

Thong-Bhitongan: Development of Educational Media based on Ethnomatematics of Madura Coastal Culture

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ARTICLE INFO

Keywords:

Thong-Bhitongan;
Media, Nomural;
Mathematics

Article history:

Received 2023-01-04

Revision 2023-03-11

Received 2023-05-21

ABSTRACT

This study is aimed to develop mathematics learning media inspired by the typical games of the coastal communities of Sumenep Madura Regency. We provide the media with "Thong-Bhitongan" which is defined as a counting tool in Indonesian. This development uses a development design adapted from Thiagarajan, which consists of a definition, design, and development. "Thong-Bhitongan" is a concrete media that students can play with. The validation results of the "Thong-Bhitongan" media were 82.5, and the material validation was 85. Product trials were carried out at three target schools of Kampus Mengajar 4: Duko II Elementary School, Guluk-guluk II Elementary School, and Guluk-guluk IV Elementary School. The results of the product trials showed that the "Thong-Bhitongan" learning media developed was effective in helping to increase students' understanding of numeracy material, as evidenced by the post-test results which were better than the pre-test results and had exceeded the minimum completeness score. In addition, the media "Thong-Bhitongan" also achieved a good response from students. It is expected that the product of this research, namely the mathematics learning media "Thong-Bhitongan" will become an alternative medium in improving students' nomural abilities.

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1. INTRODUCTION

The basic knowledge that all humans must be able to have is reading, writing, and arithmetic (Fitriani et al., 2018). One way to improve numeracy skills is by learning mathematics (Pratiwi & Pujiastuti, 2020). Mathematics is an important science that can contribute to humans' daily activities (Zulaekhoh & Hakim, 2021). However, some students often think that mathematics is only something related to numbers and is not used in everyday life, even though almost all activities in social life use mathematical calculations, such as the buying and selling process (Pujiastuti et al., 2020). Indonesian students' mathematical abilities still need improvement (Fazira & Qohar, 2021). In 2018, Indonesia

participated in the Program for International Students Assessment (PISA), and Indonesia was ranked 75th of 81 countries in the field of mathematics, with a score of 386. PISA stated that Indonesia's mastery of mathematics still needed to improve.

One of the Mathematical concepts that students must be able to provide life for students is simple arithmetic operations. Making sure that their students have a basic comprehension of addition is one of the major issues faced by math teachers. Students in the first year of primary school should have a solid understanding of the fundamental process of addition. Even if they have advanced to higher grades, many students still have trouble mastering addition operations (Fahma & Purwaningrum, 2021). Special treatment is needed for students to be able to master this concept, one of which is using contextual learning that is linked to the local culture of the community. This is called ethnomathematics. Ethnomathematics means knowledge that talks about culture and mathematics (Zhang et al., 2021). Mathematical knowledge will be meaningful through the interaction between the learner and the world around him, and the learner's experience is considered the key to further learning (Weldeana, 2016). Because it is essential to provide meaningful learning experiences for students, one of which is by using media (Jatmiko & Hobri, 2021). The use of instructional media helps students to be active in the learning process and makes it easy to communicate messages and content (Romanvican et al., 2020). The teaching material that is used should be able to facilitate teachers to transfer values and knowledge (Imswatama & Lukman, 2018).

By using learning media, it is hoped that students can achieve maximum learning outcomes, increase motivation, and expedite the learning process (Romanvican et al., 2020). Learning mathematics is providing learning experiences to students with a series of planned activities to gain new knowledge about mathematics through various mathematical skills (Fendrik, Marsigit, & Wangid, 2020). Based on the results of observations with students of Kampus Mengajar batch 4 carried out at SDN Duko II Sumenep regency, the fact said that the cause of the incompleteness of students' mathematics learning outcomes came from student's lack of understanding of mathematical concepts. On the other hand, the teachers still needed help teaching something abstract to elementary school students who were still in the concrete operational stage. Related to abstract mathematical objects, learning starts from concrete objects so that students can understand mathematical concepts correctly, especially when it is related to students (Fendrik et al., 2020). Learning mathematics will be easier if we use media. Lower-grade students, especially in 2nd-grade school of elementary education, still have difficulties learning mathematics on addition and subtraction material, so appropriate media are needed to explain subtraction and addition material.

