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# Development Of Mathematics Learning Model Using Etnomatics To Improve Mathematics Problem Solving Ability

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**Abstract**

In junior high schools, ethnomathematics has not yet been utilized to its fullest extent in mathematics instruction. In truth, mathematics is a closely related subject to daily life. This project intends to develop a valid, practical, and efficient ethnomathematics-based mathematical learning model for enhancing mathematical problem-solving skills. This study employs the ADDIE design by Branch, which consists of five phases: analysis, design, development, implementation, and evaluation. This research targets junior high school instructors and students in the Indonesian province of Bone. In addition, other participants in this study were educational specialists who evaluated the established models and instruments. Several instruments, including questionnaires, interviews, validation sheets, observation sheets, and tests, were used to collect data. The data was subsequently examined using qualitative and quantitative techniques. The results indicated that the ethnomathematics-based mathematics learning model was valid, applicable, and useful for enhancing the mathematical problem-solving skills of junior high school pupils in Bone Regency, Indonesia.

**Keywords:** problem solving, ethnomathematics, mathematics learning model

## INTRODUCTION

The mastery of problem-solving skills in mathematics is an essential ability that students must master. This is consistent with the principles and standards of school mathematics established by the National Council of Teacher Mathematical (NCTM, 2000), which declare that problem solving is a necessary component of completing mathematics education.

The significance of acquiring problem-solving skills has not been accompanied by mathematical proficiency among pupils. In 2015, the Trends in International Mathematics and Science Study (TIMSS) revealed that the mathematical ability of Indonesian students was 379 and that they were ranked 46th out of 51 countries (Mullis et al., 2016). This is evidenced by facts on the ground, such as the fact that the mathematical ability of Indonesian students ranked 46th out of 51 countries. Moreover, according to the 2018 Program for International Student Assessment (PISA) scores, Indonesia ranks among the worst 10 of 79 nations. These numbers indicate that Indonesian pupils continue to do poorly in mathematics on a global scale.

Based on the results of observations conducted on April 6, 2021 at four secondary schools in Bone Regency, Indonesia, namely by testing questions to determine the level of mathematical problem-solving abilities in students who have obtained the materials for building flat sides, it is known that some students work on problems without first interpreting them, causing them to struggle with the subsequent problem-solving steps. In other words, they are less capable of solving issues successfully using Polya's stages. This demonstrates the limited problem-solving abilities of Junior High School students with regard to the construction of a flat side area.

Students' inadequate problem-solving abilities can be attributed to the following factors: (1) learning is more teacher-centered, making students less active learners; (2) students' lack of enthusiasm in learning mathematics; and (3) students' inability to comprehend story-shaped problems. (4) questions - Problem-solving difficulties are unrelated to the local culture of their location.

Ethnomathematics is a method for describing the relationship between ambient culture and mathematics as a family of knowledge (Putri, 2017). The application of ethnomathematics makes it easier for students to comprehend the studied concepts or material because learning is closely tied to their culture, which is a daily occurrence in their environment (Wahyuni, 2013). According to (Rismawati et al., 2019), learning mathematics related to the actual world cannot be isolated from the local culture around it, as it is not uncommon for a culture to contain mathematical principles that are used in daily life from generation to generation.

By introducing, linking, and utilizing the surrounding culture as a learning resource, either media or instructional aids related to sub-materials in the teaching and learning process, ethnomathematics can be taught (Aprilyani & Arif Rahman Hakim, 2020). This study explores the ethnomathematics of the Bugis culture in the Bone Regency of South Sulawesi Province. According to (Takko, 2020), the Bugis community has a unique culture that can be exploited as a learning resource, including traditional food, traditional games, traditional housing, and others. This culture can be utilized as a learning resource due to its distinctive design, which mimics a flat shape and a space, assuming that the adopted culture is already recognized and can assist students in studying mathematics.

According to research (Wahyuni et al., 2013), through the application of ethnomathematics in mathematics education, students can grasp the required mathematical skills without abandoning their cultural values. The findings of the study (Andriyani & E, 2017) indicate that an ethnomathematical approach to learning can enhance student learning outcomes. According to the findings of the study (Rismawati et al., 2019), kids find it difficult to learn mathematics since learning mathematics, which is tough and tedious when studied in class, is not connected to their local culture. In addition, research done by Murnaka et al. (2019) indicates that students who get contextual mathematics learning have a higher average problem-solving skill than students who take standard mathematics sessions.

