Learning cylinder through the context of Giant *Lopis* tradition

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Abstract. Geometry comprehension is a significant aspect and basis for studying mathematics. However, geometry is nonetheless a challenging material for students, particularly a cylinder. Therefore, this study aims to establish a learning trajectory using the *Giant Lopis* tradition as a context to help students understand the idea of a cylinder. The approach used in this study was Realistic Mathematics Education, named PMRI in the Indonesian version. The subject of the study is the ninth grade students of SMP 38 Semarang, with the involvement of 6 students who are selected in diverse abilities. The methodology applied was Design Research that consists of three stages, namely: preliminary design, experiment design, and retrospective analysis. However, this study reveals only the findings of the design experiment, which is a pilot experiment in particular. The data was compiled using various methods, e.g., observation, video recordings activities in class and group study, collecting student data, and interviewing students. The learning activities of students involve four activities: identifying the elements of the cylinders through an interactive video of Giant *Lopis* tradition, finding the surface area of the cylinder, finding the volume of the cylinder, comparing surface area or volume for different size of cylinder, and solving contextual problems of a cylinder.

1. Introduction

Science and technology developed rapidly in the 21st century [1]. The field of education and associated stakeholders face the challenge of preparing students for the 21st century age of globalization [2]. In this case, students must obtain skills of the 21st century to prepare students for future global challenges [3]. The core framework of 21st-century skills is the capability of 4Cs, consisting of critical thinking, communication, collaboration, and creativity. The field of mathematics is one that helps students to 21st-century competencies and has to additionally be mastered in the 21st century age [4]. This meant it was implied essential for students to study and learn about mathematics.

The one essential material to examine to learn in mathematics is geometry [5,6]. Through geometry, students recognize the effect and relations between geometric shapes and structures [6]. In addition, [7] stated that geometry could assist students in developing consciousness in solves problems, compares, generalizes, and performs skills. Furthermore, students can well overcome high-level mathematical thought skills by possessing high geometry skills and problems in daily life. However, geometry is nevertheless a challenging material for students [8-13], mainly the material of cylinder.

The difficulty of students in geometry material is to measure geometric misconceptions and to identify the shape of fields in solid geometry, particularly in cylinders [14]. Moreover, the other difficulties experienced by students are students experiencing issues in thinking the connection between the measurements and volume of the cylinder, the lack of comprehension of the relationship among the geometrical ideas repressed their speculation in the conclusion of the plan by utilizing those connections,
Several matters cause students to challenge in learning cylinder material; one of them is teacher-centered learning [16]. Subsequently, numerous students do no longer recognize the notion of constructing the three-dimensional shape of a cylinder; they only memorize and resolve problems utilizing by the formulation given by teachers in the class [15]. In this case, the teacher plays a crucial role in teaching mathematics in the classroom [17]. Teachers should have the expertise of how to educate their lessons, how to communicate it to students, and how to achieve the standard of students [18]. Therefore, it is essential for teachers to do design learning before starting learning in class [19]. However, in fact, there are still many teachers who have not yet designed learning on the material to be taught in the classroom.

Furthermore, the teacher needs to design the material of the curved surface of the cylinders in a more practical manner and meaningful. The Indonesian Realistic Mathematics Education or called PMRI is an efficient and practical approach to studying mathematics [20]. It is backed by research conducted by [21], which states that the PMRI method is considered to enable students to comprehend mathematical concepts utilizing topics connected to and even present in their everyday lives. Since 2001, the PMRI method has been commonly used to enhance student motivation, attitudes, and learning outcomes [22-26].

Mathematics learning with PMRI approach starts from authentic contexts or circumstances experienced by students, which is an extension to associate students from the real stage to formal mathematics. The context function in Indonesian Realistic Mathematics Education (PMRI) is as a beginning stage for students in developing mathematical grasp and as a source of mathematical applications [27]. In this study, the authors chose the context of the Giant Lopis tradition since the tradition could characterize a three-dimensional shape of cylinder that had not been utilized as a context for learning mathematics previously. However, using the Giant Lopis context additionally intends to provide the students chance to discover local wisdom in Central Java and to be more engaged in substantive mathematical learning.

The authors have used the design research method to conduct this research study. It consists of three main steps: preliminary design, experimental design (pilot experiment and teaching experiment), and retrospective analysis. However, this research emphasis was confined to the experiment's pilot stage. To develop a hypothetical learning trajectory, the authors carry out research based on the background above to encourage students to discover the notion surface area and volume of cylinder based upon Giant Lopis tradition context in the form of interactive video.

2. Method
The authors have utilized methods of design research in this study. Design Research aims to develop Local Instructional Theory (LIT) through collaboration among researchers and teachers to enhance the quality of learning [28]. LIT involves managing learning as well as being a presumed learning process that envisions how students could even consider and recognize throughout the learning process [29]. Furthermore, [30] defines three stages of design research: preliminary design, experiment design (pilot experiment and teaching experiment), and retrospective analysis. This research is confined to the pilot experiment phase. The subjects in this study were the third-grade students of SMP N 38 Semarang.

In the preliminary design process, researchers conducted an analysis of the material in the cylinder and the use of PMRI as the learning approach. The findings are structured to include expected learning as a hypothetical learning trajectory for a number of classroom learning activities. HLT is dynamically utilized to resemble a cyclical process that can evolve and develop during the teaching experiment. In addition, the teaching experiment in a pilot experiment involving 6 heterogeneous students, 2 high-ability students, 2 medium-ability students, and 2 low-ability students. Data collection involves observation, video recordings activities in class and group study, collecting student data, and interviewing students.
3. Result and discussion
Based on the analysis, especially in the pilot experiment stage, it can be achieved that students can be aided from various activities, namely: identifying the elements of the cylinders through interactive video Giant Lopis tradition context, finding the surface area of the cylinder, finding the volume of the cylinder, comparing surface area or volume for different size of cylinder, and solving the contextual problems of the cylinder. However, the findings can be described and discussed as follows.

