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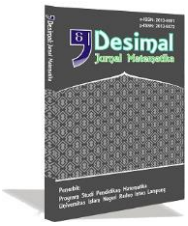

The development of student worksheets using ethnomatematics based prediction, observation, and explanation learning models to improve student's critical thinking ability

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ABSTRACT

This research is a research and development that aims to develop and assess the quality of student worksheets (LKPD) using ethnomathematics-based prediction, observation, and explanation (POE) learning models to improve students' mathematical critical thinking abilities that are valid, practical, and effective. This research is a development research that refers to the ADDIE development model, namely, analysis, design, development, implementation, and evaluation. In this research, the test subjects were students of class VIII G MTs Al-Urwatul Wutsqaa Sidrap Regency with 26 students. Based on the results of the trials that have been carried out, it is found that (a) The validation of LKPD and other instruments are 3.78 in the "very valid" category, (b) Practical based on the average percentage for the implementation of LKPD has 1.93 of average with the implemented category. Overall, the percentage of the average student response is 93.75% with a very positive category, and the average teacher response is 100% with a very positive category. Thus, the developed LKPD meets practical criteria. (c) Effective because the average percentage of students' activity is 84.13% with the very good category, the average ability to manage learning is 4.1 in the good category. The average percentage of student learning outcomes tests on critical thinking abilities is 78.6. Therefore, it could be said that students' critical thinking abilities used LKPD is good. It can be concluded that the trial phase which was carried out using the ethnomathematics-based student worksheet of POE learning models to improve students' critical mathematical abilities had met the criteria of validity, practicality and effectiveness.

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INTRODUCTION

Comprehensive understanding of mathematics does not only include mathematical knowledge, concepts, principles, and structures. Complete understanding includes the use of capacity in mathematical thinking processes.

Mathematical thinking is the ability to think related to use reasoning to build mathematical arguments, develop strategies or methods, understand mathematical content, and communicate ideas. Mathematical thinking skills need to be placed as a learning goal and a way of learning mathematics (Wijaya, 2012). Therefore, it is necessary to have critical thinking abilities for students, especially now that Indonesia's educational system has used the 2013 curriculum, which requires students to dig more information and then use their critical thinking abilities to conclude. Brooke and Richard support this that critical thinking is applying reason carefully in determining whether the statement is true, especially in concluding solutions (Moore & Parker, 2009).

The information is often memorized for use only during exams or written work, but all required to be done is to uncover the information, apply it in new ways to new problems, and determine what worked and did not work (Jackson & Newberry, 2012). It is one of the reasons that critical thinking abilities are needed. Learning mathematics in the classroom can improve students' critical thinking abilities through meaningful learning, students can relate their initial knowledge to problems in the real world or problems that are commonly encountered in everyday life.

The ability to think critically is the center of observers and figures attention in education. It happens because many research results show that Indonesia is in the last rank in terms of critical thinking. It happens because the current learning process emphasizes in improving student learning outcomes, not measuring their critical thinking abilities. Therefore, thinking critically is one of the abilities that must be developed to lead students to achieve optimal learning goals and solve various problems through the understanding.

Critical thinking is also capable of being one of the soft skills provisions in competing in the global world or an increasingly advanced era and developed technology and other fields.

One of the media that can help teachers present mathematical problems in the learning process in a good and systematic way is LKS (Student Worksheets). In the 2013 curriculum, LKS was replaced with the name of the student worksheet called LKPD. It is printed teaching material in the form of sheets containing material, summaries, instructions for implementing in learning tasks that refer to basic competencies (Fatimah, Sutarto, & Harijanto, 2017). Besides being able to make it easier for students to understand the material provided, LKPD can also improve students' mathematical thinking skills. LKPD is prepared based on a predetermined structure which includes titles, study instructions (student guides), competencies to be achieved, supporting information, assignments and work steps, and assessments. (Rifzal, Akmam, & Nurhayati, 2015). In this research, the focus of developing teaching materials in the form of LKPD was chosen because it is more practical, the content is flexible because it can be designed according to the goals and conditions of local students and can be made by both teachers and researchers themselves.

