Development of Ethno-mathematics based Mathematics Teaching Material Technology: A Needs Analysis

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Abstract. Ethno-mathematics based Mathematics teaching materials are combination of teaching materials that contain cultural elements associated with Mathematics subject content. This study aims to analyze the need for the development of ethno-mathematics-based mathematics teaching materials for fifth grade elementary school students. This research uses a qualitative approach with descriptive research type. The main data were obtained directly by the researcher through observation, interviews, and questionnaires. The research subjects were teachers and students of grade V SD 3 Temulus. The needs analysis activity begins with curriculum analysis (KI and KD), teacher and student analysis. Data were analyzed by reducing data, presenting data and drawing conclusions. The results showed that: (1) all materials in teaching materials were in accordance with the curriculum; (2) teachers and students need ethno-mathematic based teaching materials to find out about customs and culture in the surrounding environment. It can be concluded that ethno-mathematics based Mathematics teaching materials are needed by grade V SD students.

1. Introduction

Education has a role in increasing quality human resources. According to the constitutonal National Education System nomor 20 of 2003, qualified human beings are educated humans who believe and fear God Almighty, have good attitude, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens. In addition to focusing on learning activities, education also forms human character.

Mathematics education hold on an important role in advancing modern science and technology. For this reason, Mathematics is taught from elementary, junior high, senior high school to college. Mathematics learning is a mental activity to understand meanings and relationships and symbols which are then applied to real situations [1]. Stated mathematics lessons are subjects that require high reasoning and logic, so that in mathematics learning activities, students are required to be intelligent, creative, skilled and independent in understanding and applying the concepts being learned[2].

Mathematics and culture are something that cannot be avoided in everyday life, because culture is a complete and comprehensive unity, applicable in a society. Stated that one that can bridge between culture and mathematics education is ethno-mathematics. “Ethnomathematics” is a compound word if
we look over the word itself and the definitions of its word-initial “ethno” and the etyma “mathematics”. [3] The word-initial “ethno” is part of the word “ethnology” which is defined as “the science that analyzes and compares human cultures” or “cultural anthropology” in the dictionary and the definition of “mathematics” is “a science dealing with ‘quantitative relations’ and ‘spatial forms’ in the real world” [4]. Ethno-mathematics utilizes mathematics concept widely that bound up with mathematics activity sort, covering activity agglomerates, get computing, measure, designing building or tool, play, determining location and any other as it [5]. Ethno-mathematics aims to give learners and researchers deeper insights on the concepts and relation between mathematics and culture [6].

Ethno-mathematics is studying aspects of mathematical culture. It is presenting the mathematical concepts of the school curriculum in ways in which these concepts are related to student experience and everyday culture [7]. Culture-based Mathematics Learning is one of the ways that it can be perceived to make meaningful and contextual mathematical learning highly related to the cultural community, where mathematics is studied and will be applied later, and with that cultural community, as well as interesting and enjoyable mathematics learning [8]. Mathematics learning (including graph theory) must be close to the mind and local culture [9]. By connecting abstract Mathematical concepts with the culture in the surrounding environment, it is hoped that students will not experience learning difficulties so that their learning outcomes are high. Ethno-mathematics was first sparked and developed by Brazilian mathematician Ubiratan D’Ambrosio. [10] Specific exploration related to any culture that can be used as learning material and the context of mathematics assessment in schools has been widely carried out. Javanese culture has also been used frequently in mathematics learning [11].

Based on observations and interviews with teachers and students of SD 3 Temulus, it was found that students do not like mathematics because the material is considered difficult and many formulas memorize. During the learning process, students feel bored, tired, confused in working on questions because they do not understand the material presented by the teacher, students tend to be passive in learning so that the teacher is more dominant because of the lack of response from students. In addition, teaching materials in the form of Mathematics student books do not improve student learning outcomes. Material that is difficult for students to understand is the subject of data processing. Students find it difficult to read data in the form of tables and diagrams. Their research state that students are less interested in mathematics because the material is considered difficult and the methods used in learning have not accustomed students to active learning [12].