Some statements above became the main idea of developing Sumenep's local culture-based media. "*Tong-bitongan*" is a learning media that will be developed to facilitate the delivery of mathematics material, especially in the early grades. *Tong-bitongan* is based on the local culture of the Sumenep people, most of whom are in coastal environments. This research aims to develop valid, practical, and effective *Tong-bitongan* media. The media to be developed by the researchers is in the form of a simple calculating device; it can be stated as an ancient calculating tool, but it still exists. Researchers modified *Swipoa*, also known as an abacus, in such a way that it can be used as a learning media in class, which is expected to help students learn mathematics. In the past few decades, numerous studies have been conducted on the development of online and computer-based media for teaching and learning (Yu et al., 2021). There is nothing inherently wrong with such developments, as they add diversity to the range of learning media available to students. However, given that elementary school students are still at the concrete operational stage, they require concrete media to support the delivery of early numeracy concepts. Children (7–12 years old) in the concrete operational stage have different viewpoint from adults or parents (Hidayati, 2012). Hence, instructors must be able to motivate students to develop accurate concepts, particularly in the study of mathematics. In addition, the development of "*Tong Bitongan*" media also aims to focus on introducing and teaching the original culture of Sumenep society so that students do not forget their identity and distinctive characteristics.

"Tong Bitongan" is designed and developed in such a way as to complement and enhance existing media in an effort to improve the numeracy skills of elementary school students.

Traditional media and games have been shown to increase children's interactions (Jayadi & Arnidah, 2019) Arnidah, 2019), while implementing a thematic-integration approach in character education can be done by adopting some of the local cultural values as teaching materials (Asrial et al., 2020). "Tong Bitongan" is very suitable to be developed in early grades of the elementary school level because elementary school children are entering the early stages of knowing and learning how to count. Particularly, in Sumenep Regency, which has 125 islands with various disparities in education access. This media was developed to make it easier to stimulate students to be active in learning. The media "Tong Bitongan" is an ancient calculating tool that is simple and made of wood or plastic. The function of "Tong Bitongan" is the same as the calculator, but the difference is that the numbers on the calculator are replaced with beads. Media "Tong Bitongan" can complete arithmetic subtraction, addition, multiplication, and division operations. But in this study, the researchers focused on completing arithmetic operations on addition and subtraction to suit students' learning difficulties.

"Tong Bitongan" was developed in the early grades of elementary school, mainly grade II elementary school to facilitate students' understanding of the concept of addition and subtraction following Basic Competency (KD) 3.3: explaining and performing addition and subtraction of numbers involving whole numbers up to 999 in daily life and link addition and subtraction. The "Tong Bitongan" media will be very integrated into learning mathematics, namely addition and subtraction material from a theme 1 sub-theme 4.

2. METHODS

This research is a research and development because learning media will be developed on the material of addition and subtraction for early grades based on the culture of coastal communities. This study used the 4D (four D) development method. The 4D development model, was suggested by (Thiagarajan et al., 1974). The stages of this research started from the first stage, namely the define stage, then the second stage, the design stage, the development stage, and the dissemination stage. However, in this research procedure, researchers will only carry out three stages of 4D development, namely define, design, and development. The trial will be carried out in 3 schools in Sumenep Regency, which are target schools of the Kampus Mengajar batch 4 in 2022. The population in the study was Public Elementary Schools in Sumenep Regency. The sampling technique in this study used a purposive sampling technique which was adapted to the purpose of this study, namely to produce valid, practical, and effective "Thong-Bhitongan" mathematics learning media (Hirzi & Gazali, 2020).

The result of calculation and analysis uses the Content Validity Index (CVI) approach, and it will later be defined descriptively in the form of validity categorization/classification (Sugiharni, 2018). To determine media development's validity, the researcher uses the product validation criteria in table 1.

Table 1. Criteria of Product Validation

Category	Total Score	Eligibility Presentation	Criteria
1	$25 \leq x \leq 43,75$	Invalid	Inappropriate and total revision
2	$43,75 \leq x \leq$	Valid Enough	Fairly appropriate and many revisions
3	$62,5 \leq x \leq 81,25$	Valid	Appropriate and slightly revised
4	$81,25 \leq x \leq 100$	Very Valid	Very appropriate and not revised

(Malasari et al., 2019)

Analysis of the effectiveness of learning media is obtained from learning achievement tests which are intended to achieve learning objectives (Jatmiko & Hobri, 2021). At the product trial stage, the

design that will be used in this study is the one-group pretest-posttest design. This design involves three classes in the trial class. Students in the previously selected class were given a pre-test before learning with the "Thong-Bhitongan" learning media. Furthermore, students were given a final test to find out their learning outcomes after learning with the "Thong-Bhitongan" learning media

The following is a trial design, in this study using a one-group pretest-posttest design (Kurniasari 2012).