In MTs Al-Urwatul Wutsqaa Sidrap Regency, it was found that the researcher found the problem of some students' low thinking skills in the learning process. It can be seen from the low scores of students' daily tests where many students get scores below the KKM (standard of minimum completeness of mastery learning). The KKM score in mathematics is 75. The number of students in four of the seven class VIIIs is 105, and those who get score below the KKM are 69.53%, those who achieve the KKM score are 30.47%, and only 32 out of 105 students completed

the KKM score. It happens because of the students' thinking ability is still low. Also, the teaching materials used are only textbooks and LKPD. However, the available LKPD only contains questions from textbooks and does not yet support creating opportunities for students to develop their competencies. It makes students not accustomed to solving problems in their way and not accustomed to constructing concepts in mathematics. LKPD should be made attractively and systematically to help students learn more independently and in groups.

One alternative that can be used to solve the problem above is LKPD using the POE (Prediction, Observation, Explanation) learning model. According to Teerasong, the POE learning model provides students with an opportunity to produce their own conceptual knowledge through reconciliation and negotiation between initial knowledge and new knowledge (Muna, 2017). POE is a learning model that is more student-centered. This model invites students on how to practice their thinking skills by looking at an existing phenomenon. The implementation of POE learning model into a worksheet and making the worksheet more varied can also be used to measure and evaluate students' thinking abilities in solving the problems in it.

POE learning model can make student learning activities high, which allow students to have good learning outcomes (Fatimah, Sutarto, & Harijanto, 2017). Also, the use of LKPD can encourage students to work alone, directing students in developing concepts to trigger students to carry out learning activities more effectively and efficiently (Syawaludin, 2016). LKPD using the POE learning model will contain interesting descriptions so that students will not get bored reading it, resulting in increasing students' cognitive abilities. In this LKPD, there are also descriptions of simple math experiments that students can do independently. This LKPD is arranged as attractive as possible so that students always want to read it again and again, and they are not bored to learn and make it easier to deliver because LKPD is more systematic in guiding students to solve problems, so that students easily understand the concept of the material being taught and make it easier for students to learn to solve problems in everyday life.

This LKPD is prepared based on the stages of the POE learning model. There are three stages of POE learning, namely prediction, observation, and explanation, which are developed to find students' predictive abilities and their reasons for making predictions about a symptom to see how far the student can predict (Muna, 2017). The steps in the POE learning model make students to be active in proving their predictions.

In the POE learning model, three tasks must be done. In the first stage, prediction, students are asked to write down their predictions about a problem. The teacher asks students what they will think, what they see, and their reasons for answering. Some researchers say that students are more likely to learn from their observations that confirm their predictions (Joyce, 2019). Of course, students' predictions must be based on theory and clear reasons, and the explanation given can ensure that their prediction results are correct.

Furthermore, at the observation stage, students are invited by the teacher to make observations related to the beginning's problems. Students are asked to observe what happened; then, students test whether the assumptions they make are right or wrong (Anggraini, 2017). At this stage, students have the opportunity to prove the allegations put forward by making observations. Students' observation can be in the form of demonstrations from the teacher, experiments in groups, investigations in

groups, or gathering information from various books or other learning sources.

In the last step, namely explanation, students compare their observations with the predicted results and then explain why this happened. Suppose the predictions' results are under the results of observations and after they get an explanation of the correctness of the predictions. In that case, the students will be more convinced of the concept. However, if the predictions are not correct, students can seek an explanation for the inaccuracy of their predictions (Muna, 2017). Each stage in the LKPD using the POE learning model can help students to develop their critical thinking abilities and foster, an attitude of curiosity about what is happening to prove themselves to the real situation related to mathematics subjects.