3.1. Activity 1: Identifying the elements of the cylinders through interactive video Giant Lopis context
Before starting activity 1, the teacher gives an insight into the material that students have previously learned about the cylinder. The teacher provides a review of the question and answer system, and the students were active in the apprehension of the material provided. After that, the students watched the video of the Giant Lopis context with genuine excitement, as the video was shown in interactive media. The following figure 1 was an illustration when students observed the video.

![Figure 1. Students eagerly observed an interactive video of the Giant Lopis tradition.](image)

In addition, teachers may examine the activity outcome of watching an interactive video about the Giant Lopis context to lead students to reinvent the concept of the cylinder. By utilizing the context, students had to find and try to draw the illustration of the Giant Lopis that depicts the shape and the elements of the cylinder. The teacher requested students to identify the elements of the cylinder. The student's results show whether students can already illustrate the Giant Lopis as a cylindrical shape and determine what the features are. Then the teacher interviews to find out more about the results of the student's answers. The results of student interviews can be stated that students improve their grasp of the principles of cylinder elements. Written works and interviews showed that the aim of this activity was used to accomplish it.

3.2. Activity 2: Finding the surface area of the cylinder
In this stage, students are expected to find the surface area of the cylinder. The teacher asks students to make cylinder nets and determine what shapes are formed. Then students determine the area of each shape in the cylinder nets to locate the surface area of the cylinder. Students were really active in discussions because students can explore how the right cylinder nets. From these activities, students will find the surface area of the cylinder. Students answer of this activity can be considered in figure 2.

![Figure 2. The student answer to find the formula of the surface area of the cylinder.](image)
Based on the student's answer in figure 2, it can be shown that the problem on the student worksheet can be solved by a discussion with their group. It can be inferred from the interview that students can locate the surface area of the cylinder by adding the area of shape formed the cylinder which are two circle and rectangular. The written result and interviews have shown that this activity is being accomplished.

3.3. Activity 3: Finding the volume of the cylinder
In this activity, students were requested to find the volume formulas of triangle prism and cuboid of the same height. Students can easily find the formula of the prism triangle and cuboid cause the teacher had discussed it before in apperception material. Afterward, students consider the correlation between the volume of the prism triangle and cuboid to find the volume of the cylinder. From these questions, students will find the volume of the cylinder. In addition, figure 3 below shows the outcomes of students' responses to this activity.

![Figure 3](image3.png)

Figure 3. The student answer to find the formula of the volume of the cylinder.

Evidently, in figure 3, it can be seen that by discussion in a group study, students may resolve a given problem on the student's worksheet for the third activity. Students could find the formula of volume of cylinder by observing and comparing the volume formula of triangle prism and cuboid which are the surface area of base side times an altitude. Then they recognize about shape of the base side for each three dimensional shapes which are triangle, square, and circle. As a result of the interview, it can be discovered that students can find the volume of the cylinder. It has been proved from the written outcomes and interview that the aim of this activity 3 has indeed been achieved.

3.4. Activity 4: Comparing surface area or volume for different size of cylinder
In activity 4, students were requested to compare the surface area and volume of cylinder with different size of radii and height. Students try to find which one cylinder having the biggest volume or surface area by drawing and illustrating their size, then the largest one gotten by guessing and calculating using the formula that have been learned in previous activity. Afterward, students could consider that among three different size of cylinder have different volume and surface area and could determine the biggest one. In addition, figure 4 below shows the outcomes of students' responses to this activity.

![Figure 4](image4.png)

Figure 4. Student answer in comparing the volume of cylinder.
It can be clearly seen from figure 4 that students can determine the biggest and largest one cylinder by comparing its size, illustrating, and then calculating. In addition, from the interview result also shown that students can comparing the volume or surface area of the cylinder with various size. It has been proved from the written outcomes and interview that the aim of this activity 4 has been achieved.

3.5. Activity 5: Solving the contextual problems of the cylinder

Students were asked throughout this activity to solve problems related to the cylinder. With the principle learned in the previous material, students were able to fix the problem. The students' outcomes to this activity can also be seen in figure 5 below.

Figure 5. Students answer from a given problem.

Figure 5 indicates that students already know about the problem of the cylinder, so it is evident that students have learned the concept of a cylinder to solve the problem adequately. The results are compatible with the objectives of a hypothetical learning trajectory.

From the above result, it can be inferred that the design learning of PMRI using the Giant Lopis context integrated with an interactive video could help students discover the principle of surface area and volume of a cylinder learned. This result is in line with some previous studies [21,22,25,26,27] stated that implementing PMRI in learning process by the context that familiar to students could support them understanding idea learned. By using Giant Lopis context packaged in interactive video, made the students be more enthusiastic and motivated in learning process so that the learning outcomes can be achieved. It is also premised on PMRI’s characteristics, which is to suggest interactivity, meaning that the learning process is indeed a process of individual learning as well as being a process of social learning [31].

4. Conclusion

The hypothetical learning trajectory resulted in this study composed of four activities, that is: identifying the elements of the cylinder through interactive video Giant Lopis context, finding the surface area of the cylinder, finding the volume of the cylinder, and solving the contextual problems of the cylinder. The results of this research indicate that by using the Giant Lopis context, students could be encouraged to understand the concept of the cylinder through a series of designed activities.

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