Table 2. Design of Learning Device Trial

Group	Pretes	Treatment	Postes
Trial class	THB1	X	THB2

Description:

THB1 : Student score before treatment

THB2 : Student score after treatment

X : Learning by using "Thong-Bhitongan" media

Implementation of this trial was carried out by partner teachers and two observers (observers). Observations were made in each meeting to find out student activities and partner teacher activities in managing to learn. The results of this trial were used to revise the imperfections in "Thong-Bhitongan" media, so it produces a good quality "Thong-Bhitongan" learning media. Then the good quality "Thong-Bhitongan" learning media was applied in the implementation class, which aimed to determine the effectiveness of learning with "Thong-Bhitongan" learning media on the material of addition and subtraction in class II of elementary school. Students are considered complete individually if they get a score of more than 65. It means that students have been able to solve, master interests, or achieve learning goals. Meanwhile, the class success (classical completeness) is seen from the total number of students who can complete or achieve a minimum score of 65. In this case, the product being developed can be stated effective if the percentage of classical completeness obtained is more than 75% (Hirzi & Gazali, 2020).

3. FINDINGS AND DISCUSSION

The product of this research development is the "Thong-Bhitongan" Mathematics learning media. The material in this study refers to the K13 curriculum, which is used in pilot schools. The development of "Thong-Bhitongan" media is based on the culture of the people in Sumenep Regency. Sumenep Regency has a very beautifully acculturated culture between Madurese, Chinese and Arabic cultures. It can be seen in several historical heritages of Sumenep, such as the Sumenep Great Mosque. The material for arithmetic operations with "Thong-Bhitongan" uses the exchange method, which can make it easier for students to implement arithmetic operations. The learning process using concrete objects will facilitate the accommodation of knowledge to students. In the process of learning mathematics, media can generate desire, motivation, and stimulation. The goal is that learning communication runs effectively so that the planned learning objectives are achieved (Murtikusuma et al., 2019). The following are the stages of development of this research:

3.1. Defining (define)

At this stage, it begins with establishing basic development problems, analyzing students, analyzing concepts and assignments, and formulating learning objectives.

- a. Define the basic development problem.

The basic problem in this study is to develop concrete learning media that are easy to use, can be played by students, and can help students understand the concept of counting;

The determination of this problem is based on the results of initial observations in target schools for the Kampus Mengajar Program batch 4. Based on the observations conducted, there were still many students who did not understand the concept of counting, even when students were promoted to grade III. It is undeniable that learning lost during the pandemic has had a very significant impact on students' knowledge, especially in the early grades of elementary school. Their socioeconomic background and various limitations force them to continue their studies without a sufficient understanding of the material.

b. Student analysis

Adjustment of the development design suitable for elementary students' characteristics is needed. It must be easy to use, simple in design, easy to play with, and attractive in colour.

(Rafiqah, 2013) states that student analysis is carried out to determine students' characteristics so that they are following the targeted media development. Based on the results of observations, interviews, and group discussion forums, the following student data were obtained:

1) The age of grade II elementary school children is between 8 and 9 years. At this time, the child is at the level of concrete operational cognitive development and needs to be taught to think abstractly. Children will explore everything around them at this age using all their five senses and imagination abilities. In this process, the teacher builds formal knowledge based on informal knowledge that students already have using the conceptual framework for learning elementary school mathematics (Fendrik et al., 2020), so that concrete media that is easy to play is considered suitable for grade II students.

2) The student's ability in the academic field in the Sumenep district is very diverse with various supporting factors. The facility, parental support, economic and social conditions as well as the intrinsic motivation of each student varies. Some students have high, medium, and low academic abilities.

3.2. Concept analysis

Analyzing the concept, and determining the material embedded in the "Thong-Bhitongan" media under KI and KD in K13. The media is devoted to the material of addition and subtraction in class II elementary school.

3.3 Task analysis

Task analysis aims to enable students to achieve the specified basic competencies. Researchers design learning tasks and material content that students must complete. At this stage, the aim is to determine the suitability of the material in "Tong Bitongan" media with KD 3.3: explaining and doing addition and subtraction of numbers involving whole numbers up to 999 in everyday life and linking addition and subtraction.