The assessment that is carried out using this learning model occurs during the learning process and the tasks that students carry out. By assessing student activities in implementing the POE learning model, it can be seen that the efficiency, effectiveness, and productivity of the learning process in achieving predetermined goals. The success of learning is seen from the learning outcomes achieved by students and the process. So it can be said that the assessment of the process and the learning outcomes in learning with the POE learning model can support the success of learning by assessing student learning outcomes without neglecting the process that occurs in it during learning (Muna, 2017). In addition by using the POE learning model, students are taught to be better at appreciating the processes that occur during learning.

In addition to using the POE learning model, one-way students do not feel unfamiliar with the material to be taught to be given contextual problems at the beginning of the lesson. Contextual problems must be built based on student activities or the community in which students are located (Suwito & Trapsilasiwi, 2016). Suppose mathematics learning only applies a limited view of what mathematics is. In that case, this will make students experience a significant loss because they ignore many beautiful and interesting ideas from all the unique cultures that exist in the world (Brandt & Chernoff, 2014). Besides, Orey argues that mathematical knowledge results from social interactions where relevant ideas, facts, concepts, principles, and skills are acquired due to cultural contexts (Arya & Puspadewi, 2016). Therefore, culture can be a context as a starting point in the mathematics learning process.

Torres-Velasquez and Lobo, suggest that teachers need to contextualize mathematics learning by linking math content with culture and real-life in student experiences (Arya & Puspadewi, 2016). The National Council of Mathematics Teachers also recommends the importance of connecting mathematics with students' personal lives and the culture in which they are located (National Council of Teacher Mathematics (NCTM), 2000).

Culture is the right problem to include in mathematics learning material, especially when these students can find out more about their local culture. Hiebert and Carpenter said that mathematics that is taught in schools and mathematics that is students found in everyday life is very different (Zaenuri, 2018). According to Kurniawan, Anam, Abdussakir, and Rofiki (2019), ethnomathematical integration research in mathematics learning in school is needed to develop students' mathematical thinking skills. Therefore, mathematics learning needs to provide content that can bridge mathematics in everyday life based on local culture and school mathematics.

For example, ethnomathematics-based learning in everyday life is the mathematical concept of candidal

inscriptions, traditional tools, cloth and embroidery motifs, traditional games, and various activities have been cultured among the local community. It was confirmed by Bishop, who said that mathematics is a form of culture and has been integrated with all aspects of community life wherever he is (Zaenuri, 2018). Thus, a student's mathematics is influenced by their cultural background because they are based on what they see and feel.

By implementing cultural learning as a learning approach, the material studied can be related to the student's own culture. Students' understanding of material becomes easier because it is directly related to a culture, which is their daily activity in society (Fitriatien, 2017). It is supported by Achor, Imoko, and Uloko, who said that the learning outcomes and memory of students who were taught with a cultural learning approach were higher than the learning outcomes and memory taught with conventional approaches. Students feel that learning is meaningful, relevant, and fun (Arya & Puspadewi, 2016). Meaningful learning here is the learning to understand and the learning that has been obtained from other circumstances so that learning is better understood (Rohaeti, 2011).

POE-based LKPD can provide a more meaningful mathematical learning experience and at each stage, it is able to facilitate students in developing critical thinking abilities related to mathematics subjects. In addition to using the POE learning model, the introduction of culture such as customs or regional specialties can also be used as one of the means in the learning process. Cultural-based mathematics education or known as ethnomathematics is also included in community-based education because culture is part of society.

Mathematical scientists, from Brazil Ubiratan D'Ambrosio, termed mathematics learning activities with cultural elements known as ethnomathematics. The emergence of ethnomathematics results from mathematical activities that are influenced by environmental activities due to cultural influences (Fitriatien, 2017). In this way, students are offered several opportunities to become mathematics friends, to change their attitudes towards mathematics, in contrast to the classroom in the traditional curriculum.