The application of ethnomathematics to the study of mathematics is anticipated to increase problem-solving, hence enhancing academic attainment. This study intends to design a mathematical learning model that utilizes valid, practical, and effective ethnomathematics to enhance problem-solving skills in junior high schools in Bone Regency, Indonesia, without sacrificing their cultural values.

## RESEARCH METHOD

This research is research and development (R & D) that tries to create learning models and learning technologies. Evaluation of the Validity, Practicability, and Effectiveness of Learning Models and Learning Tools (Joyce, 2015), (Nieveen, 1999) (Wilson, 1996). The development process follows the ADDIE paradigm, which consists of five stages: analysis, design, development, implementation, and evaluations (Branch, 2009).

The participants in this study were Indonesian junior high school students from the Bone Regency. At the needs analysis stage, the study subjects were 80 students and 4 mathematics teachers; at the content and construct validation stage, they were 2 education experts; and at the practicality and efficacy test, the research subjects were 21 students.

Instruments in the form of observation sheets, documentation, questionnaires, interviews, and tests were utilized for data collection. The relevant instruments include the model implementation observation sheet, the student activity observation sheet, teacher and student reaction questionnaires, and math problem-solving ability assessments.

Quantitative and qualitative data are necessary for this investigation. Quantitative data include the implementation of the model, the capacity of teachers to manage learning, student involvement in learning, student reactions to the implementation of learning, and mathematical problem-solving skills. Moreover, qualitative data is derived from interviews with teachers. The data is then examined to determine the validity, applicability, and efficacy of the ethnomathematics-based mathematics learning paradigm.

## RESEARCH RESULT

Design learning model and tool outcomes

The results of constructing a mathematical learning model leveraging

ethnomathematics to enhance mathematical problem-solving skills are presented in the form of six learning phases.

Table 1. Syntax of Mathematics Learning Model Utilizing Ethnomathematics

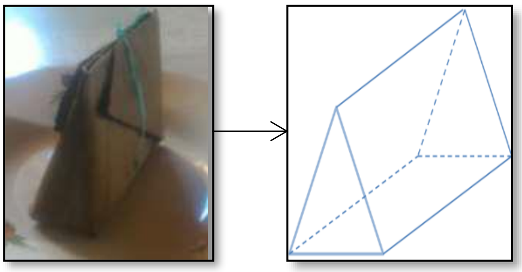
| Phase | Learning Steps |
|---|---|
| Phase-1<br>Relating | 1. Provide students with the inspiration to learn with diligence and assurance.<br>2. Accomplishing the learning objectives that will be executed<br>3. Explain to pupils the significance of studying teaching materials and the execution of learning (including the connection of local culture to the resources). |
| Phase-2<br>inqiury | 1. Describing the current local culture and illustrating real-world challenges relating to the topic;<br>2. Develop students' reasoning by assigning them relevant and memorable learning exercises, such as searching for and locating flat shapes and the surrounding environment. |
| Phase 3<br>Associating | 1. Divide the class into small discussion groups and pose questions.<br>2. Distribute Worksheets for Students (LKS)<br>3. guiding pupils to conduct group conversations in order to generate responses to the distributed worksheets by constructing their own knowledge and abilities in relation to the problems on the worksheets. |
| Phase 4<br>applying | 1. Ask group representatives to write or present the outcomes of their talks in front of the class, while allowing other students (groups) to reply.<br>2. Inciting students to answer or ask questions with the intent of fostering their curiosity.<br>3. Explaining content that, based on the outcomes of his observations, students have not grasped while posing questions to students.<br>4. Provide practice questions (questions in student books or quizzes) that are realistic and applicable to students' everyday lives in order to assess their comprehension. |

| | |
|---|---|
| | 5. Together with the students, summarize and draw conclusions from the discussion's outcomes. |
| Phase 5 reflection | 1. Consider both the positive and negative aspects of the completed exercises, as well as what might be done to improve the next lesson.<br>2. Inform participants of the material for the next meeting and provide homework. |

In addition, in the stage of the development of learning tools in the form of teacher books, student books, lesson plans, and student worksheets adapted to the mathematics learning model employing ethnomathematics and the characteristics of mathematics learning, and the results of the identification of elements of Bugis local culture in Bone Regency, Indonesia. The following are the outcomes of identifying ethnomathematics within the framework of Bugis culture and mathematics education.

