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A Learning Trajectory for Surface Area Concept with the Context of the Tourist Destination Bukit Sulap

Idul Adha, Zulkardi*, Ratu Ilma Indra Putri, Somakim

Department of Mathematics Education, Universitas Sriwijaya, Palembang, Indonesia
*Email: zulkardi@unsri.ac.id

Abstract

The concept of surface area for flat shapes is often perceived as a challenging mathematical topic among elementary school students. In fact, the context of tourism can be integrated into the learning of geometry, for example, the topic of surface area. The objective of this study is to develop a learning trajectory that enhances problem-solving skills with respect to surface area problems in the context of Bukit Sulap, a tourism destination in Lubuklinggau City. The design research methodology, which included a validation study, was implemented in three stages: preparation and design, experimental teaching, and retrospective analysis. The subjects of this study were 27 elementary school students in Lubuklinggau City, Indonesia. The instruments utilized in this study included surface area problem solving task sheets, video recordings of in-depth interviews conducted during the learning process, field notes, and observation sheets. The findings of the study indicate that learning trajectories designed within the context of Bukit Sulap facilitate students' comprehension of problems, formulation of problem-solving strategies, implementation of these strategies, and interpretation of the results of problem-solving processes. The activities included in the learning trajectory are as follows: defining the contextual problem; self-review; designing a resolution plan; implementing the resolution plan; and establishing a mathematical model regarding surface area within the context used. Through the use of tourism as a context, students are expected to be able to solve surface area problems and learn the principles of surface area of flat shapes. This learning approach is an effective technique for improving problem-solving skills regarding surface area.

Keywords: Bukit Sulap Tourism, Learning Trajectory, Problem Solving, Surface Area

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INTRODUCTION

Geometry is frequently regarded as a challenging subject matter among elementary school students. One of the topics covered in elementary school geometry is the surface area of specific shapes (Fitriyani et al., 2018; Nugroho, 2023). The difficulties encountered by students regarding this topic can be attributed to the utilization of a structuralistic methodology for the conveyance of learning materials (Andriani et al., 2020; Widada et al., 2019). Conveying concepts and principles directly by the teacher, a local culture-based learning approach is needed that is close to students' minds, so that the learning trajectory becomes easier for students in carrying out the abstraction process and students' cognitive processes become better (Nugroho et al., 2021). During this learning process, the teacher seemed to use books excessively in the explanation aspect, and there was a tendency for language, material and questions to only come from books (Syafriafdi et al., 2019). In such an environment, students tend to adopt a more passive role in their mathematical learning, while the teacher assumes a more dominant position.

In this context, the surface area that encompasses the external surface of an object represents a fundamental concept in geometry (Druken, 2021). This concept can be used in the calculation of the

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requisite quantity of material to cover an object. In the context of daily life, examples of this concept's practical applications include the calculation of the quantity of paint needed to paint a wall, the determination of the amount of cement needed to plaster a wall, and the estimation of the area of cloth necessary to make a theater drape. By understanding and applying the concept of surface area, elementary school students can enhance their spatial reasoning skills and cultivate proficiency in addressing practical challenges that entail measurement and estimation (Sukestiyarno et al., 2023). The finding of the two studies is in alignment with those of the present study. In other words, an understanding of surface area enables students to establish connections between geometric shapes and their associated physical properties. For example, when determining the surface area of a rectangular prism, students are required to identify and measure the length, width, and height of each side, subsequently calculating the sum of the areas. Considering these findings, it is evident that the results of this present study can be developed further to provide a foundation for students to gain a deeper understanding of the concept of surface area and its practical application in everyday life. This could include situations such as determining the amount of wrapping paper is needed to cover a gift box or the quantity of paint required to cover the walls of a room.

In elementary school mathematics, students are introduced to the concept of surface area through an exploration of the fundamental properties of geometric shapes (Abadi & Amir, 2022). This involves the identification and naming of different two-dimensional shapes, including squares, rectangles, triangles, and circles. Subsequently, students' progress to the comprehension of three-dimensional shapes, including cubes, rectangular prisms, pyramids, and spheres. It is anticipated that students will apply their understanding of these shapes to visualize and calculate the surface area of each (Widada et al., 2020). By summing the areas of all the faces of a three-dimensional object, students can determine its surface area. In addition, students can also learn about formulas and strategies for calculating surface areas for certain shapes (Quiroz et al., 2015). These include formulas such as the formula for calculating the area of a rectangle by multiplying its length and width, or the formula for calculating the area of a triangle using half the product of its base and altitude (Sukestiyarno et al., 2023). Regarding this, for instance, a relational student may learn the Pythagorean formula by coherently combining pieces of information through a process of abstraction from several real contexts to represent those contexts in mathematical concepts or principles (Herawaty et al., 2020).

