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The effectiveness of developing culture-based mathematics learning media through visual basic application

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Abstract

Learning media in the process of teaching and learning mathematics have been found in Indonesia. However, learning media with cultural approach nuances are still difficult to find. This shows that the need for learning media to integrate the culture in learning mathematics. Technological developments have changed all fields, including culture. Culture-based mathematics learning through Visual Basic Application (VBA) media has not been studied much, so it is hoped that it can overcome problems in learning mathematics to improve students' mathematical reasoning abilities and ultimately preserve culture. This study aims to develop culture-based mathematics learning media through VBA, which has a good level of validation, practicality, and effectiveness. The research method used is development research using the Plomp model, which includes the initial investigation, design, and assessment phase. The subjects of this study were 34 students of class IX-A from one of the junior high schools in Indonesia. The instrument used was a test containing a description test of 4 questions based on indicators of reasoning ability and a non-test instrument containing student questionnaires and interview instruments. The media developed in this study were analyzed through validity and practicality to obtain valid and practical media. The results showed that culture-based mathematics learning media had very valid quality criteria (84.5%), we're very practical (82.14%), and potentially influenced the development of students' mathematical reasoning abilities (80.65%). In addition, teachers and students showed a positive response to the implementation of learning. This indicates that culture-based mathematics learning media through VBA is a feasible alternative to be used and developed in mathematics learning. This has the impact that through learning with cultural nuances, student ethics will be better, mutual respect, respect, and even culture can be preserved. Thus, learning culture-based mathematics through VBA is very effectively used in learning curvature material.

Keywords: Culture-Based Mathematics Learning, Mathematical Reasoning, Visual Basic Application

Introduction

Mathematics is taught in schools as a culture-free subject. Even though it should involve facts, concepts, and content that are universally accepted (Rosa & Orey, 2013). One of the teacher's approaches in teaching mathematical concepts to students includes using an ethnomathematics approach. The role of ethnomathematics is a combination of traditional games and mathematical concepts (Prabawati, 2016).

Technological developments have modified all fields, including the proliferation of various information in the field of education. The quality of education needs to be built and improved more optimally (Hidayat et al., 2022; Pahrudin et al., 2021; Wang & Yan, 2020). Education today requires students to master various fields of knowledge in a complex manner, especially mathematics (Dahl, 2018; Khodeir et al., 2017; Snape, 2017). This is because mathematics is an important and useful subject for students to apply in everyday life (Hendriana et al., 2018; Hidayat & Husnussalam, 2019; Lisnani & Tanujaya, 2021; Tanujaya et al., 2021; Widodo et al., 2020). In addition, mathematics plays an important role in the field of education because it is the basis for the development of science so that it triggers creative, logical, systematic, and analytical thinking patterns (Desti et al., 2020; Putra et al., 2020; Riastuti et al., 2017). However, based on the 2018 Program for International Student Assessment (PISA), it is known that the mathematical ability of Indonesian students has decreased compared to 2015, from a score of 397 to 386 (Firdausy & Indriati, 2021). This shows the students' reasoning ability in solving mathematical problems is still low.

Facts on the ground also reveal that the mathematical reasoning ability of junior high school students or the equivalent is still low (Agoestanto & Sukestiyarno, 2019; Fitriani et al., 2018; Im & Jitendra, 2020; Kusmaryono et al., 2018; Pertiwi et al., 2021). The weak mathematical reasoning ability is also experienced by students based on the research of Puspitasari et al. (2018) found that most of the students in giving answers were less systematic and detailed. This shows that the low absorption of students, lack of skill in arithmetic, and lack of interest in mathematics are the result of a less interactive and conducive learning process and mathematics learning that is still not fully based on the development of students' abilities (Ahmad et al., 2021; Chao & Chang, 2018; Nahar et al., 2020; Outhwaite et al., 2019; Umbara & Nuraeni, 2019). In addition, there are three difficulties faced by students in solving problems, namely the difficulty of the language aspect, the difficulty of the prerequisite aspect, and the difficulty of the applied aspect (Ding et al., 2020; Hassan & Rahman, 2017; Pahrudin et al., 2021; Psycharis & Kallia, 2017).