1. Barongko

Barongko is one of the most popular Bugis dishes. Barongko is composed of mashed bananas, coconut milk, and eggs, which are then wrapped in banana leaves. This cake is frequently offered at Bugis traditional occasions such as weddings (Pathuddin & Raehan, 2019). This barongko cake is based on a geometric shape, a triangular prism.



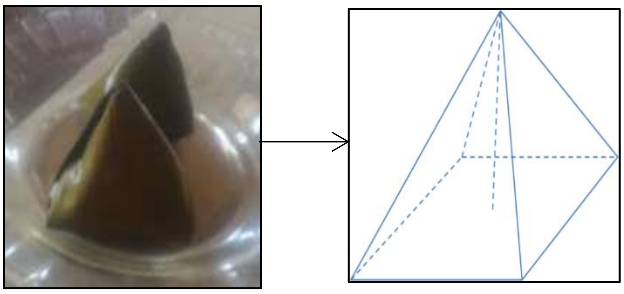
Barongko Cake Triangular Prism

2. Doko Doko Cangkuli

Doko-Doko cangkuli is a classic Bugis dish consisting of sticky rice and a coconut filling flavored with brown sugar (Itawirah, 2021). The geometric shape of this doko doko cangkuli cake is a rectangular pyramid.

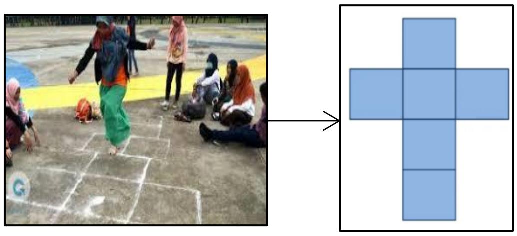
3. Ma'dende

Ma'dende is one of the most popular



Doko Doko Cangkuli Cake Rectangular

traditional games of its day, and girls predominantly play it. In other regions, this game is known as "Engklekan." 'Dende' is typically played by up to four or five children



Ma'dende Cube Nets

(Pathuddin & Raehan, 2019). Typically, this game mimics the net of a form (cubes, blocks, prisms and pyramids).

Validity test findings

The level of validity of products that have been generated through research and development is determined by quality testing. The product validity score is determined by averaging the scores of the two experts who offered an evaluation. Experts have created and evaluated five products: model books, teacher books, student books, lesson plans, and student worksheets. The test results for the five products are displayed in Table 2 below.

**Table 2. Product Validity Test Results**

| Learning products | Average | Category |
|---|---|---|
| Material Book | 3,68 | Very Valid |
| Teacher's Book | 3,89 | Very Valid |
| Students' Book | 3,80 | Very Valid |
| Lesson Plan | 3,72 | Very Valid |
| Students' Worksheet | 3,77 | Very Valid |
| **Average** | **3,74** | Very Valid |

According to Table 2, the learning product that has been generated is deemed valid based on expert opinion. This is demonstrated by the total average score of 3.74 with the following details: (1) books with an average rating of 3.68, (2) books for teachers with an average rating of 3.89, and (3) books for students with an average rating of 3.89. a 3.80 average, (4) lesson plans with a 3.72 average, and (5) student worksheets with a 3.77 average. According to the previous study method's validity criteria, the mathematics learning model employing ethnomathematics is deemed to have a high degree of validity if its average score falls between 3.5 and 4.0.

**Results of practicality tests**

Using ethnomathematics, model books and model devices were developed and validated, and then implemented to determine the practicability of the model by analyzing the results of observing the model's implementation from the first to the last meeting, the results of observing student activities from the first to the last meeting, teacher responses, and student responses. The following table details the findings of observations about the implementation of the model, student activities, instructor replies, and student responses.