3.4. Formulation of learning objectives

Summarizes all analysis of concepts, materials, and domains to be developed. Learning mathematics is providing learning experiences to students with a series of planned activities to gain new knowledge about mathematics through various mathematical skills (Fendrikfendrik et al., 2020).

3.5. Design

Designing media models to attract students to learn by playing.

a. Material selection

The material is arranged based on KI and KD in the 2013 curriculum for elementary schools. The focus of the material in this study is addition and subtraction. The preparation of the test corresponds to the selection of material used in the "Tong-Bitongan" media which aims to measure the extent to which the level of accuracy indicates students' understanding of addition and subtraction material in answering knowledge competency test questions.

b. Media Selection

Media selection aims to determine the learning media that will be developed according to student characteristics and needs. The learning media chosen in this study is "Tong-Bitongan" media. It helps help students understand addition and subtraction material. Mathematics learning will be more exciting and meaningful for students when the learning process can be linked to the culture surrounding them because they can directly learn with the local culture in place (Fendrikfendrik et al., 2020).

3.6. Development

This stage aims to produce "Thong-Bhitongan" products. In this stage, there is also an expert assessment stage and a development trial stage in schools. "Thong-Bhitongan" will be tested on students. At this development stage, the main goal is to obtain learning media that have been revised based on expert input (Al-Tabany, 2017). The initial step at this stage is to validate the product on the validator. The results of the validation are used as a basis for revising "Tong-Bitongan". "Tong-Bitongan" involved two material expert validators and two media expert validators. The validation results from the two material experts are shown in Figure 1.

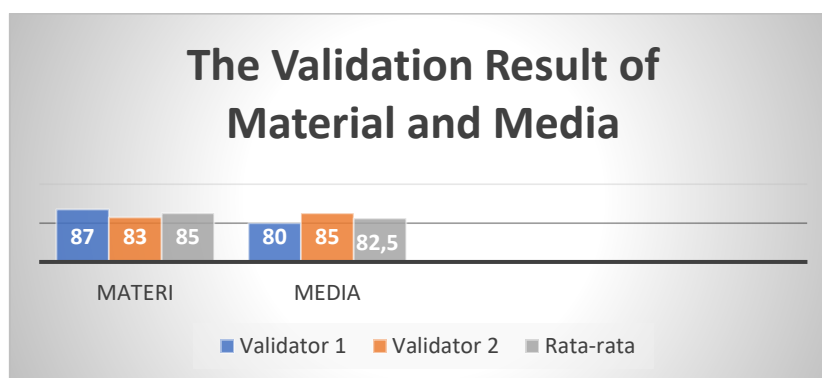


Figure 1. The Validation Result of the Two Material Experts

The diagrams from the material experts showed that overall the results of the validation of the material experts were in the very good category, based on the average score of the two material validators showed a value of 85 out of 100. The score was based on the results of the average material expert validation score from each aspect, namely the learning aspect. Scores above 80 for material and media validity values belong to the very high category (Sugiharni, 2018). There are four scopes in the material validation instrument: material coverage, material accuracy, scientific thinking activities, and efforts to facilitate understanding concepts. Furthermore, the average validation of media material experts from each aspect, namely media, is 82.5 out of 100 and is included in the very good category. Media validation consists of four aspects, namely content presentation components, development engineering, display attractiveness components, and ease of use. The design for the "Tong-Bitongan" media that has been developed can be seen in Figure 2.

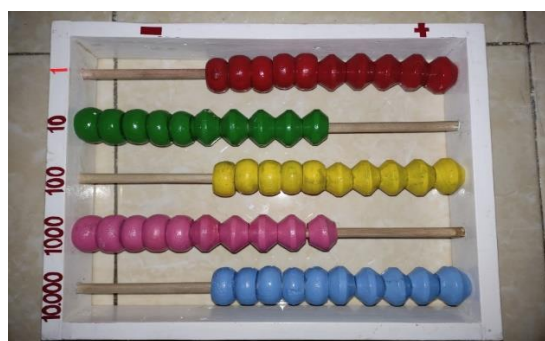



Figure 2. Design media "Tong-Bitongan"

The last result of the "Tong-Bitongan" media has a small elongated shape. There are 5 poles, 10 beads in 1 pole, and it has attractive colours typical of elementary school students. The shape of the beads is deliberately made different between the 1-5th and the 6th-10th. Beads 1-5 are more pointed and beads 6-10 are more rounded. It is to reduce errors when students play this media. The use of "Tong-Bitongan" media with the exchange method. An example of the use of "Tong-Bitongan" media is as follows. For example, it is adding $346 + 62 = 408$.