These problems become a big homework for educators in designing better learning, determining the learning strategies used, presenting learning materials, and making learning designs that can make students understand the material adapted to student characteristics, improve student achievement and abilities, especially mathematical reasoning abilities in junior high school mathematics learning, especially in the material of curved side space. Constructing curved side space is one of the important materials to be understood and mastered comprehensively by students to solve problems that are being faced in real life, identify objects in the context of building spaces, measure surface area, to calculate volume, with mathematical rules the calculations carried out will structured and students' reasoning processes will continue to develop. Through a good reasoning process, it is hoped that students can manage their knowledge to be creative (Desti et al., 2020), act flexible, think critically, creatively, and logically so that they are able to face various challenges in the future in facing the era of the industrial revolution 4.0 (Astutik & Prahani, 2018; Bagherzadeh et al., 2017; Rohaeti et al., 2019).

To solve problems related to the weak mathematical reasoning ability in the curved side space material, it is deemed necessary to have innovative learning nuances, one of which is culture-based mathematics learning through VBA (Rohaeti et al., 2020). It is hoped that with a learning designed to display cultural elements, it can help students become aware of their love for their own culture in accordance with their local customs, and by finding mathematical concepts with demonstrations from VBA can trigger students' logical thinking better (Rohaeti et al., 2019). Through a meaningful learning process designed by the teacher, it is expected to influence students' learning motivation (Hutajulu et al., 2019).

Learning mathematics using VBA is very good to be developed (Pertiwi et al., 2021; Rohaeti et al., 2020), because it can support students' motivation and learning resilience. This is because etymologically mathematics is very broad, thus there is a need for continuity between mathematics outside school and mathematics in school. Through learning mathematics with cultural nuances, it is hoped that it can contribute to the achievement of learning objectives in terms of attitudes, religion, and knowledge (Ruqoyyah et al., 2020). Thus, through the application of learning based on culture-based mathematics learning through VBA, it is hoped that the mathematics subject matter will be easier to understand and meaningful for students (Fitriani et al., 2018; Pertiwi et al., 2021; Rohaeti et al., 2020; Rohaeti et al., 2019).

Culture-based mathematics learning is the integration of mathematical concepts and practices into students' cultural knowledge. In addition, teachers are expected to assist students in developing the ability to count, measure and think mathematically in various contexts that are in line with the 2013 curriculum to the independent learning curriculum which requires students to have character, one of which is preserving culture in the context of mathematics (Humairah et al., 2022). Research on culture-based mathematics learning through VBA was seen as rarely done before. Therefore, it has become an urgency to conduct development research to improve students' mathematical reasoning abilities. Thus, the main objective of this study was to observe and analyze the culture-based mathematics learning process through the development of VBA based on the results of the analysis of the validation sheet, observation of the implementation of learning, questionnaires for teacher and student responses to the learning process, and its effectiveness on the mathematical reasoning abilities of class IX junior high school students.

Methods

The type of research method carried out is development research which is expected to be able to design, develop, produce, and test the effectiveness of a product (Plomp, 2013). The product developed is in the form of VBA learning media that presents the concept of volumetric curved side spaces with cultural image features. The development model used refers to the modified Plomp development model consisting of three phases, namely the initial investigation phase, the design phase, and the assessment phase. The subjects in this study were students of class IX-A SMP Negeri 2 Pamarican, Ciamis, West Java, Indonesia. Class IX-A (15 years old) was chosen because this class has not yet studied the material for curved sides and needs to be further developed its reasoning and is able to follow the applied learning so that student learning outcomes can be seen when using culture-based mathematics learning. The instrument used in this study consisted of a validation sheet from 2 experts (teachers), a test item 4 questions type description, as well as interviews with students and teachers. Data processing techniques to determine the development of culture-based mathematics learning were tested for validity, practicality, and effectiveness, while to see the test results, it was seen from the percentage of students' average scores. The following are the steps of the Plomp model carried out at the time of the study, as follows.

Initial Investigation Phase

At the initial investigation stage, interviews were conducted with two mathematics teachers for class IX from SMP Negeri 2 Pamarican, West Java, Indonesia, then the results of the interviews were described. This data analysis was conducted to analyze the analysis of the study of the curriculum, needs analysis, learning analysis, concept/material analysis, student analysis and analysis of school conditions that support the development of the developed product.

