Design of Student Learning Trajectory PMRI-Based Cylinder Material in the Context of Adobe Animate-Assisted Ethnomathematics Exploration

Lattifah Tuni'mah[1], Ahmad Rafly [2], Faisa Marsha Anindya[3], Christine Tamara Ayungsih[4], Masayu Amalia Yulianti[5], Farida Nursyahidah[6]*
Department of Mathematics Education, PGRI University Semarang, 50232, Semarang
*faridanursyahidah@upgris.ac.id

Abstract.

Cylinder is one of the sub-materials in the curved side space building material which is considered quite difficult for students. Students often experience difficulties in understanding concepts, identifying properties, and solving problems related to cylinders. The use of local wisdom in teaching materials can help students understand the material of curved tube side shapes. Therefore, the purpose of this study is to design a learning trajectory to help students understand PMRI-based tube material based on ethnomathematics exploration. This study used the design research method which consisted of 3 stages, namely preliminary design, design experiment (pilot experiment and teaching experiment), and retrospective analysis. The subjects in this study were grade 9 students of SMP Negeri 6 Semarang. The learning trajectory in the context of ethnomathematics exploration consists of identifying cylinder shapes through listening to traditional Sesaji Rewanda stories, determining the surface area of a cylinder, determining the volume of a cylinder, and solving contextual problems related to cylinders. From a series of activities carried out, it can help students understand concepts and solve problems in tube material.

Keywords: ethnomathematics, design research, PMRI, cylinder

1. Introduction

Geometry is a branch of mathematics that is often encountered in solving problems (1) and become important material for students (2). The importance of learning geometry is still in contrast to the conditions of students who experience difficulties in learning (3). In his research, (4) states that geometry cannot only be done with the lecture method but must be done with the formation of concepts through a series of activities carried out by students. One of the subject matters of geometry is the shape of curved sides.

Building a curved side room is one of the materials that is considered quite difficult for students (5). Students have not been able to understand the concept of curved side shapes so which it makes students difficult to solve problems in the material(6). Errors in solving problems made by students on curved-sided geometric material occur during the process of understanding questions, strategizing, implementing strategies, or re-examining the results of their work (7).

One of the materials for curved side shapes which is considered quite difficult for students is a tube. The difficulties experienced by students in tube material include difficulties in solving mathematical problems (8). The difficulties experienced by students were caused by a lack of mastery of the prerequisite material and memory regarding the concepts of circumference and area of a plane learned in the previous class (9). In line with this (10) states that the lack of mastery of concepts properly and correctly can cause students difficulties in working on the questions given.

To overcome student learning difficulties, it is necessary to design learning with an approach that is appropriate to the characteristics of students and material through the use of contexts that students can imagine. Learning cannot be done only by conveying information directly but requires a process of preparation through a series of experiences by students (11). One solution to students' learning difficulties in tubes is the PMRI approach (12). The PMRI approach is more experience-oriented and applies to everyday life so that learning is more effective and students can understand concepts well (13). The use of the PMRI context forms learning that is more meaningful, and enjoyable, and can develop students' concepts in the material being studied (14). The characteristics of PMRI consist of the use of models, contexts, creations of the use of Indonesian nature and culture, and emphasizing how students rediscover concepts or procedures through realistic problems presented (15).

The use of the ethnomathematics exploratory context of Sesaji Rewanda is in line with the PMRI approach which can help students understand cylinder material. Ethnomathematics is a way of studying mathematics by utilizing local culture to understand mathematical concepts (16). Ethnomathematics can be used as a teacher as a method in tube learning so that it is easier for students to explore critical thinking skills, conceptual understanding, and problem-solving abilities.

2. Method

This study used the design research method with the PMRI approach to develop the instruments used in learning. The subjects in this study were class IX students of SMP N 6 Semarang. Data collection was carried out from July to August 2023 through observation, interviews, pre-test and post-test, video recording, and collection of student work. The design research method consists of three stages, namely 1) preliminary design, 2) experimental design, and 3) retrospective analysis. In this study, the researchers only explained the first stage, namely preliminary design, such as reviewing the basic competitions students have and the need to formulate learning trajectories in the context of ethnomathematics exploration of the Sesaji Rewanda traditional tradition.

3. Result and Discussion

At the preliminary design stage, the initial idea of cylinder learning was implemented by utilizing the ethnomathematics context of the Sesaji Rewanda traditional tradition. At this stage, several activities were carried out, such as a literature review, examination of initial abilities, and preparation of HLT. In this article, it is explained about the study of student abilities and the design of learning trajectories as follows:

3.1. Examining the Pre-Requirement Competition Students Have on Cylinder Material

In studying cylinder material, there are several basic competencies that students in class IV have related to geometric shapes, namely 1) comparing prisms, cylinders, pyramids, cones, and spheres; 2) describing geometric shapes and combinations of several geometric shapes, as well as their surface area and volume; 3) Identify prisms, cylinders, pyramids, cones, and spheres.

3.2. Developing a Hypothetical Learning Trajectory

After reviewing the abilities possessed and needed by students in cylinder material, the next step is to formulate and develop the HLT design in the ethnomathematics context of the Sesaji Rewanda Semarang customary tradition. This learning trajectory consists of 4 series of activities that aim to improve students' ability to the material and create meaningful learning.