Table 3. The result of the Expert's scoring

	3 Beads equal 100 for each = 300	4 Beads equal 10 for each = 40	6 Beads equal 1 for each = 6	Total $300 + 40 + 6 = 346$
Addition				
		6 Beads equal 10 for each = 60	2 Beads equal 1 for each = 2	
After sliding to the right (+)				
	3 Beads equal 100 for each = 300	10 Beads equal 10 for each = 100	8 Beads equal 1 for each = 8	
Because 10 beads can be exchanged for larger beads, 10 beads equal 10 for each (green in color) are exchanged for beads of equal value. 10 green beads, equal 100 for each are exchanged for 1 yellow bead equal 100 for each. So that the nominal value is easy to read.				

	<p>4 Beads equal 100 for each = 400</p>	<p>The green bead is empty because it has been exchanged with a yellow bead which is equal 100 for each</p>	<p>8 Beads equal 1 for each = 8</p>	<p>Read as 408 in Media</p>
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The development of "Tong-Bitongan" media was tested in 3 target schools of Kampus Mengajar Program batch 4, namely SDN Duko II, SDN Guluk-guluk II, SDN Guluk-guluk IV in Sumenep Regency. It was used to revise and improve the product based on data and information obtained in the development process in limited trials. The practicality test was carried out by submitting a practical test questionnaire for Mathematics learning tools to teachers and second-grade students. The results of a questionnaire filled out by teachers and students regarding the indicators: easy to understand, easy to use, useful, and display, are generally classified as practical. The average value of the questionnaire items for each indicator is presented in Table 4

Table 4. Average Score of Questionnaire Item

No	Indicator	Average	Criteria
1	Easy to Understand	80	Simple
2	Easy to Use	86	Very Simple
3	Useful	81	Simple
4	Display	82	Simple

Mathematics learning is always interesting because of students' negative perceptions of mathematical material. Based on filling out the questionnaire, which was distributed during the limited trial to 43 students from 3 "Tong-Bitongan" user schools accompanied by Teachers and Teaching Campus students, it was obtained data that "Tong-Bitongan" media received very good responses. It is known based on the percentage of student response questionnaires which reached 83.8% in the very good category. The student response questionnaire contains 12 questions. This demonstrates that "Tong-Bitongan" is practically utilized for the initial numeracy learning process.

Thus, the development of "Tong-Bitongan" can be considered suitable for use as a medium for learning mathematics. Mathematics learning can be done with more fun by involving concrete and contextual objects because when the teacher explains with a lecture, students tend to pay less attention to learning (Romanvican et al., 2020). Concrete and playable media can help students understand abstract mathematical thinking processes more efficiently. To see the effectiveness of the "Tong-Bitongan" media, the researcher conducted an effectiveness test using the one-group pretest-posttest model. The result is that students experience changes in learning outcomes at the beginning of the test (pre-test) and the results at the end of the test (post-test). The results of the analysis can be seen in the following table.

Table 5. Result of Pre-test and Post-test

No	Class	Number of Students	Average Score of Pre-test	Average Score of Post-test
1	SDN Duko II	13	58,62	76
2	SDN Guluk-Guluk II	15	65	78
3	SDN Guluk-Guluk IV	15	61	80
	Total Student	43	61,54	78,00

The results of statistical calculations found that the average value of the initial test (pre-test) was 61.54 and the average value of the final test (post-test) was 78.00. Based on the results of learning

implemented in 3 schools (SDN Duko II, SDN Guluk-guluk II, SDN Guluk-guluk IV), it can be seen that learning can be carried out well, student activities are effective, student responses are positive, and completeness classical student learning is achieved. Thus, it can be said that learning Mathematics assisted by "Tong-Bitongan" media is effective.

This research is particularly interesting as it develops a contextual and concrete mathematics learning media that is imbued with local community wisdom. Learning based on local wisdom can enhance students' motivation and promote more participatory learning experiences (Abadi & Soebijantoro, 2016). This is in line with the findings of this study, which demonstrate that a concrete learning media infused with local cultural wisdom can assist students in early numeracy learning. Based on the results of pre- and post-tests in this study, the average improvement of students surpassed the minimum passing grade, indicating that "Tong-Bitongan" is an effective tool to enhance students' early numeracy skills.