Design Phase

This phase is a learning design phase through VBA and a validation sheet to measure the validity of a VBA. The VBA validity analysis developed using indicators according to van den Akker et al. (2012) is as follows:

a. Two experts (validators) stated that culture-based mathematics learning through VBA is based on a strong theoretical basis.
b. Two experts (validators) stated that the learning components for culture-based mathematics learning through VBA are good to use and apply in learning.
c. The test results show that the data that has been analyzed is valid (theoretically). Learning is analyzed based on the following steps:
   1) Recapitulating all statements from the validator.
   2) Finding the average validation results from all validators for each criterion.
   3) Finding the average total score.
   4) Determine the category of validity and practicality (theoretically) match the total average with the predefined categories.

5) If the validation results show that it is not valid and needs revision, it is necessary to revise the learning in VBA. but if there is no revision then the field trial is continued.

The steps of the validity analysis process using a Likert scale are as follows:

a. On a positive statement, given a score of 4 for strongly agree, 3 for agree, 2 for disagree, and 1 for disagree. Likewise for negative statements, the opposite applies.
b. Perform the summation process of all scores on each validator.
c. Validity assessment and categories (see Table 1).

Table 1. Validity category

Validity Value (%)	Category
$80 < V \leq 100$	Very Valid
$60 < V \leq 80$	Valid
$40 < V \leq 60$	Quite Valid
$20 < V \leq 40$	Invalid
$0 \leq V \leq 20$	Very Invalid

Assessment Phase

At the assessment phase, the analysis technique used is the practicality and effectiveness of learning developed through VBA. van den Akker et al. (2012) suggests that a learning is categorized as practical, if it contains the following three indicators:

a. The learning developed can be implemented in the classroom through the consideration of two experts.
b. There is a statement from the teacher to implement the results of learning development in the classroom.
c. The implementation of the developed learning is good which can help provide a stimulus for increasing understanding to students in terms of the content of the material and students can construct their understanding of the learning media (in this case is VBA).

Data from the implementation of student and teacher observations will be analyzed based on the practicality of developing the learning media. The practical assessment of this learning development and categories can be seen in Table 2.

Table 2. Practicality category

Practicality Value (%)	Category
$80 < P \leq 100$	Very Practical
$60 < P \leq 80$	Practical
$40 < P \leq 60$	Quite Practical
$20 < P \leq 40$	Impractical
$0 \leq P \leq 20$	Very Impractical

Regarding student responses, it can be categorized as positive, if more than 80% of students respond in a good category in all aspects. The effectiveness of culture-based mathematics learning through VBA uses the indicators proposed by Kemp et al. (1994). Learning is said to be effective if it meets the following indicators: (a) The average student test results are at least 70%; (b) The level of conformity of student activities is expected to be at least 60%; (c) There is a tendency to increase formative/developmental test scores; (d) More than 50% of students gave a positive response to culture-based mathematics learning through VBA; and (e) The teacher gives a positive response to the learning carried out. Effectiveness analysis of this learning development and categories can be seen in Table 3.

Table 3. Effectiveness Category

Practicality Value (%)	Category
$80 < E \leq 100$	Very Effective
$60 < E \leq 80$	Effective
$40 < E \leq 60$	Quite Effective
$20 < E \leq 40$	Ineffective
$0 \leq E \leq 20$	Very Ineffective

Results and Discussion

Initial Investigation Phase

In this phase, a series of analysis processes are carried out which include curriculum analysis, student analysis, and concept analysis. In the curriculum analysis of the four components, namely objectives, content, methods, and evaluation by paying attention to the adjustment of core competencies and basic competencies from the curved side space construction material for class IX junior high school. Student analysis in this development is a process of finding out from the suitability of student characteristics with the concept and design of learning development so that the implementation of learning can take place well.

Based on the results of interviews with two teachers at SMPN 2 Pamarican, information was obtained that students' ability to reason about complex thinking was still underestimated. This is based on the objectives of learning mathematics contained in the 2013 Curriculum, which is expected to make mathematics learning more effective and meaningful so that it will increase students' motivation and achievement in learning mathematics. This is also in line with the research of Nurhasanah et al. (2017) which shows that the transfer of knowledge and thought processes experienced by students does not just happen, but students are expected to be able to construct their own knowledge based on the initial information they have. While in the learning process, especially in the analysis of mathematical concepts in the material of curved side space, this is done by identifying the main concepts to be taught.