The preliminary findings of this study indicate that some elementary school mathematics teachers in Lubuklinggau City, Indonesia, employ a structuralistic approach in their instructional practices. The teachers provided explainations of definitions, formulas, and mathematical facts. This learning approach resulted in students exhibiting deficiencied in their mathematical problem-solving skills. Many students (76%) demonstrated an inability to learn how to solve problems regarding the surface area of geometric figures. A significant proportion of the students (68%) encountered difficulties in understanding the problem given, while 70% faced challenges in formulating a problem-solving plan. Moreover, 73% of the students had difficulties in implementing the solution plan, while 76% of them experienced challenges in interpreting the results of solving the problem. Similar findings were reported in another study, in which only 24.24% of the students demonstrated an understanding of the mathematical problems presented, and only 16.67% were able to create mathematical models correctly (Anggoro et al., 2023). These results highlight the need for a learning approach that can effectively address these difficulties.

One potential learning approach is to apply a realistic context (Friansah et al., 2024; Zulkardi et al., 2020). A substantial body of research has demonstrated that learning mathematics within realistic contexts can improve mathematical problem-solving skills (Widada et al., 2019; Agusdianita et al., 2021). Indonesian Realistic Mathematics Education also known as PMRI is a theoretical framework that emphasizes the importance of linking mathematics to students' everyday experiences and real-world scenarios (Zulkardi et al., 2019). This theoretical perspective posits that students should be capable of problem-solving based on contextual problems.

The capacity to solve problems is among of the most important goals in mathematics education (NCTM, 2010). The ability of students to solve problems can facilitate the development of mathematical thinking, advanced knowledge, and mathematical skills. The capacity to solve mathematical problems is contingent upon the possession of sufficient mathematical thinking skills. Solving problems entails identifying a solution to challenges and achieving goals that may not be readily attainable (Wedelin et al., 2015). It represents one of the most significant achievements of students' cognitive processes and can be regarded as the epitome of human activity. Problem-solving is a cognitive process that entails physical activity to identify solutions to the problems that are encountered (Bradshaw & Hazell, 2017). Problem-solving comprises four distinct activities: understanding the problem, formulating a solution plan using a mathematical model, solving the problem in accordance with the mathematical model, and reversing the solution to the original problem (Biswas & Ferdausy, 2017). In mathematics, a model is a mathematical representation derived through abstraction from a real-world scenario. The objective of developing a model is to enhance the process of problem-solving. Once a mathematical model is constructed using the established rules of mathematics, a solution to the model is derived (Özcan, 2016). This process presents a significant challenge for students in understanding the underlying mathematical concepts and principles.

The process of problem-solving necessiates the application of critical and high-level thinking. Critical thinking is defined as the ability of a student to analyze information and ideas with careful attention to detail and from a variety of perspectives (Anggoro et al., 2022; Frischkorn & Schubert, 2018). However, the problems that students were asked to solve in these studies were formal problems within formal mathematical structures. In the present study, the problems that students were asked to solve were those that were drawn from their everyday life and related to habits and routines. The context was the surface area of a geometric shape. The results of the present study indicate that the use of the context of the tourist attraction Bukit Sulap, the highest point in Lubuklinggau, which was familiar to the students, facilitated their ability to solve problems related to the surface area of geometric figures.

Based on the survey conducted prior to the present study at Annida Integrated Islamic Elementary School in Lubuklinggau City, the surface area problem context that was most salient to the students was that of the Bukit Sulap tourist attraction. The contexts that can be utilized include, but are not limited to, the surface area of the stone retaining walls, the surface area of the triangular roof of the lavatory, and the surface area of the trapezoidal and triangular roof of the gazebo at Bukit Sulap.

