembruk Cacing motif and the Paras Gempal motif, while Prahmana and D'Ambrosio (2020) on learning geometric transformation using Yogyakarta batik. This study focuses on how teaching and learning activities can be carried out in a series of digital manipulative activities where students have the highest possibility of bringing out creative reasoning in students. Creative students are able to modify and produce something original, meaningful, useful, and impactful (Kemendikbud, 2022). Efforts to achieve these goals require a strong foundation based on two considerations: first, presenting the situational context of batik into the classroom in the most effective way possible, and second, involving students in the digital manipulative approach and learning theory so that a mutually supportive learning process is established.

Therefore, researchers transformed teaching and learning activities into a digital manipulative environment to optimize technical aspects and equipment efficiency by using digital software, namely Geogebra, software that has a transformation feature. This digital approach provides an easier experience, makes the need for physical material equipment more efficient, and allows students to concentrate on the essence of the concept of transformation while maintaining an appreciation of the value of local wisdom. This combination of tradition and technology is an extraordinary approach that promises a better future evolution in the Digital world. Banyuwangi is one of the batik producing areas on the island of Java, precisely in the province of East Java, one of which is the Mertosari Batik UMKM industry in Balak Village, Songgon District, Banyuwangi Regency. In addition to the typical Banyuwangi batik motifs that are generally common such as the Gajah Oling batik motif, Kangkung Setingkes motif, Gedegan motif, Kopi Pecah motif, Sembruk Cacing motif and Paras Gempal motif. The presence of mathematics with cultural nuances in Banyuwangi Regency unknowingly appears in the typical Songgon Sulur Godong Batik motif. Songgon Sulur Godong Batik was developed by Micro, Small and Medium Enterprises (MSMEs) which strive to make Sulur Godong a distinctive feature that is different from other regions. Based on this, researchers are interested in further exploring the Sulur Godong motif in Balak Village to be used as digital manipulative materials and developing it into a learning tool.

METHOD

The type of research used in this study is Research and Development. In terms of terminology, development research is an activity in the scientific corridor that is adjusted to the academic or scientific field which includes the process of compiling, implementing, evaluating, and refining an activity (Nur and Wahyu, 2020). The development model chosen is the Thiagarajan, Semmel & Semmel (4-D) model. The reason for choosing the Thiagarajan model for use in this study is because the Thiagarajan

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model is detailed and systematic, making it easier to carry out the process of developing devices and instruments. The Thiagarajan model consists of four stages known as the 4-D model. The four stages are the definition, design, development, and dissemination stages. The learning tools that will be developed in this study are in the form of teaching modules, Student Worksheets and ethnomathematics-based tests to improve creative thinking.

The subjects in this research are class XII students of DPB 1 SMKN Ihya Ulumuddin Regency Banyuwangi. This research was carried out in the odd semester of the 2024/2025 academic year. The place used for this research is class XII DPB 1 SMKN Ihya Ulumuddin Singojuruh regency Banyuwangi. The design and development of Ethnomathematics-based Test Questions uses a 4-D model or what is often called the Four D Model. Thiagarajan, Semmel & Semmel (in Hobri, 2010) stated that the 4-D model (Four D Model) consists of four stages, namely defining, designing, developing and disseminating. The selection of this model is due to several factors, namely the development stage of the device is more systematic and involves several expert assessments before being tested on students which will then be revised until it can be tested on students. The procedures in the 4-D research are as follows.