Design Phase

In the design phase, the process of designing culture-based mathematics learning is carried out through VBA. The design of culture-based mathematics learning media through VBA is presented in Figure 1.

Figure 1. Design of features in VBA

Figure 1 shows that there are mathematical concepts in the traditional Sundanese objects originating from West Java, namely: (1) a cone-shaped cap which is a curved side space; (2) a tubular jug which is a symmetrical curved side chamber; and (3) the takraw ball is a sphere formed from infinity, so that if it is converted into nets, it will be in the form of a circle.

After designing (see Figure 1), inputs were obtained from ICT experts from the Regional Personnel Education and Training Agency (RPETA / BKPPD) of Cirebon city, namely: (1) the media display does not display images of culture (culture); (2) the programming language used is too detailed, it is recommended to use a simpler one to make it easier to work; (3) in the conclusion section, it is shown from the VBA media demonstration so that it is easily understood by users/students.

Based on the revision of the VBA programming language, the display of the volume concept of curved sides with the VBA model used in culture-based mathematics learning is better (see Figure 2).

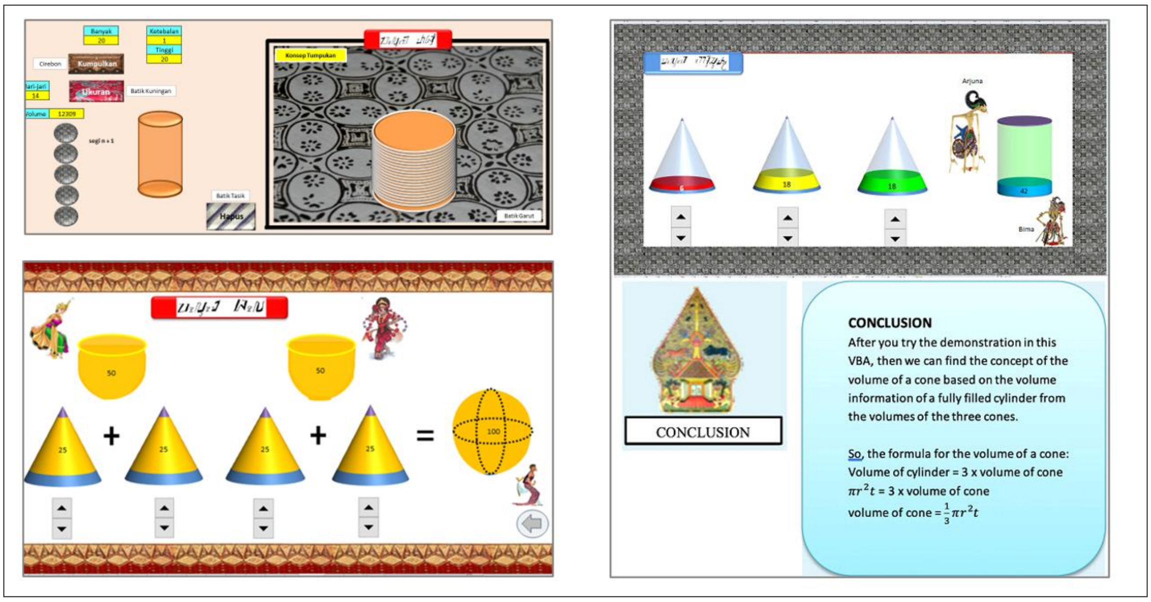

Figure 2. VBA features in finding the concept of cylinder, sphere, and cone volumes

The VBA presentation is designed with a unique design, which includes cultural images such as *wayang*, dance, batik, the colors of the Indonesian flag, Sundanese script and others, so that students are expected to get to know and preserve culture well. In addition, students are also expected to be able to master and understand the mathematical concepts being taught (see Figure 2).

Assessment Phase

After the design process is carried out, it is evaluated and revised based on input from experts. Some things that need to be revised are 1) the VBA display is even more interesting, include cultural images/animations, 2) more complex mathematical concepts, include conclusions for the formulas obtained, 3) adjust to the learning time. After being revised and then validated by experts (see Table 4).

