

Integration of Ethnomathematics in Learning Geometry Transformation

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Abstract—Ethnomathematics is a term used to relate mathematics to culture. The purpose of this study was to determine the effectiveness of ethnomathematics integration in learning geometric transformations. The research used was a design research type validation study that consists of 3 phases, namely: (1) experimental preparation, (2) experimentation, and (3) retrospective analysis. The research was conducted at the SMP Laboratorium Undiksha Singaraja, Bali. The research data were collected through observation, interviews, and tests. Furthermore, the data were analyzed descriptively. The results showed that the geometric transformation learning trajectory began with the provision of problems, phenomena, patterns, pictures, related to ethnomathematics, then students conducted investigations individually or in pairs regarding mathematical ideas in ethnomathematics. Students become more enthusiastic, can see, and use mathematics in a cultural aspect, and their problem-solving skills will improve.

Keywords—ethnomathematics, problem solving, geometry transformation, design researchers

I. INTRODUCTION

Student learning outcomes are influenced by student performance. Student performance is influenced by teacher performance, and teacher performance is influenced by experience, ability, commitment, infrastructure, and the availability of learning resources. Various studies have shown that student learning outcomes in mathematics are low [1]–[4]. One effort that has the potential to improve student learning outcomes is to make mathematics learning meaningful, in the sense of linking mathematics in the classroom with aspects of student culture.

In general, the class is characterized by ethnic, linguistic, gender, social and cultural diversity. Therefore, mathematics teachers must pay attention to the diversity of existing cultures because mathematics is defined as human and cultural knowledge [5], [6]. The term used to associate mathematics with culture is called ethnomathematics. This term was first introduced by the Brazilian Matematiawan D'Ambrosio. The term Ethno describes all the things that make up the identity of cultural groups such as language, code, values, jargon, beliefs, food and clothing, habits, and physical characteristics, while mathematics, in this case, has the meaning of calculating,

measuring, classifying, sorting, concluding, comparing, and modeling [7]–[9].

According to Harding, ethnomathematics aims to draw on cultural experiences and the use of mathematics so that it not only makes learning mathematics more meaningful, but also to provide students with the insight that mathematical knowledge is embedded or inherent in the social and cultural environment, and students value the use of mathematics more in everyday life [10]. The result of research Yusuf et al is that by using game ethnomathematics in Hausa culture, mathematics can be learned more easily [11]. The implementation of ethnomathematics in the school mathematics curriculum helps students to develop their cognitive abilities, social attitudes, and emotional [12]. A study conducted by Unodiaku found that the application of ethnomathematics can improve student achievement in learning cylindrical volume [13]. Similar studies show that the application of ethnomathematics based learning can improve student achievement [14], [15]. The result of research Suharta et al., is that Balinese Traditional House Ethnomathematics (ERTB) is similar and shift and uses traditional Balinese measures, namely arcs, *nyari*, and *rai* [16]. The results of ERTB exploration in the form of similarities, shifts, as well as the size of the stick, search, and interesting *rai* are used as a basis for classroom learning to improve student learning outcomes.

Geometry transformation is one of the important materials taught to students of class IX SMP. Students are expected to understand and apply the concepts of symmetry, reflection, and shifting. Based on the foregoing, the problem that arises is how to integrate ethnomathematics in learning geometry transformation material so that student learning outcomes are better.

According to D 'Ambrosio [7], ethnomathematical characteristics are as follows.

- Practiced among cultural groups such as children, laborers, ethnic groups, professional classes, etc.
- That identity depends on interests, motivation, specific codes, and jargon, which excludes academic mathematics.

- Such mathematics is informal and found to be used by engineers, builders, etc.
- Mathematics is broader in the sense that apart from arithmetic it also includes classifying, ordering, inferring, modeling, etc.

By the above description, ethnomathematics has a fairly broad meaning and has played an important role in the history of mathematics and mathematics education. Ethnomathematics encourages mathematics educators to understand how mathematics continues to be a culture and is used by all people in real life.

The result of research Suharta [16] is, ethnomathematics has grown and developed in Balinese Traditional House Architecture. The use of measurements based on body measurements, namely *lengkat*, *nyari*, *rai*, is very dominant in Balinese architecture. The concepts of equality and shift are widely used in construction and Balinese carvings. Judging from formal mathematics, the concepts of equality and shifting carried out by Balinese architecture are symmetry, reflection, and shift. For learning mathematics in the classroom to be more meaningful, ethnomathematics can be used as a source. The use of *lengkat*, *nyari*, and *rai* measurements can be attributed to the length measurement material. By using these measurements, learning will be more interesting because students are different from one another. Likewise, with the concept of equality, and this shift is closely related to material symmetry, reflection, and shifting. The reasons for using ethnomathematics in mathematics learning are (1) to reduce the notion that mathematics is final, absolute (certain), and (2) to help students develop the ability to formulate, apply and interpret various contexts, as well as social and emotional attitudes.