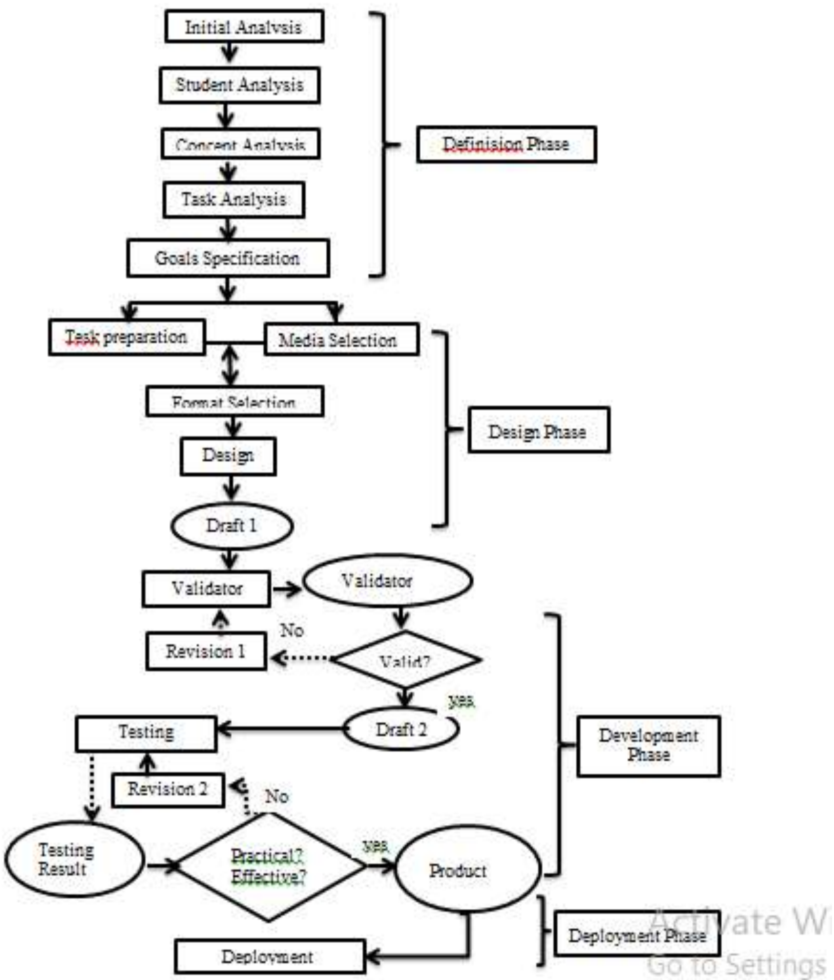

Fig.1. Desain Model 4D

RESULT

The process of developing a mathematics learning device based on Ethnomathematics of Sulur Godong batik to improve students' creative thinking skills in the material of Geometric Transformation using the 4-D method. The learning devices developed are in the form of Teaching Modules, Student Worksheets (LKPD), and Tests that go through the stages of defining, designing, developing, and disseminating. The explanation of the development stages is described as follows.

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a. Defining Stage

The purpose of this stage is to determine and define the needs required in learning by analyzing the objectives and limitations of the material to be delivered. This stage has five steps which are described as follows.

1) Beginning-End Analysis

The Beginning-End Analysis is carried out to determine the basic problems that underlie the need for the development of learning devices based on Ethnomathematics of Sulur Godong batik on the material of Geometric Transformation. The existing problems become a reference for the development of learning devices, so that they become an alternative for problem solutions. Identification of learning problems is carried out by interviewing teachers directly before starting research in the classroom and the following information is obtained.

1. Learning activities in the classroom mostly use the lecture method, namely the teacher provides an explanation of the material directly in front of the class, while students only listen, take notes and do the assignments given.
2. The learning resources used still use textbooks and Student Worksheet made by publishers which only contain short material descriptions and practice questions. In this case, the learning resources used still lack practice questions that facilitate students' thinking processes because they tend to only use certain formulas so that they do not support students' creative thinking skills.

2) Student Analysis

Student analysis is carried out to find out information about student characteristics that are in accordance with the development of learning tools, and in accordance with the research subject, namely class XII of SMK Negeri Ihya Ulumuddin who are taking the Geometry Transformation material. Analysis of student characteristics includes student abilities, cognitive development, and student background knowledge.

3) Concept Analysis

Concept analysis is conducted to identify and systematically organize the materials used in Learning Outcomes. This is because the success of the teaching and learning process depends on the success of the teacher in designing the materials. Learning materials in the Independent Curriculum cannot be separated from the established learning outcomes. Based on the initial-final analysis and student analysis, the learning outcomes used in developing learning devices is adjusted to the Independent Curriculum.

4) Task analysis

Task analysis aims to identify tasks or student abilities during the learning process according to Learning Outcomes. Based on the concept analysis that has been prepared, students carry out activities in the Student Worksheet and answer questions in the Student Worksheet. So that it will help teachers achieve the learning objectives to be achieved.

5) Specification of Learning Objectives

Based on the stages that have been carried out in the previous analysis, at this stage the formulation of learning indicators and learning objectives on Geometry Transformation. The results of the formulation of learning objectives are presented in the following table.