Research conducted at SD 5 Jepang, Mejobo District, Kudus Regency stated that the results of mathematical communication skills were still low or partly below the KKM [2]. Mejobo District is one of the sub-districts Kudus Regency which is famous for its woven bamboo handicrafts. Bamboo matting is produced into various kinds, such as gebyok, basek, fan and various kinds made from woven bamboo[10]. In the material for the volume of cubes and blocks, students use knowledge about bamboo baskets. The application of ethno-mathematics so that students are more interested in participating in lessons and foster positive attitudes towards local culture. The results showed that students’ mathematical communication skills with the ethno-mathematics based Realistic Mathematics Education approach achieved learning completeness above 75%.

The success of the learning process in addition to utilizing the surrounding environment is also the selection of various teaching materials. The teaching learning materials are defined as the instruments of presentations and transmission of the prescribed educational material. Agree with Ahmad define interactive teaching materials we have to understand the meaning of the teaching materials and interactive. Instructional materials are all kinds of materials that are used to assist educators in implementing the teaching and learning activities in the classroom [13].
The development of teaching materials can be used as an alternative in dealing with students who have learning difficulties. The development of teaching materials can be used as a solution to overcome the difficulties of students in solving math problems [14]. The teaching materials developed certainly contain processes and strategies that make solving math problems easier. This is also supported who recommend the provision of teaching materials, learning tools, computer-assisted learning media to improve mathematics learning more effectively. It can be concluded that teaching materials are a set of materials used by teachers and students in learning activities.

Teaching materials are a learning resource that can be developed by teachers as facilitators in teaching and learning activities. Teaching materials prepared by the teacher should be designed and developed in accordance with the conditions and situations of teaching and learning activities faced by students. With the existence of teaching materials, an effective interaction between students and teachers will be formed, so that it can increase student learning activities in improving learning outcomes. The selection of learning materials (teaching materials) should consider the principles of relevance, consistency and adequacy. Principle of relevance, meaning that the selected learning material has relevance (linkage) with the achievement of basic competency and competency standards; The principle of consistency means that there is a consistency between the teaching materials and the basic competencies that students must master, for example, the basic competencies that are planned for four types, the teaching materials that must be taught must include four types; The principle of sufficiency means that the material being taught should be sufficient in helping students master the specified basic competencies, not too little learning material, and not too [15].

Ethno-mathematics is the science of studying community culture, historical relics related to mathematics and mathematics learning [13]. Ethno-mathematics is learning mathematics by linking a material being studied with local culture so that students understand more easily a material because it is directly related to their own culture [12]. Ethno-mathematics means cultural mathematics, not only referring to ethnic culture, but also to general experiences such as language, beliefs, customs, or history. Ethno-mathematics based Mathematics teaching materials are a combination of teaching materials that contain cultural elements associated with Mathematics subject matter. Ethno-mathematics in the picture above is actually an intersection between cultural anthropology, mathematical modeling, and mathematics itself [16]. The first stage when we study in ethno-mathematics research is to dig the way thinking of the community we are exploring, and then after the data were collected, we have to describe it into mathematical modeling with appropriate mathematical concepts.

Learning with ethno-mathematics makes it possible for material to be learned from their culture to generate learning motivation and understanding of a material by students more easily because the material is directly related to their culture which is their daily activity in society. Character education is an education system that integrates values in accordance with national culture with aspects of knowledge, aspects of feeling attitudes, which are implemented towards God Almighty, self, society, and nation [17]. So that ethno-mathematics can be examined how people understand, express and use cultural concepts that are described mathematically [18]. The application of ethno-mathematics as a means to motivate students in learning mathematics, learning will be more meaningful, in the sense that students know the benefits of learning mathematics in real life [19]. Furthermore, argue that in the application of ethno-mathematics based learning it allows teachers and students to actively participate based on the culture they are familiar with. As a learning medium, culture and its various manifestations can be the context of examples of concepts or principles in a subject, as well as the context of applying principles or in a subject [20]. The relationship between mathematics and culture can be better understood, the perceptions of students and society about mathematics become more precise, mathematics learning can be more adapted to the cultural context of students and society, and mathematics can be more easily understood because it is no longer perceived as something 'foreign' by
participants students and society. Ethno-mathematics refers to forms of mathematics that vary as a consequence of being embedded in cultural activities whose purpose is other than doing mathematics [16].