All students could be successful in mathematics lessons when their understanding is associated with a meaningful culture (Greer, Mukhopadhyay, Powel, & Barber, 2009). Many students had a greater appreciation for mathematics after studying the subject matter from perspective. This culture has contributed to students feeling more comfortable and confident about discussing mathematical concepts (Supriadi, Arisetyawan, & Tiurlina, 2016). It happens because the culture that is often experienced by students and can be an alternative planting of cultural values to produce national children who have a strong mental character and personality who can take the attitude to empower themselves in the value shifts that have begun eroded in this modernization era. Ethnomathematics can be one of the alternatives to the cultivation of cultural values that began to be eroded in this modernization era. Ethnomathematics-based learning does not mean making society go back to primitive times, but how a culture that has become a native character of the nation can continue to survive with the appropriate time and time.

METHOD

This research and development type is often referred to as Research and Development (R&D) concerning the ADDIE development model, namely, Analyze: the analysis stage is a process of

defining what the research participants will learn, Design: this stage is also known as making a design (blue print), Development: development is the process of realizing blue-print or design that becomes a reality, Implementation: Implementation is a concrete step to implement the developed learning system, and Evaluation: The evaluation phase of this research is carried out until the formative evaluation aims to the needs of revision. The product to be developed in this research is Student Worksheet (LKPD) using the ethnomathematics-based POE (Prediction, Observation, and Explanation) learning model to improve students' mathematical critical thinking abilities. With the test subjects were students of class VIII MTs Al-Urwatul Wutsqaa in Sidrap Regency. The data collection instruments used in this research were as follows; (1) expert validation sheet is used to measure the validity, the following is a table of eligibility criteria based on the validity aspect.

Table 1. The Validation Category

Interval	Category
3.5 ≤ M ≤ 4	Very Valid
2.5 ≤ M≤ 3	Valid
1.5 ≤ M ≤ 2.5	Valid Enough
M ≤ 1.5	Invalid

(2) LKPD observation sheet is used to measure practicality from students' and teachers' responses to the questionnaires, the following is a table of assessment criteria based on students' and teachers' responses.

Table 2. Students and Teachers Responses Aspects Category

Interval	Category
0% - 25%	Very Not Positive
26%-50%	Less Positive
51%-75%	Positive
76%-100%	Very Positive

(3) Observation sheets are used to measure effectiveness, divided into student activities, classroom management observation sheets and test learning outcomes. Here are the criteria used for each observation sheet.

Table 3. Student Activity Categories

Interval	Category
P ≥ 81%	Excellent
61% ≤ P < 80%	Good
41% ≤ P < 60%	Pretty Good
21% ≤ P < 40%	Less Good
P < 20%	Very Poor

Table 4. The Category of Ability to Manage Learning

Interval	Category
TKG ≥ 4.50	Excellent
3.50 ≤ TKG < 4.50	Good
2.50 ≤ TKG < 3.50	Pretty Good
1.50 ≤ TKG < 2.50	Less Good
1.00 ≤ TKG < 1.50	Very Poor

Table 5. Critical Thinking Ability Category

Interval	Category
80 < N ≤ 100	Excellent
60 < N ≤ 80	Good
40 < N ≤ 60	Pretty Good
20 < N ≤ 40	Less Good
0 ≤ N < 20	Very Poor

The data that has been collected using the instruments mentioned above are then analyzed and directed to explain the validity, practicality and effectiveness of the product being developed.

RESULTS AND DISCUSSION

LKPD development is carried out using the ADDIE model, namely Analyze, Design, Development, Implementation, and Evaluation. The following is a brief discussion.

a. Analysis Stage

1. Curriculum analysis

This analysis aims to determine what curriculum is applied by the school and how subject teachers, especially mathematics teachers, implement it. The observation results show that the curriculum used in MTs Al-Urwatul Wutsqaa in Sidrap Regency is the 2013

curriculum. However, the implementation in the classroom still does not reflect the 2013 curriculum. This is because teachers still use teaching patterns that have not been able to develop the critical thinking abilities of mathematics students, where students have not been able to connect their initial knowledge to a problem that exists in the real world or commonly encountered in daily life.