Table 1 : Formulation of Learning Outcomes and Learning Objectives

Learning Outcomes	Learning Objectives
Students can perform algebra operations on matrix and apply them in geometry transformations	1. Students can find the concept of Translation and Reflection in Sulur Godong batik. 2. Students can solve contextual problems related to translation and reflection. 3. Students can find the concept of Rotation and Dilation in Sulur Godong batik. 4. Students are able to solve contextual problems related to Rotation and Dilation. 5. Students are able to create a simple batik motif image on Geogebra which contains the concept of Geometry Transformation.

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b. Design Stage

This stage aims to design learning tools in the form of teaching modules, Student Worksheets and creative thinking ability tests. This stage begins after specific learning objectives are set. There are four steps at this stage, namely:

1) Test Preparation

The test in question is a test of student learning outcomes on the Geometry Transformation material in the form of descriptive questions. The test will be given at the beginning of learning (pre-test), Student Worksheets, and at the end of learning with a test based on Batik Sulur Godong Ethnomathematics to improve students' creative thinking skills. The test will contain questions related to Batik Sulur Godong and the questions compiled contain indicators of students' creative thinking skills.

2) Media Selection

Media selection is a tool to help deliver material so that students can more easily understand the concepts in the Geometry Transformation material. The media selection process is adjusted to the results of task analysis, concept analysis, and student characteristics. In accordance with the research design, namely the development of Ethnomathematics-based devices using digital manipulatives in the form of Geogebra applications, the media used during the learning process are in the form of Student Worksheets and Geogebra applications to stimulate students' creative thinking skills with a presentation that is made systematic and interesting.

3) Format Selection

The selection of the format in question is choosing an approach, strategy, model, method, and learning resources. The format of the Ethnomathematics-based learning device uses digital manipulatives on the material of Geometry Transformation for class XII Phase F.

4) Initial Design

The initial design will produce a learning device that has been developed or is called draft-1. The learning device in the form of a teaching module, Student Worksheets, and Test is validated by 1 lecturer of Mathematics Education, University of Jember, and 2 mathematics teachers before being tested. The teaching module is designed for 2 meetings while the Student Worksheets is compiled using Geogebra, and the test is used to measure students' creative thinking skills at the end of the learning process.

c. Development Stage

This stage aims to produce a draft of the revised learning device based on the suggestions given by the validator. The validated device is then tested in the trial class. There is a small group trial to determine readability, after which a large group trial is carried out to determine the practicality and effectiveness of the learning device. The description of the results of activities at the development stage is described as follows.

1) Validator assessment

Improvements to the developed learning device are carried out based on the assessment and suggestions of the validator. The validated learning devices include teaching modules, Student Worksheets and Ethnomathematics-based Tests. Meanwhile, the research instruments consist of observation sheets for the implementation of learning devices, and student response questionnaire sheets. Validation was carried out by 1 expert lecturer and 2 mathematics teachers.

Table 2: Validator Identity

No	Validator	Description
1.	Validator 1	Lecturer of the Mathematics Education study program, FKIP, Jember University
2.	Validator 2	Mathematics teacher of the SMK Negeri Ihya Ulumudin, Banyuwangi
3.	Validator 3	Mathematics teacher of the SMK Negeri Ihya Ulumudin, Banyuwangi

2) Device Trial

The trial activity is divided into two, namely small group trials and large group trials. Small group trials in this stage are to determine the readability of the learning device, namely the text can be read and is easy to understand, while large group trials are conducted to determine the practicality and effectiveness of the learning device that has been declared valid and worthy of being tested after the readability test is carried out.

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d. Dissemination Stage

The developed device is ready to be disseminated on a larger scale. Dissemination is done by distributing learning devices online and offline. Offline, dissemination is done by sharing learning devices in the form of hard files through the school library where the research is conducted. In this study, dissemination is also done online by sharing a Google Drive link, so that the device can be accessed by other teachers.

The results of data analysis of the development of learning tools based on Ethnomathematics batik Sulur Godong using digital manipulatives on geometry transformasion are as follows

a. Validity Criteria for Learning Devices and Instruments

The validity criteria for the developed learning devices and research instruments used can be seen from the validation results scores by three validators.