In a learning process there are two important elements, the methods of teaching and learning media. Teaching method is a method or technique to implement the teaching plan in the form of real and practical activities in order to achieve the learning objectives, while learning media is itself a teaching aid that also affects the learning process. A harmonious combination between the methods of learning with instructional media will create the learning atmosphere more fun and meaningful [21].

On the basis of this explanation, the researcher is motivated to introduce local culture in Kudus Regency through the development of teaching materials in elementary schools. This study aims to analyze the need for ethno-mathematics based mathematics teaching materials for fifth grade elementary school students. The resulting teaching materials will be used to overcome problems in learning mathematics and can be used during teaching and learning activities. In the learning process students not only learn mathematics but apply a caring character for the environment by getting to know and studying the customs and culture of the surrounding environment.

2. Methodology
This research uses a qualitative approach with descriptive research type. The research subjects were a teacher and 23 students of grade V SD 3 Temulus, Kecamatan Mejobo, Kudus Regency. The main data was obtained directly by the researcher through observation, interviews and questionnaires. The instruments used to collect data are as follows. (1) Observation guidelines to obtain problems faced by students in learning and learning outcomes, (2) Guidelines for interviews with teachers to obtain information about the development of ethno-mathematics based teaching materials, (3) Questionnaire to analyze teacher needs to obtain information related to the curriculum including: syllabus, lesson plans and questionnaires for student needs to find out the product specifications desired by students. The data analysis used descriptive qualitative analysis. Data were analyzed by reducing data, presenting data and drawing conclusions.

2.1 Data reduction
Data reduction is a form of analysis that sharpens, classifies, directs, removes unnecessary data, and organizes data in such a way that final conclusions can be drawn and verified. The data reduction stage in this study includes:

a. Doing observations made by teachers and students in the learning process in the classroom.

b. Analyze core competencies and basic competencies contained in the syllabus, lesson plans and teaching materials.

c. Conducting interviews with research subjects, namely teachers and 3 students. Then the results of the interview were simplified into a good and neat language structure.

d. Students fill out a questionnaire to determine student responses to the need for ethno-mathematics based mathematics teaching materials.

2.2 Data Presenting
After the data is reduced, the next step is to present the data. Presentation of data in qualitative research can be done in the form of brief descriptions, charts, relationships between categories, flowcharts and the like. This activity raises and shows an organized and categorized collection of data or information that allows a conclusion or action. By presenting the data, it will be easier to understand what happened, then plan the next work. The data presentation stage in this study includes:

a. Presenting observations during classroom learning. The data obtained are presented in the form of narrative text.
b. Presenting the results of the analysis of core competencies and basic competencies contained in the syllabus, lesson plans and teaching materials. The data obtained are presented in the form of narrative text and tables.

c. Presenting the results of interviews about the mathematics learning process. The data obtained are presented in the form of narrative text.

d. Presenting the results of the student response questionnaire to ethnomathematics-based mathematics teaching materials. The data obtained are presented in the form of tables and narrative text.

2.3 Drawing conclusions
The third step in qualitative data analysis according to Miles and Huberman is drawing conclusions. Drawing conclusions is the final stage of this research. Drawing conclusions based on the results of data analysis that has been collected, whether obtained using observations, interviews and questionnaires. The results of the analysis at the data presentation stage are used to compile an analysis of the needs for mathematics teaching materials based on ethno-mathematics.

3. Results and Discussion
Ethno-mathematic based mathematics teaching materials are designed and developed based on the results of observations, interviews and results of teacher and student needs analysis.