This research seeks to develop "Tong-Bitongan" media which can be used as a learning media for students to understand the concept of addition and subtraction. Research that specifically examines the growth of contextual ethnomathematics-based media, particularly those that concentrate on the Madura cultural background, is still limited in the literature. Yet, the researcher discovered a study that investigated the development of a module based on ethnomathematics. The research that relates to this report, "The Novel Method to Enhance Mathematical Literacy in Elementary School: Ethnomathematics Module with Realistic Mathematics Teaching," was done by Yuliana et al. in 2023. According to the results of this module creation study, students' mathematical literacy can be improved by using an ethnomathematics-based learning module in combination with a practical approach to teaching mathematics. The module received a very good validation score from language experts (93.8%), subject matter experts (94%), and design experts (92%), indicating that it is valid, applicable, and effective.

In addition, the research results are in line with Fariza's research (2021) which shows that learning media can motivate students to learn mathematics (Fazira & Qohar, 2021). "Tong-Bitongan" media can be used as an alternative learning media for early elementary school students. Based on the suggestions from the material expert validator, the "Tong-Bitongan" media underwent several revisions until, finally, the "Tong-Bitongan" media can be said to be valid and feasible to use. The "Tong-Bitongan" media also gets positive responses from students and teachers and can help students understand the concept of arithmetic so that classical class grades can be achieved.

Learning media that utilizes local wisdom in its region makes learning more meaningful, even for slow learners (Wanabuliandari & Purwaningrum, 2018) and can build national character (Ikhwanudin, 2018). In the 21st century the use of IT-based media is needed to improve students' digital literacy skills, but the development of concrete media is also needed to facilitate students' motor skills. Elementary school students tend to think more practically than abstractly since they are still in the operational stage of concrete thinking. Learning numeracy at early stages with "Tong-Bitongan" has been shown to have positive implications for students. Students find it easier to understand numeracy concepts using concrete media that are relevant to the Madura cultural background. One of the reasons why mathematics is often perceived as difficult is that teachers typically teach mathematics in an abstract manner during the early years of elementary school. By using culturally relevant and concrete teaching aids, such as "Tong-Bitongan", teachers can make mathematics more accessible and engaging for students, which can help to improve their confidence and motivation in learning mathematics. This, in turn, can positively impact their overall academic performance and future success. According to Jean Piaget's hypothesis, children who have reached the concrete operational stage can manipulate logical and systematic symbols that have a connection to actual objects to demonstrate intelligence. Due to operational thinking occurring at this level, this stage is seen as a milestone in children's development (Brouse & Chow, 2009).

The development of concrete media is still considered very suitable for students at the elementary school level, especially in the early grades. More than that, using media is very important to help early elementary school students learn. With learning media, students will be motivated and

help teachers to create more enjoyable learning. Any learning will be very effective if learning is fun (Handayani & Iswantiningtyas, 2020). Indeed, "Tong-Bitongan" is one of the mathematical learning media that is worth trying in the learning process. It has been shown to be effective in improving students' early numeracy skills, and it can be considered an alternative tool for teaching mathematics in a culturally relevant and engaging manner.

4. CONCLUSION

The study, development, and discussion results in the research on "Tong-Bitongan: Development of Educational Media based on Ethnomathematics of Madura Coastal Culture" demonstrate that "Tong-Bitongan" is a valid, practical, and effective mathematical learning media. "Tong-Bitongan" meets the validity criteria with a score of 82.5 for media validation and 85 for material validation. "Tong-Bitongan" also meets the practicality criteria, as indicated by the positive response from students in the questionnaire, with an average score of 83.8%. This is because "Tong-Bitongan" can help them understand simple numerical concepts more easily and in a contextual manner. Moreover, "Tong-Bitongan" meets the effectiveness criteria, as evidenced by the changes in the average scores from pre-test to post-test conducted in three pilot test schools. Based on the research data, the average pre-test score of students was 61.54, while the post-test score was on average 78. The pilot test was conducted in three target schools under the supervision of the "kampus mengajar" teaching team in batch 4.

This developmental study has proven to be valid, practical, and effective in Sumenep Regency. However, further development of the "Tong-Bitongan" media is needed to facilitate a deeper understanding of the concept of counting. Similar studies can also be conducted to develop various ethnomathematics-based learning media that are tailored to the unique cultural characteristics of other regions. Through the development of various ethnomathematics-based learning media, not only can educational goals be achieved, but also cultural preservation, so that students do not forget their national identity.

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