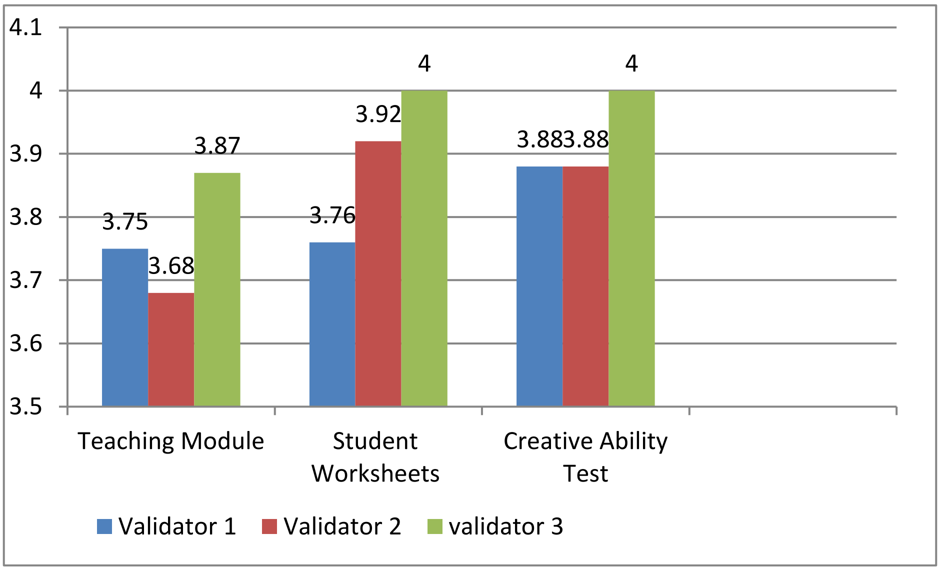

Fig. 2 Learning Device Validation Result

The results of the validation of the three learning devices from each validator were declared valid, which means that the device has carried out the measuring function appropriately. Each validation result value obtained from the three validators was sought for the total average for each device. Not only learning devices, research instruments were also validated by three validators. The research instruments include student activity observation sheets, observation sheets for the implementation of learning devices, and student response questionnaires. The results of the assessment by three validators are summarised in the table.

Table 3: Research Instrument Validity Coefficient

No.	Research Instruments	Validity Coefficient	Criteria
1.	Learning Device Implementation Observation Sheet	3,81	Valid
2.	Student Activity Observation Sheet	3,89	Valid
3.	Student Response Questionnaire	3,81	Valid

Based on the results of the analysis, the research instrument is in the interval $4 \leq Va \leq 5$ which is categorized as valid. This indicates that the research instrument has carried out its respective measuring functions appropriately. Therefore, it can be concluded that the learning device and research instrument meet the validity category "Valid".

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b. Criteria for Practicality of Learning Devices

The criteria for the practicality of the Ethnomathematics-based mathematics learning device using digital manipulatives are based on the results of observations of the implementation of the learning device. Observations of the implementation of the learning device were carried out three times. The observers of this activity were researchers together with teachers at SMK Negeri 1 Ihya Ulumuddin and mathematics teachers as model teachers. The aspects assessed in this activity include the implementation of learning stages, social systems and principles of reaction and management. Data from observations of the implementation of the learning device are presented in Figure.

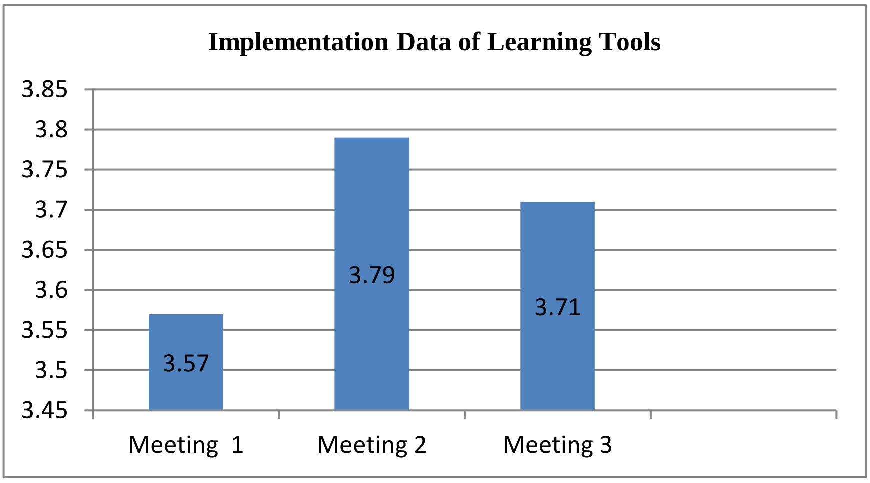

Fig. 3: Implementation Data of Learning Tools

Based on the results of observations that have been made, student activities in the first and second meetings using LKPD where students are taught to rediscover geometry transformations with ethnomathematics-based learning can be concluded that students are active in the learning carried out. The following is a brief recapitulation of the observation of student activity in the second meeting using the student worksheet in Table.