**Table 3. Results of Observation of Model Implementation**

| Aspects | Average | Category |
|---|---|---|
| Model Syntax | 3.90 | Very Practical |
| Social System | 3.86 | Very Practical |
| Reaction principle | 3.91 | Very Practical |
| Support system | 4.00 | Very Practical |
| Instructional impact and accompaniment | 3.86 | Very Practical |
| **Mean** | **3.91** | **Very Practical** |

The syntax aspect of the model has an average value of 3.90, the social system aspect has an average value of 3.86, the reaction principle has an average value of 3.91, the support system aspect has an average value of 4.00, and the instructional and accompaniment impact aspect has an average value of 3.86. The overall average value of the learning implementation is 3.91. Consequently, it can be claimed that the mathematics learning model incorporating ethnomathematics was implemented very well over the course of six meetings.

**Table 4. Results of Observation of Student Activities**

| Aspects of Student Activity Observation | Mean (%) | Percentage of Conformity (P) | |
|---|---|---|---|
| | | Ideal Time (%) | Tolerance 5% |
| Pay great attention to the first material presented by the instructor. | 10.75 | 12.50 | 7.5 – 17.5 |
| Student textbooks or workbooks should be read and comprehended in their entirety. | 10.42 | 12.50 | 7.5 – 17.5 |
| Discuss with friends problem-solving | 24.40 | 25.00 | 20 - 30 |
| Respond to the teacher's or friend's explanations with either questions or suggestions and responses. | 20.12 | 20.00 | 15 - 25 |
| Providing solutions to challenges assigned by the teacher | 17.52 | 17.50 | 12.5 – 22.5 |
| Summarizing a concept or process | 6.97 | 6.25 | 1.25– 11.25 |
| Pay close attention to the teacher's comments | 7.10 | 6.25 | 1.25- 11.25 |
| Non-relevant behavior during teaching and learning | 2.67 | 0.00 | 0 - 5 |

Based on table 4, it can be concluded that students' activities linked to learning mathematics with the ethnomathematics-based mathematics learning model have fulfilled the ideal percentage of time for the eight observed components. In terms of student participation in the learning process using an ethnomathematics-based mathematical learning model, it is concluded that the model fits the criteria for practicability.

**Table 5. Teacher Responses to the Learning Model Results**

| Rated aspect | Average ( $\overline{X}$ ) | Description |
|---|---|---|
| Learning Media | 3.75 | Very Practical |
| Serving Eligibility | 3.60 | Very Practical |
| Language eligibility | 3.63 | Very Practical |
| Assessment in improving math problem solving skills | 3.88 | Very Practical |
| **Total Mean** | **3.72** | Very Practical |

According to the results of the analysis presented in table 5 above, the average instructor reaction to the practicability of the ethnomathematics-based mathematical learning model is 3.72. If this value is validated on the evaluation criteria to be between 3.5 and 4.0, then it belongs to the positive group or is highly useful. Consequently, the teacher's response was deemed to satisfy the practicality criteria for the implementation phase of the ethnomathematics-based mathematics learning model.

**Table 6. Responses to the Learning Model by Students**

| Rated aspect | Average ( $\overline{X}$ ) | Description |
|---|---|---|

| | | |
|---|---|---|
| Giving student assignments | 3.71 | Very Practical |
| Learning atmosphere | 3.66 | Very Practical |
| Student response to teacher | 3.67 | Very Practical |
| **Total Mean** | **3.68** | Very Practical |

According to the results of the analysis presented in table 6 above, the average student answer to the practicability of the mathematics learning model employing ethnomathematics is = 3.68. If this value is validated on the evaluation criteria to be between 3.5 and 4.0, then it belongs to the positive group or is highly useful. Regarding the implementation process of the mathematics learning model employing ethnomathematics, the student replies were deemed to satisfy the practicality criterion d. Model effectiveness test results

The results of the model's efficacy test are based on the improvement of mathematical problem-solving test scores in the experimental group, as described by the analysis of pre- and post-test scores. The categories of enhancing pupils' ability to solve mathematical problems are shown in Table 7 below.