Activity 1: Identifying the structure of cylinder space through ethnomathematics of the Rewanda Sesaji Customary Tradition

The purpose of learning in the first activity is to identify the shape of cylinder through ethnomathematics of the traditional Sesaji Rewanda tradition. In the first activity, students were asked to observe an interactive video in the context of the traditional Sesaji Rewanda tradition. At this stage the aim is for students to be able to know the shape of cylinder in the Sesaji Rewanda traditional tradition and to know the components in a cylinder. After observing the video students are given activity sheets that have been designed according to the stages so that the learning objectives are achieved.

Figure 1. Identifying the structure of cylinder space through ethnomathematics of the Rewanda Sesaji Customary Tradition

Sumber: https://v-images2.antarafoto.com/ritual-sesaji-rewanda-semarang-nrxghp-prv.jpg

In identifying the shape of cylinder space, students are also assisted by using an android-based application assisted by Adobe Animate which has been designed by researchers as a learning medium. Figure 2 illustrates the start panel and menus in the application.

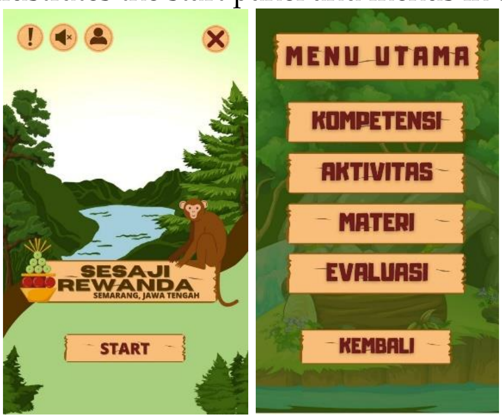

Figure 2. Start panel and menu of applications assisted by Adobe Animate

The alleged thinking of students in activity 1 is as follows.

Table 1. Alleged student thought in activity 1

Activity	Alleged Student Thought
Observing the context of videos and images	• Students recognize and identify the form of replicas of teak wood in the Rewanda Sesaji tradition. • Students name the components in the cylinder. • Students make buildings similar to teak wood replicas

Activity 2: Determine the Surface Area of a Cylinder

After students have finished identifying and determining the components in cylinder, students are then asked to find the formula for the surface area of cylinder. In finding the formula for the surface area of a cylinder students can use the help of learning media assisted by Adobe Animate.

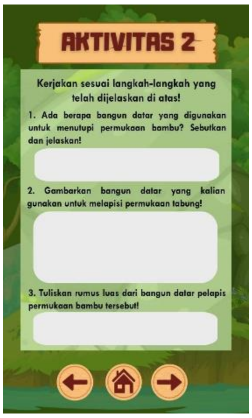

Figure 3. The activity of discovering the surface area of a cylinder in the android application

Apart from being assisted by learning applications, students also use Student Activity Sheets (LAS) in determining the formula for the surface area of a cylinder. Estimates of students' thinking in activity 2 as follows

Table 2. Alleged student thought in activity 2

Activity	Alleged Student Thought
Find the formula for the surface area of a cylinder via LAS	• Students identify the flat shapes that make up cylinder • Students discover that the formula for the area of a cylinder can be found from the result of adding up all the plane shapes that make up the cylinder

Activity 3: Determine the Volume of the Cylinder

The activity carried out at this stage is to determine the formula for the volume of the cylinder. The teacher distributes LAS according to the groups that have been divided in the

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previous activity. In finding the formula for the volume of a cylinder, students can use the Android application media assisted by Adobe Animate as shown in Figure 4.

Figure 4. The surface area discovery activity of cylinder on the android application

Furthermore, students solve problems that exist in LAS. Student activity in determining the cylinder volume formula can be seen in table 3.

Table 3. Alleged student thought in activity 3

Activity	Alleged Student Thought
Find the volume formula of a cylinder via LAS	• Students identify the flat shape of the cylinder in the previous activity • Students investigate the determination of the formula for the volume of a cylinder equal to the base area multiplied by the height

Activity 4: Solving Cylinder-Related Contextual Problems

To give students a gradual understanding of the surface area and volume of a cylinder, in the last activity the teacher gives questions related to the surface area and volume of a cylinder. The questions given are HOTS and open ended. This is done to improve students' critical thinking in solving problems.

4. Conclusion

Based on the research conducted, the results obtained are the learning trajectory of PMRI-based cylinder-building material in the context of ethnomathematics exploration of the traditional offerings of Rewanda. The resulting learning trajectory consists of four activities namely, identifying the geometric shape of cylinder through ethnomathematics of the Sesaji Rewanda custom tradition, determining the surface area of cylinder, determining the volume of cylinder, and solving contextual problems related to cylinder.

At the preliminary design stage the researcher must equip students with real situations to explore and obtain informal information which is then converted to the formal stage through the modeling carried out. The instrument used must also support the learning design. Reflections on each HLT activity need to be explained to anticipate students' mistakes and difficulties in doing LAS.

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