3.1 Observation results
The results of observations made by researchers on the learning process and learning outcomes show that students pay attention to the teacher's explanation, are active in learning activities to obtain high learning outcomes. Conversely, students who pay less attention to teacher explanations such as daydreaming, playing alone, and passively in learning activities get low learning outcomes (under KKM). The reference books used by the teacher in learning are only student books published by the Ministry of Education and Culture that have not been linked to culture. The teacher does not use other companion books for deepening the material as material for student enrichmen.

![Fig 1. Learning Process Activities](image)

In the picture, only some of the students take part in the lesson. Because during the Covid pandemic 19 students were divided into 2 groups. Learning is carried out in a blended learning manner by paying attention to health protocols, namely wearing masks, maintaining distance and avoiding crowds.

3.2 Results of the interview
From interviews conducted by researchers with teachers and grade V students of SD 3 Temulus, the following information was obtained: (1) students did not like mathematics because of many memorization, such as multiplication, division and formulas; (2) students' ability to count is low so that their learning outcomes are low; (3) teachers in learning are less innovative, only explaining in numbers and have not been linked to daily life let alone the culture of the surrounding environment.
Fig 2. The researcher conducted an interview with a grade V teacher at SD 3 Temulus

Interviews conducted by researchers and teachers are unstructured interviews. In interviews, researchers did not use interview guidelines. Usually this is done when the answers given by research subjects develop outside of structured questions.

**Table 1. Results of interviews between researchers and students**

| Aspects                          | Results of the interview                                                                 |
|----------------------------------|------------------------------------------------------------------------------------------|
| Learning methods                 | The teacher uses the lecture method in learning mathematics                              |
|                                  | Learning sources from student books and teacher books published by the Ministry of Education and Culture 2013 curriculum |
| Teaching materials               | Evaluation using the form of a written test and an oral test (barking)                   |
| Evaluation                       | Teachers in delivering data presentation material are less creative and innovative         |
| Constraints                      | Teachers have not integrated subject matter with local culture                           |
| Integration with Ethno-mathematics | It is better if the teaching materials used by the teacher be integrated with ethnomathematics so that learning is more creative and innovative. |
| Recommendations for Mathematic teaching materials |                                                                 |

**3.3 Results of teacher and student needs analysis**

The results of the teacher needs analysis are analyzing the curriculum including the syllabus and lesson plans. The curriculum analysis focuses on the subject content of grade V SD with Content Competencies (KI) and Basic Competencies (KD) according to Permendikbud No. 37 of 2018 as follows:

3.8 Describe the presentation of data related to students’ self and compare it with data from the surrounding environment in the form of lists, tables, pictograms, bar charts, or line charts.

4.8 Organizing and presenting data relating to students and comparing it with data from the surrounding environment in the form of lists, tables, pictograms, bar charts, or line charts. Based on KD, this is then translated into indicators for realizing learning objectives. The results of the KI, KD analysis and indicators are in accordance with the syllabus and lesson plans. From the suitability of KI, KD and indicators, then ethno-mathematics based teaching materials are designed and developed. Ethno-mathematics teaching materials to make it easier for students to learn mathematics which are not only in the form of numbers and formulas but indirectly students learn the local culture in the surrounding environment.
Table 2. Basic Competency Analysis in the Syllabus, Learning Implementation Plan and Teaching Materials

| No | Basic Competencies                                                                 | Syllabus | Lesson Plans | Teaching Materials |
|----|-------------------------------------------------------------------------------------|----------|--------------|--------------------|
| 3.8| Describe the presentation of data related to students' self and compare it with data from the surrounding environment in the form of lists, tables, pictograms, bar charts, or line charts. | √        | √            | √                  |
| 4.8| Organizing and presenting data relating to students and comparing it with data from the surrounding environment in the form of lists, tables, pictograms, bar charts, or line charts. | √        | √            | √                  |

Based on the table above, the competencies contained in the syllabus, the lesson plan and teaching materials are in accordance with the 2013 curriculum. KD is used as a benchmark for the preparation of ethnomathematics-based mathematics teaching materials on data presentation material.