Table 4: Percentage and Criteria for Student Activity Observation

No.	Activities	Avarage Score	Percentage
1.	Observer 1	3,64	91%
2.	Observer 2	3,81	95,25%
3.	Observer 3	3,72	93%
Avarage Percentage		93,08%	
Criteria		Excellent	

c. Learning Device Effectiveness Criteria

The criteria for the effectiveness of learning devices in this study were measured using two indicators of learning outcome data in the form of students' creative thinking abilities obtained by students after working on test questions and processed by calculating the percentage and student responses.

1) Learning Outcome Data (creative thinking ability test results)

The creative thinking ability test questions contain 5 descriptive questions that were carried out at the last meeting. The questions contained in the creative thinking ability test questions have met the valid criteria based on the validation results by experts. The final score is processed to produce a final value that is converted to the category of creative thinking ability level. The results of the creative thinking ability test data in general are presented in Table.

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Table 5: Creative Thinking Ability Test Results

Highest Score	90
Lowest Score	32
Class Average	67,7
Many students scored ≥ 60	22 Student
Many students scored < 60	5 Student

2) Student Response

The second indicator of the effectiveness of learning devices is seen from student response data obtained through student response questionnaires. The questionnaire was given offline at the last meeting after the creative thinking ability test was carried out. The following is a summary of the questionnaire results contained in the table.

Table 6: Student Response Questionnaire Result Data

No	Percentage of Positive Responses	Students
1.	70% ≤ Score < 80%	6
2.	80% ≤ Score < 90%	10
3.	90% ≤ Score < 100%	9
4.	100%	4
	Average Percentage	**88,2%**

The average percentage value of students' responses to the 8 aspects of the assessment given gave positive results ≥ 80%, which is 88.2%. So according to the criteria that have been set, it can be said that the learning device is effective to use.

DISCUSSION

The results of the development of mathematics learning devices based on Sulur Godong batik Ethnomathematics using digital manipulatives of Geometry Transformation for class XII Phase F met the valid criteria with the validity coefficients of the teaching module, Student Worksheets, and creative thinking ability tests being 3.78; 3.87; and 3.92. Learning devices that had met the valid criteria were tested in class XII DPB 2 to determine readability and in class XII DPB 2 to determine effectiveness and practicality. Based on the analysis of observation data from the trial activities, it was obtained that the learning devices met the practical criteria of 92.25% with a very good category. The effectiveness criteria were met, indicated by the percentage of students' creative thinking ability tests being at least good so that students' classical completeness was 83.0% and students' responses were positive at 88.2%. Based on the field test data, it is known that overall, out of 29 students in grade XII of SMKN Ihya Ulumuddin who have creative thinking skills with a very creative category, there are 7 students (24.2%), the creative category is 17 students (58.6%), the fairly creative category is 4 (13.8%), the less creative category is 1 student (3.4%) and there are no students with a very less category. So it can be concluded that the test package meets the effective criteria with the results of students who meet the minimum creative category of 82.8% obtained from the very creative category of 7 students (24.2%) and the creative category of 17 students (58.6%).

CONCLUSION

The process of developing a mathematics learning device based on Ethnomathematics of Geometry Transformation material using a 4D development model consisting of four stages, namely defining, designing, developing, and disseminating. At each stage there are several steps, where at the defining stage an initial analysis is carried out which results in the need for learning devices that can stimulate students' creative thinking skills. The next stage is the design stage, where learning devices consisting of teaching modules, Student Worksheets, and high-level thinking ability tests are designed with the needs at the define stage. At this stage, an initial product design is produced called draft 1. The next stage is the development stage, where the validation and trial processes are carried out. Validation was carried out by one expert lecturer in Mathematics Education, FKIP, University of Jember and two mathematics teachers at SMK Negeri Ihya Ulumuddin. After being validated, a small group trial was carried out to determine the readability of the device and a large group trial to determine its effectiveness and practicality. After being tested in class XII of SMK Negeri Ihya Ulumuddin, it can be concluded that the learning device is valid, practical, and effective. The final stage is the distribution of devices offline at SMK Negeri Ihya Ulumuddin and online by uploading learning devices via a Google Drive link so that learning devices can be accessed by other teachers.

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