2. Analysis of student characteristics

In this analysis, observations and direct interviews were carried out with students so that the LKPD produced was following what the students would need. Based on the results of students' interviews, it has deficiencies in the design aspect such as monotonous fonts, has no color variations, a less communicative and interactive language so that the students will not be active to work on the worksheet. Therefore, a more interesting and interactive worksheet is needed so that students are more active and enthusiastic during the learning process.

3. Analysis of the subject matter

Material analysis is carried out to select and determine, detail, and systematically arrange relevant teaching materials to be taught. The selection of teaching materials is carried out by considering the suitability of the material's concepts and contents. The researcher chose the material pattern of numbers and Cartesian coordinates to consider that this material is one of the materials following the learning model to be used and has interesting activities that can help students improve their mathematical critical thinking abilities.

b. Design Stage

At this stage, the form or model of the LKPD will be developed to be done by students as a learning process that can improve students' mathematical critical thinking abilities.

1. Preparation of Tests

Based on the material analysis, a test was compiled, which was used as a data collection instrument regarding student mastery of the material being taught. The selection of the test is adjusted to the analysis of the material and facilities in the school. This activity is carried out to determine the right test in presenting learning material. The selection of this test must be able to facilitate students to understand the material.

2. Format Selection

LKPD contains instructions and steps for completing an assignment given by the teacher to students. Assignments given to students are in the form of activities carried out directly in the classroom. LKPD was developed from the ethnomathematics-based POE learning model consisting of 3 stages, namely, predicting where students are asked to write their predictions about a problem in the LKPD. The teacher asks the students what they will think about the problem. The next stage is observing, where the teacher invites students to make observations related to the beginning's problems. The last stage is explaining, where at this stage, students present their work. The teacher guides students to determine whether the predictions made previously are in accordance with the results of observations made through analysis and evaluation.

3. Preliminary Design of LKPD

The design begins with preparing reference books related to the subject matter to be discussed, compiling a map of learning needs that is useful to find out how many books must be compiled according to the 2013 curriculum. The problems presented in this LKPD contain problems that have to do with ethnomathematics, which is expected to activate and assist students in finding their concepts and help develop their thinking skills, especially critical mathematical thinking abilities. Other instruments were also compiled at this stage, which included validity

instruments, practicality instruments, and effectiveness instruments.

c. Development Stage

1. Draft LKPD

At this stage, in addition to post-guidance revisions, LKPD and instruments validation are also carried out by experts (validators) to determine the feasibility of LKPD products to be used. The validators' evaluation is carried out by ticking the relevant aspects and completing small notes on the parts that need to be corrected along with their suggestions. The following is the revised product results based on the suggestions given:

a) The illustration on the cover still looks abstract and unattractive.

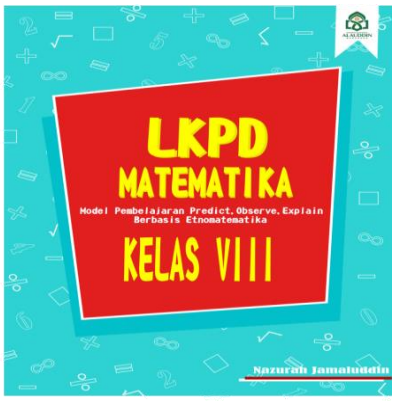

Figure 1. Cover Before Revision

Figure 2. Cover of First Revision

Figure 3. Cover of Second Revision

Figure 4. Cover of Third Revision

b) In the content section, it is necessary to improve the background, the suitability of the appearance between the before and after pages must match, and the selection of attractive colours.