The results of the student needs analysis are to obtain information about the product specifications desired by students. The researcher gave a questionnaire to 23 students of SD 3 Temulus. Recapitulation of a questionnaire on student needs for the development of ethnomathematics-based mathematics teaching materials in grade V SD 3 Temulus.

Table 3. Recapitulation of the student needs questionnaire

| No | Question                                                                 | Number of students who answered |
|----|-------------------------------------------------------------------------|---------------------------------|
|    |                                                                         | Yes   | %   | No   | %   |
| 1  | Do you like math content?                                               | 10    | 43  | 13   | 57  |
| 2  | Are you active in learning Mathematics?                                 | 8     | 35  | 15   | 65  |
| 3  | Are you easy to understand the material provided by the teacher in learning Mathematics? | 11    | 48  | 12   | 52  |
| 4  | Are teaching materials at school always used in every Mathematics lesson? | 23    | 100 | -    | 0   |
| 5  | Do the Mathematics teaching materials used in learning make you understand the material? | 12    | 52  | 11   | 48  |
| 6  | Do the Mathematics teaching materials used in learning use illustrations accompanied by pictures? | 20    | 87  | 3    | 13  |
| 7  | Are the Mathematics teaching materials used related to the culture around you? | 9     | 39  | 14   | 61  |
| 8  | Are teachers doing experiments in learning?                             | 7     | 30  | 16   | 70  |
| 9  | Do you like the appearance of an attractive image for Mathematics teaching materials? | 23    | 100 | -    | 0   |
| 10 | Do you like teaching materials that are integrated with ethnomathematics? | 23    | 100 | -    | 0   |

From the results of the student assessment questionnaire, the following information was obtained: (1) students need a mathematics companion book in addition to the student books published by the Ministry of Education and Culture to increase the depth of the material being studied, (2) learning is still teacher-centered, so students feel bored just listening to lectures, (3) the lack of teachers doing experiments on Mathematics and relating it to culture.
In the research, students took a test about presenting data 2 times. In the first test, students received an explanation of the material from the student book published by the Ministry of Education and Culture, which resulted in 12 students whose scores were above the KKM, meaning that there were 11 students whose scores were below the KKM. Whereas in the second test students received an explanation of mathematics teaching materials based on ethno-mathematics. The results of students whose scores were above the KKM were 18 students, meaning that there were still 5 students whose grades were below the KKM. This shows an increase in student learning outcomes when using ethno-mathematics based mathematics teaching materials. The percentage of student learning outcomes of ethno-mathematics based teaching materials can be seen below.

![Fig 3. comparison of student test scores above the KKM](image)

The arrangement of ethno-mathematics based teaching materials is adjusted to the characteristics of students, including: age, student activities in teaching and learning activities, student difficulties in understanding the teaching materials used in learning. The age of fifth grade elementary school students at SD 3 Temulus is between 10-11 years old. According to Piaget's theory, at that age range students are at the concrete operational stage. At this stage, students still need objects that are concrete / real, are less able to imagine or imagine abstract things. Therefore, in the preparation of ethno-mathematics based teaching materials it is equipped with pictures, such as the kudus tower, batik kudus, lentog tanjung, parijoto, etc. Pictures are made colorful so that students will be interested in learning them.

4. Conclusion
Ethno-mathematic based mathematics teaching materials are learning resources that can be designed and developed by teachers to solve student problems in learning mathematics. The teaching materials are arranged in accordance with the situations and conditions faced by students which are related to the culture in the environment around students. Thus students do not feel bored and bored because they get new knowledge about the local culture so that student learning outcomes increase. The results showed that: (1) all materials in teaching materials were in accordance with the curriculum; (2) teachers and students need ethno-mathematic based teaching materials to find out about customs and culture in the surrounding environment.

Teachers should compile teaching materials that are attractive and easy to understand by students. The preparation of this teaching material is not only related to Mathematics subject content but is followed by other subject matter related to the culture in the surrounding environment.

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