**Table 7. Normalized Gain Category**

| Gain normalization coefficient | Percentage (%) | Category |
|---|---|---|
| $g < 0,3$ | 0 | Low |
| $0,3 \leq g < 0,7$ | 47,62 | Fair |
| $g \geq 0,7$ | 52,38 | High |

According to Table 7, the increase in students' ability to solve mathematical problems after being taught using an ethnomathematics-based mathematics learning paradigm is 52.38 percent, or in the high range.

## DISCUSSION

The design phase consists of multiple stages, such as: (1) formulating SMAR learning objectives (specific, measurable, applicable, and realistic); (2) determining appropriate learning strategies in achieving goals; (3) designing learning tools; (4) designing learning materials; and (5) designing learning outcomes evaluation tools (Tegeh & Kirne, 2013). (Siddiq et al., 2020). This phase of design is described by (Istiqomah, 2016) as having similar stages, such as (1) collecting learning materials, (2) the process and preparation of teaching materials, (3) conceptualizing learning materials, and (4) compiling learning materials.

In the construction of learning models, logical models, model components, model usage instructions, and learning model devices based on learning analysis and identification of student characteristics are created. The production of learning tools based on learning analysis is accomplished by identifying the mathematical curriculum for junior high school that refers to the Ministerial Regulation. Analysis of the material and learning characteristics constitutes the construction of the assessment instrument.

The initial product prototype was a mathematical learning model employing ethnomathematics and learning aids including a syllabus/lesson plan, instructor books, student books, and worksheets. The assessment tool included a model implementation observation sheet, a student activity observation sheet, a teacher response questionnaire, a student response questionnaire, and a math problem-solving ability exam.

Before use, produced products must be validated based on the consensus of experts. Typically, the questionnaire utilized in the validation process evaluates language, learning content, and presentation. (Ramadhan et al.,

2019) The product's validity can be demonstrated if the experts feel that the development product can assess the skills indicated in the domain being measured (Kholis et al., 2020).

This study examined the validity of two types of development goods: learning products and instruments created by researchers. The verified learning products consist of model books, textbooks with teacher and student editions, Learning Implementation Plans (RPP), and Student Worksheets (LKS). The researchers also created the following research instruments: (1) learning implementation observation sheets, (2) student activity observation sheets, (3) teacher response questionnaires, and (4) student response questionnaires. All sorts of development items and devices yielded extremely valid validation findings.

The products that have been declared legitimate are subsequently tested to determine their practicability and efficacy. Several variables that have the potential to pique the attention of instructors and students, including the level of implementation of learning and the results of teacher and student assessments, are considered when evaluating the practicability of product creation (Hedayani, 2018). Observations of student activities, instructor reactions, and student responses based on data collected during the observation of the model's execution. It is well known that the models and instruments for learning mathematics using ethnomathematics that are generated meet the criteria of being highly applicable. The effectiveness test follows the validity and usability tests as the last evaluation. The purpose of the efficacy evaluation is to establish whether there is an increase in students' ability to solve mathematical problems before and after getting treatment based on a mathematical learning model that incorporates ethnomathematics. The growth in pupils' ability to solve mathematical problems can be determined by the value of the gain coefficient. The research indicates that the gain value is in the high group, with a value of 52.38 percent or within the 0.7 range. This indicates that the increase in students' ability to solve mathematical problems after being taught using an ethnomathematics-based mathematical learning model falls into the "high" category.

According to (Aini et al., 2018; Nofitasari et al., 2016; Utami et al., 2018; Verner et al., 2018a), nuanced learning ethnomathematics is an excellent method for enhancing students' mathematical problem-solving skills. The incorporation of ethnomathematics into the learning process makes mathematics more relevant and meaningful to students, hence enhancing the overall quality of education and enhancing their capacity to interpret meaningful relationships and enhancing their comprehension of mathematics.

## CONCLUSION

The mathematics learning model using ethnomathematics generated during the development process has met the valid, practical, and effective criteria for increasing the problem-solving abilities of junior high school pupils. As a result, the teacher, as one of the factors of learning success, must be able to construct and design learning models in line with the peculiarities of the subject matter and the needs of the students. The application of ethnomathematics must be given more consideration if it is to be studied on a broader scale, as it is now only used by a minority of students.

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