Figure 5. Before Revision

Figure 6. After Revision

Figure 7. Before Revision

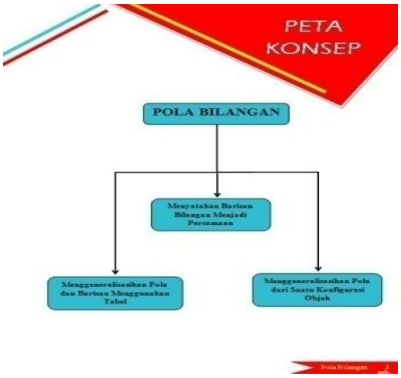

Figure 8. After Revision

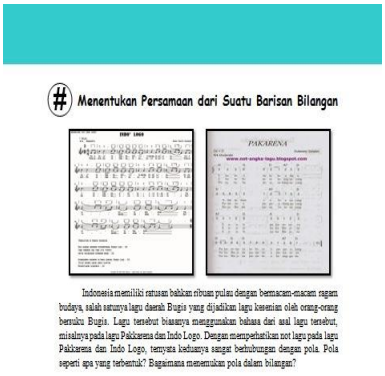

Figure 9. Before Revision

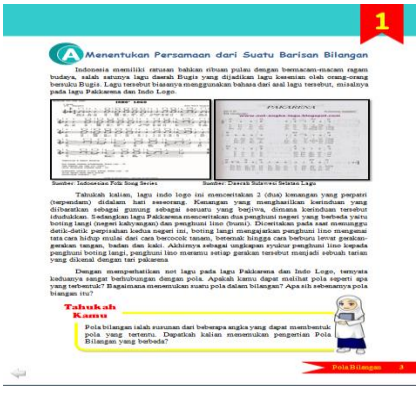

Figure 10. After Revision

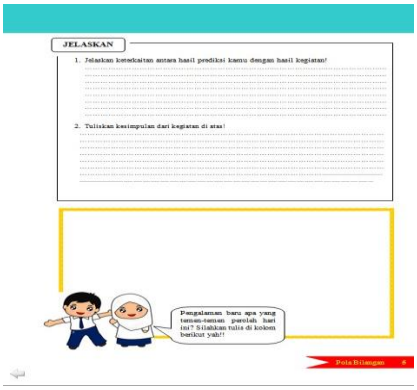

Figure 11. Before Revision

Figure 12. After Revision

d. Implementation Stage

At the beginning of learning using LKPD, students did not understand how to use LKPD. The teacher had to read and explain each step that had to be taken in using LKPD, and when discussing, several students did activities outside of learning. However, for the further meeting, the students gradually understood the instructions and the instructions on the LKPD by themselves.

In learning using LKPD, it appears that students are interested and motivated to solve problems that exist in LKPD. It can be seen when students have difficulty completing activities in the LKPD. Students will ask the teacher about solutions or the ways they must take to solve the difficulties they are facing.

After students get their conclusions and write them down in the LKPD, the teacher reinforces the conclusions that the students have obtained by first asking one of the students to reveal the results of the conclusions they have obtained. With the teacher's conclusion, students can better understand the material they have learned (Ugu, 2020).

e. Evaluation Phase

The ADDIE model's evaluation stage is defined as a process carried out to provide value to the learning program. Evaluation can be carried out during the implementation of the five steps of the ADDIE model. Also, evaluation can also be done by looking at learning outcomes, student responses, and teacher responses. It is done to produce a viable product.

Based on the validity test results, namely the validators' evaluation, it was concluded that the LKPD using the ethnomathematics based POE learning model and other validation instruments had met the validity criteria. Although previously several revisions had been made according to those given by the validators. Based on the results of the validation analysis from the validators, validation results were obtained on several validity instruments including: LKPD with 3.68 of average, student responses with 3.67 of average, teacher responses with 3.94 of average, the ability to manage learning with 3.78 of average, student activity with 3.89 of average, RPP with 3.8 of average, implementation of LKPD with 3.81 of average, and test of learning outcomes with 3.68 of average. Each of these validity instruments is in the very valid category, thus LKPD and its supporting instruments meet the validity criteria.