Table 4. The results of culture-based mathematics learning validity test

No	Learning	Validity
1	Culture-based mathematics learning	82%
2	VBA	87%
	Average	84.5%

Table 4 shows that culture-based mathematics learning is very valid (see Table 1), this shows that most of it can be said to have been very good for the implementation of learning scenarios. In addition, VBA media shows a very valid validation level with very good criteria and the use of VBA is relevant to the learning process. The two learnings have been said to be valid because they are in accordance with the validity assessment indicators which consist of four components, namely the content feasibility component, the linguistic component, the presentation component, and the graphic component, as well as in accordance with the specified indicators.

In the practicality phase, which was delivered to teachers and students, which was conducted through questionnaires at the three meetings in the curved side space, it showed that the practicality level of teachers and students was very practical (see Table 5). It can be concluded that the culture-based mathematics learning used is very feasible to be applied to the mathematics learning material for curved side spaces.

Table 5. The results of practicality test by teachers and students

Meeting	Teacher		Student	
	Practicality	**Category**	**Practicality**	**Category**
1	75.00%	practical	80.05%	very practical
2	82.14%	very practical	78.48%	practical
3	89.28%	very practical	82.95%	very practical
Average	82.14%	very practical	80.49%	very practical

Table 5 shows the culture-based mathematics learning through VBA has been in accordance with the achievement of practicality indicators, namely that it can be applied in learning and students can better understand the material presented, as well as meet the ease-of-use components, usefulness components, attractiveness components, and clarity components.

Related to the achievement of the practicality indicator (see Table 5) supported by the results of an interview with one of the students, which is presented as follows.

R : *I want to ask Siti, what did you learn about mathematics?*
S1 : *Earlier, I learned to build curved spaces with culture-based mathematics learning through VBA.*
R : *What is culture math education?*
S1 : *culture-based mathematics learning Ma'am. The learning is associated with traditional objects.*
R : *can you explain how to calculate the volume of the curved side space according to what you demonstrated through VBA earlier?*
S1 : *Ok. for example, to find the volume of a cylinder, we can use a circle of 12 coins that are stacked to form a tube. Because all the coins have the same diameter, and the base of the tube is circular, then the pile of coins turns into a tube, so the volume of the tube is obtained, namely: volume of the tube =* $\pi r^2 t$.
R : *According to Siti, how do you find the volume of the cone?*
S1 : *To find the volume of a cone taken from a cylinder, considering the volume of the fully filled cylinder of the three cones.*
So that the volume of the cylinder = 3 times the volume of the cone
in other words, $\pi r^2 t$ *will be equal to 3 times the volume of the cone,*
or the formula for the volume of the cone is 1/3 times $\pi r^2 t$
R : *Then how to find the volume of the sphere from the cone*
S1 : *to find the volume of the sphere, we first find the volume of the sphere. which is like this:*

Volume sphere = 2 times volume of cone or 2 times 1/3 πr^2 times t, where t is the same cone as r, which is a sphere. so, we get 2/3 πr^2 times t, since t is equal to the value of r sphere, then the result is 2/3 πr^3 so ma'am.

R : *That's just finding the volume of sphere, right? Then what about the volume of 1 full sphere?*

S1 : *Yes, you just need to multiply by 2 ma'am from the volume of sphere, So, the result 2 times 2/3 πr^3 will produce 4/3 πr^3 so ma'am.*

R : *Ooo, so that's how it is?*

S1 : *Yes Ma'am, I'm sorry if I'm wrong in reasoning.*

R : *Siti is very smart. According to Siti, is it suitable for this material to build curved side spaces using culture-based mathematics learning through VBA? then Siti is happy not to learn to use VBA?*

S1 : *In my opinion, the curved side of the building material is very suitable for using traditional objects, ma'am, such as caps, jugs, and balls, we can understand the concept directly, especially volume. And of course, I really enjoyed learning to use VBA, because in VBA there were traditional pictures, puppets, dances, batik especially Sundanese script, so I could learn Sundanese script while I didn't know it at first. All that triggers me to study ma'am.*

The last stage in the assessment phase is to test the effectiveness of culture-based mathematics learning through VBA. This test aims to see the effectiveness of culture-based mathematics learning through VBA towards increasing students' mathematical reasoning abilities. The effectiveness of the learning is seen from the results of the final test which has the characteristics of indicators of mathematical reasoning ability.

Based on the results of testing the effectiveness of culture-based mathematics learning through VBA (see Table 6), it shows that the use and implementation of culture-based mathematics learning through VBA on curved side space is categorized as very effective. The effectiveness test is said to be effective if students can answer 4 test questions based on indicators of mathematical reasoning.