II. RESEARCH METHOD

This research was conducted on students of class IX SMP Laboratorium Undiksha Singaraja. This study aims to determine the learning of geometric transformations (symmetry, reflection, and shifts) based on ethnomathematics which can develop student learning outcomes. Because of that, the research used was a design research type validation study. According to Plomp the design research type of validation study focuses on designing the learning trajectory to develop and validate theories about learning, as well as how to design a suitable learning environment [17]. In general, the activities in this research are designing learning activities and investigating how these designs will be implemented in the classroom. The research phases of the validation study type design are (1) preparation of the experiment, namely the activity of elaborating the initial learning design based on a certain theoretical framework; (2) experiment, namely the activity of testing and improving the learning design, and (3) retrospective analysis, namely the activity of studying all the data and comparing it with the alleged activities and thinking of students that have been formulated.

Data about the condition of students, learning resources, and problems experienced by students and teachers were

collected through classroom observations and interviews with teachers using observation sheet instruments and interviews. Data on mathematical literacy were collected using tests and interviews with test instruments and interview sheets. Furthermore, the research data were analyzed using descriptive statistics.

III. RESULTS AND DISCUSSION

By using research procedures as described above, the results of the research can be described as follows.

- Knowledge competencies are understanding and applying knowledge (factual, conceptual, and procedural) based on curiosity about science, technology, art, culture related to visible phenomena and events, with basic competencies "explaining geometric transformations (reflection, translation, rotation). which is related to the ethnomathematics-based problem of Balinese Traditional Houses
- Ethnomathematics-based learning trajectories adapt Indonesian Realistic Mathematics Education. Following this, the path of learning geometry transformations based on ethnomathematics is as follows.
 - Using ethnomathematics-based problems, namely problems with the context of traditional Balinese ethnomathematics, and as far as possible have more than one solution and answer.
 - Students are active, intended both physically and mentally. Based on the problems given by the teacher, students can study individually, in pairs, or groups. Students can study on the floor, inside or outside the classroom. One of the important considerations used to determine groups, especially for elementary school students is compatibility with friends. Students solve these problems in informal ways. By the experience and abilities of students, students will convey different ways and answers.
 - In learning mathematics students are allowed to discover formal mathematics under the guidance of the teacher. The discoveries of formal mathematics were inspired by informal ways of solving. Students' informal ways can be interpreted to anticipate more formal procedures. By providing similar problems, students are expected to learn through mathematics to develop and use more effective and general methods. Through interaction, negotiation of meaning, and reflection students are guided to achieve the goals that are learned.
 - A democratic classroom atmosphere means that students dare to express their opinions, give

comments, and respect each other. Attitudes like this must be practiced and encouraged. The teacher respects all students' opinions, does not blame especially words that cause students to be embarrassed. Students are always allowed to tell what was done and known, while others listen and give responses. Students are trained to learn to patiently listen to other people talk.

- Students are allowed to solve ethnomathematics-based problems in informal ways. The teacher facilitates and inspires students to solve problems and reflect. If students have problems help empathetically, and as far as possible not provide answers but with inducement questions. Also, teachers are active in preparing learning resources or learning media that are interesting, inspiring, and enjoyable for students.

Ethnomathematics based geometric transformation learning trajectories can increase student interest and student problem-solving abilities. Operationally, learning the concept of reflection can be done by integrating the ethnomathematics of Balinese Traditional buildings. First of all, students are asked to prepare a carved pattern (simple motif), or given by the teacher. During learning, students are allowed to make Balinese carvings on paper using these Balinese carving patterns. By using a technique of mirroring a certain line, a certain motif is obtained. Furthermore, the students were given information that the Balinese carving motifs were made using the concept of reflection and the concept of reflection was applied when the Balinese carving was reflected on a line that produced the previous Balinese carving.

Students discuss the distance between the image and the original shape, the shape and size of the image shape with the original shape. The expected conclusion is that the students find that the image shapes have the same shape and size as the original shape, the distance to the mirror of each original shape and the image is the same. In the same way, students can be taught congruent concepts.

These results are in line with the findings Suharta et al., that ethnomathematics-based mathematics learning using Balinese traditional carving is student-centered learning [18], using problems that are close to student life, and using multiple representations to construct mathematical understanding. Similar research by Suharta et al., [19] found that realistic mathematics learning based on ethnomathematics is student-centered learning, using problems that are close to student life and begins with using Indonesian *batik* to develop the concept of geometric transformation.

IV. CONCLUSION AND SUGGESTIONS

Based on the results of the research as described earlier, it is concluded that the development of an ethnomathematics based learning trajectory based on traditional Balinese houses can motivate students to learn, students appear more enthusiastic and motivated to learn, and their problem-solving abilities are better. By using the context of Traditional Balinese House carvings, students can better understand the concept of geometric transformation. This implies that students are better able to use their understanding to solve math problems.

The geometric transformation learning path begins with the provision of problems, phenomena, patterns, images, related to the ethnomathematics of traditional Balinese houses. Furthermore, students conduct investigations individually or in pairs related to mathematical ideas that exist in ethnomathematics. Through discussion, students are encouraged to construct mathematical knowledge. With an appropriate learning trajectory, students can understand and solve mathematics problems.

This research was limited to students of SMP Laboratorium Undiksha and only material about geometric transformation. Therefore, it is suggested to other researchers to develop more detailed, systematic learning and other materials, so that it has a greater impact on the progress of learning mathematics.

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