The practicality of LKPD can be seen from the observation sheet of student and teacher response questionnaires to LKPD. The data analysis results of these practical components are that the implementation of LKPD has 1.93 of overall average, which falls into the fully implemented category of percentages. The average student response is 93.75% in the very positive category, and the average teacher

response is 100% which is in a very positive category. Thus, the developed LKPD meets practical criteria.

The effectiveness of LKPD can be seen from student activities, the ability to manage learning and test learning outcomes. Data analysis of these components of effectiveness, namely the average percentage of student activity, is 84.13% in the very good category. The average ability in managing learning is 4.1 in the good category. The average percentage of student learning outcomes tests toward critical thinking abilities is 78.6. It can be said that students' critical thinking abilities with the use of LKPD are good. According to Lusiana et al. (2020), their research concluded that students' critical thinking abilities through POE (Prediction-Observation-Explanation) learning strategies are in a good category. This was clarified by Aida, Anggoro, and Andriani (2019) that implementing the POE learning model can help students think critically. Furthermore Larasati, Poerwanti, dan Surya (2018) revealed that students' critical thinking skills can be improved by implementing the POE learning model. According to Setiyani, Churiyah, and Arief (2019), POE can be an effective learning model because it can enhance critical thinking and student learning outcomes.

According to Rohmaini, Netriwati, Komaruddin, Hendra, and Qiftiyah (2020), the results of students' abilities depend on the conditions at which learning activities occur. So with LKPD, teachers and students are actively involved in the learning process (Rewatus, Leton, Fernandez, & Suci, 2020). Furthermore, Darwata, Yulkifli, and Yohandari (2019) revealed that LKPD would be more meaningful if students learn easily and improve their competency achievement. Budiono, Sutiarso, dan Dahlan (2018), in their research, show that the validation of developing POE-based LKPD improves students' mathematical abilities on the concept of unity which are feasible in the good category.

According to Sumiyati, Netriwati, and Rakhmawati (2018), ethno-mathematics based geometry learning media affects students' mathematical critical thinking abilities. It was then clarified by Suhartini and Maryanti (2017) that ethnomathematics-based mathematics learning could improve students' critical thinking abilities in solving geometry problems. Wijayanto (2017), in his research, revealed that the use of ethnomathematics-based learning tools on circular material could lead students to go beyond the KKM, where more than 75% of students complete.

Martyanti and Suhartini (2018) clarify that ethnomathematics as a context in learning mathematics can be packaged in the form of problems with completion stages, having relevance to indicators of critical thinking. Ethnomathematics can be used as an alternative method used by teachers to make it easier for students to understand mathematics, and it is hoped that they can explore critical thinking, metacognitive, and problem-solving abilities (Sarwoedi, Marinka, Febriani, & Wirne, 2018).

CONCLUSIONS AND SUGGESTIONS

The validity, based on the validation sheet results of data analysis by two validators, concluded that the quality of the LKPD using the ethnomathematics-based POE learning model is better and other instruments are in the very valid category. Practicality, based on the analysis of the compliance observation sheet data, it is in the overall implemented category and student responses and teacher responses are in the very positive category. Thus, the developed LKPD meets practical criteria. Effectiveness, based on the results of data analysis of the components of effectiveness, it is found that student activity and the ability in managing learning are in a good category

and test student learning outcomes on students' critical thinking abilities with good use of LKPD. Thus, the developed LKPD met the effectiveness criteria. This research uses a POE learning model that focuses on ethnomathematics in Bugis local objects or crafts such as musical instruments, traditional houses, musical notes, and some typical Bugis sarong motifs. It aims to introduce regional culture to students and teach materials to improve students' critical thinking abilities.

Based on the results of this research, math teachers are advised to use this LKPD to improve students' critical thinking abilities. Teachers should also pay attention to the relevance of the subject matter to the daily lives of students, especially with regard to the culture in the area. In addition to teachers, advice is also given to researchers. The results of this research can be used as a reference to conduct more comprehensive research.

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