In accordance with the description and preliminary survey data collected at one of the elementary schools in Lubuklinggau, the surface area learning cycle for elementary school students was found to comprise three main activities. The three activities were as follows: firstly, students received the formula presented by the teacher; secondly, they observed examples demonstrated by the teacher on the blackboard; and thirdly, they completed practice questions. The cycle resulted in a limited understanding of the concepts and principles of surface area among the students. It was thus necessary to enhance students' learning trajectories, enabling them to solve problems using contexts that resonate with their lived experiences. Elementary students in Lubuklinggau have a strong familiarity with Bukit Sulap, a local tourist attraction. This context was therefore identified as a potential avenue for initiating learning about surface area. To operationalize this approach, a learning trajectory was devised. Consequently, the research question was how to design a learning trajectory on the topic of the surface area, utilizing Bukit Sulap Tourism as a context.

METHODS

This study employed design research methodology. This methodology enables a validation process that focuses on designing learning trajectories to develop and validate theories about the learning process and describe the process of designing environments or learning trajectories (Plomp & Nieveen, 2013). The objective of this study was to develop a HLT based on the PMRI approach within the context of Bukit Sulap, with the aim of improving the quality of learning about surface area (Sembiring et al., 2008). The study involved 27 students from Annida Integrated Islamic Elementary School in Lubuklinggau City, Indonesia. It was conducted in three stages: preparation of the experiment, experimentation in the classroom, and retrospective analysis (Plomp & Nieveen, 2013).

Preparation and Design

At the preparation and design stage, three activities were conducted with the aim of developing an initial design of a HLT (Widada et al., 2019). The initial activity entailed the administration of a pretest to students on the topic of surface area in geometry. The results of the pretest indicated that students required additional time to process the information necessary to solve problems related to surface area. The second activity entailed a comprehensive literature review on various learning techniques pertaining to the surface area of geometric figures. The literature review revealed that the problems used to teach surface area generally employ the context of wall painting, cement plastering, and theater drape making. The third activity entailed selecting Bukit Sulap as a learning context and devising a series of activities that students would undertake to learn about the surface area of the retaining wall, the surface area of the triangular roof of the lavatory, and the surface area of the trapezoidal and triangular roof of the gazebo at Bukit Sulap. This was done through the process of solving problems related to more complicated surface areas.

Teaching Experiments

The teaching experiment was conducted in two phases: the teaching experiment and the pilot experiment (Nursyahidah et al., 2023). The pilot experiment was an initial trial of a HLT design, conducted with five students working in one group. The objective was to review the HLT design, with particular attention to readability and clarity of instructions and commands in the student worksheets. Additionaly, the students provided constructive input regarding the visual presentation of the design and the suitability of the context used, specifically Bukit Sulap, for surface area topic learning. The results of the HLT design improvements were implemented in a trial involving 27 students in one class.

Retrospective Analysis

In the retrospective analysis stage, the actual learning trajectory (ALT) was compared with the HLT. The process by which students constructed tables, identified patterns, rephrased the problem into a simpler form, employed logical reasoning, created drawings, and explored alternative possibilities to develop the mathematical model was observed and documented. The video recording of the learning session, the delivery of the anecdotal story, and the results of the interview were subjected to analysis to form descriptions that would illustrate the students' initial understanding of the concept of product rules. The findings in this stage were used to explain the role of Bukit Sulap as a learning context, whereby students were able to define context problems, conduct self-reviews to gain an understanding of the problem, develop problem-solving plans, implement said plans, review solutions according to surface area problems in the context of Bukit Sulap, and learn the concepts and principles of surface area of geometric shapes.

During the learning process, data were collected through observation of video recordings taken during learning sessions, analysis of student answers on worksheets, anecdotal stories, and interviews with students conducted during the learning process through group discussions and presentations of work results in front of the class. Observations were conducted to determine the level of implementation of HLT, interviews were conducted to ensure the suitability between ALT and HLT, and anecdotal stories were needed to complete data on students' physical and mental activities during learning that supported the interviews. Data collected was described qualitatively.

RESULTS AND DISCUSSION

The results in the preparation and design stages can be distilled into three principal results. The first result demonstrated the students' thinking processes in solving problems regarding surface area, which required a longer time frame to complete. The second results were that, based on a review of existing literature, the questions used to teach surface area typically involve contexts such as the surface area of a wall that requires painting, the amount of cement needed to plaster a wall based on its surface area, and the area of the cloth required to make a theater drape. The third result was that Bukit Sulap was designated as the learning context, and a series of activities that students would complete in the learning process were formulated. These activities were conducted in the context of the extensive surface area of the retaining wall, the surface area of the triangular roof the lavatory, and the surface area of the trapezoidal and triangular roof of the gazebo at Bukit Sulap. The activities involved solving problems related to more complicated surface areas.