Table 6. The results of effectiveness test of culture-based mathematics learning through VBA

Test Number	Indicator	Effectiveness Value	Category
1	Making assumptions to solve problems	78.49%	effective
2	Making models/patterns	87.30%	very effective
3	Generalize	84.14%	very effective
4	Composing the truth with proof	72.69%	effective
	Average	80.65	very effective

Table 6 shows that students who have good categories can construct truth with evidence and make assumptions to solve problems. Meanwhile, students' ability to make models or patterns and generalize can be categorized as very good. This shows that culture-based mathematics learning through VBA is effective for the process of increasing the mathematical reasoning ability of class IX junior high school students.

In the initial investigation phase, information was also obtained that in learning mathematics there is a need for interesting, unique learning innovations, and triggers understanding and conceptual reasoning of the material, so that students understand the material presented. This can be solved in culture-based mathematics learning through VBA. Learning that is collaborated with culture will trigger the growth of an ethical sense from students, mutual respect, and respect for each other and even preserving their own culture in accordance with their customs and beliefs (Rohaeti et al., 2020). In addition, learning using media such as VBA is also expected to improve students' mathematical abilities, especially reasoning (Fitriani et al., 2018; Pertiwi et al., 2021; Rohaeti et al., 2020; Rohaeti et al., 2019).

In the Design Phase, the results show a revision regarding the visualization of geometric shapes represented by cultural-based objects (see Figure 1). It shows that objects in the form of curved sides are presented that are easy for students to understand in everyday life, such as hats, jugs, and takraw balls which are traditional objects. This is an attempt to convey the relationship between culture and mathematics, especially in the material of curved side space. These efforts show that learning mathematics for everyone must be adapted to their own culture (Prahmana & D'Ambrosio, 2020). Ningsih et al. (2018) also suggest that mathematical modeling derived from modeling problems in everyday life will have a positive impact on the development of students' mathematical thinking. In addition, the results of the revised expert judgement also illustrate that Figure 2 shows that understanding geometric concepts can be integrated through information about culture which is a key aspect in the visual form of the learning process towards better student knowledge (Apsari et al., 2020; Efriani et al., 2019; Hendriana et al., 2017; Hendriana et al., 2018; 2019; Hidayat et al., 2018; Kurniawan et al., 2018). The visual form in question is an image form that has the characteristics of artistic and cultural values (Prahmana & D'Ambrosio, 2020).

Based on the results of the interview, it was seen that students gave a positive response to culture-based mathematics learning through VBA, so that students could immediately construct and explain the concept of the material well. This shows that the learning process through interesting media can motivate, construct, and master the concepts of the material being taught (Fook et al., 2021; Pertiwi et al., 2021; Rohaeti et al., 2020).

Regarding the results of the effectiveness test of learning developed through VBA (see Table 6), it shows that mathematical reasoning abilities can be further developed. This is in line with Rohaeti's opinion (Rohaeti et al., 2019) which suggests that learning through VBA media can provide opportunities for students to explore solving strategies in solving mathematical problems. But the most important thing is how the teacher can design learning so that students could explore the solution strategy. This shows that learning mathematics that is integrated with culture through VBA can be used as an alternative learning media. However, this can be in line with the learning objectives in the classroom, if the teacher who is an educator has proficient technology and communication skills.

Conclusion

Based on the development of culture-based mathematics learning through VBA, the validation results are very valid. Furthermore, from the results of the product practicality trials carried out, it can be said that the practicality of the learning is classified as very good criteria. In addition, it was reviewed based on the development stage of learning effectiveness classified as very good in the use of VBA to increase the mathematical reasoning ability of junior high school students. Presenting learning with cultural nuances, students' ethics will be better, an attitude of mutual respect, respect, and even culture can be preserved. In other words, culture-based mathematics learning through VBA is very effective to be used in learning the curved side space building material.

The culture-based mathematics learning through VBA can be used in the learning process on curved side space so that students can recognize and preserve culture well. As an educator, the teacher is expected to be more accustomed to using technology in learning that is adapted to conditions so as not to lag in its development, so that learning will not seem monotonous and boring, it will even inspire students' enthusiasm in learning. In addition, it is also hoped that there will be further development of culture-based mathematics learning to make up for the shortcomings.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been covered completely by the authors.

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