The data obtained from the preliminary activities of this study was used to develop a hypothetical learning trajectory. This trajectory consisted of three components: learning objectives, learning activities, and a hypothetical learning process (Plomp & Nieveen, 2013). These are presented in Table 1.

Table 1. HLT of surface area concept with the context of bukit sulap tourism

Main Activities	Main Purpose	Hypothetical Activities
Students define problems in the context of Bukit Sulap.	To state the scope of the surface area problem in the context of the Bukit Sulap	1. Students state the limitations of the surface area problem in the context of Bukit Sulap. 2. Students define the problem using Bukit Sulap as the context for surface area.
Students perform a self-review by explaining the definition of surface area problems in the context of Bukit Sulap.	To make a self-review to explain the definition of surface area problems in the context of Bukit Sulap	3. Students perform a self-review of the definition of the surface area problems in the context of Bukit Sulap. 4. Students explain the definition of surface area problems in the context of Bukit Sulap.
Students design a solution plan for defining surface area problems in the context of Bukit Sulap.	To determine the design plan and mathematical model using the context of Bukit Sulap.	5. Students develop a problem-solving plan using the context of Bukit Sulap. 6. Students use the context of Bukit Sulap to build their mathematical model.

Main Activities	Main Purpose	Hypothetical Activities
Students perform the plan to solve the surface area problem in the context of Bukit Sulap.	To determine the surface area of geometric figures using the context of Bukit Sulap	7. Students can relate solutions to surface areas and provide logical arguments. 8. Students solve surface area problems in the context of Bukit Sulap.
Students verify the solution according to the surface area problem in the context of Bukit Sulap.	To determine the accuracy of the answer to the problem using the context of Bukit Sulap To learn the concepts and principles of surface area of geometric shapes	9. Students check the surface area problem in the context of Bukit Sulap and decide whether the answer is correct. 10. Students verify the accuracy of the solutions to the problems so that they understand the concepts and principles of surface area of geometric shapes.

The learning trajectory depicted in Table 1 represents the HLT in this study, which was comprised of five distinct activities. The activities were as follows: (1) Students defined problems in the context of Bukit Sulap; (2) Students conducted a self-review, explaining the definition of surface area problems in the context of Bukit Sulap; (3) Students designed a solution plan for defining surface area problems in the context of Bukit Sulap; (4) Students implemented the plan to solve the surface area problem in the context of Bukit Sulap; and (5) Students verified the accuracy of the solution to the surface problem area in the context of Bukit Sulap.

This study developed the HLT based on the PMRI approach, utilizing the context of Bukit Sulap to facilitate students' understanding of the concept of surface area. Some activities were condcuted by the students to determine the surface areas of the retaining wall, the roof of the lavatory, and the roof of the gazebo at Bukit Sulap. In this study, the researcher also assumed the role of a teacher. The learning process commenced with the identification of problems within the context of tourism in Lubuklinggau City, Indonesia.

In the process of learning about surface area, the teacher provided Bukit Sulap as the context for a mathematical word problem. The problem states as the following: "On Sunday Anton and Toni went on a trip to Bukit Sulap by mountain bike. Upon their arrival at the tourist point, they were tired and rested at a gazebo. They told each other stories and Anton asked Toni:

1. What is the surface area of the retaining wall (see Figure 1)?
2. Look at the lavatory. How much surface area of the roof is visible from the front (see Figure 3)?
3. Look at the roof of this gazebo from the front and see how much of it we can see (see Figure 10)."

The following Figure 1 is consistent with the context of Bukit Sulap and provides a means of calculating the surface area.

Figure 1. Stone retaining wall of Bukit Sulap

Figure 1 provides an illustration of a surface area context, specifically the stone retaining wall at Bukit Sulap. The wall surface is rectangular in shape. In the initial stage of the problem-solving strategy, the students delineated the problem within the context of Bukit Sulap. Thereafter, the subsequent step was in accordance with the problem/solution strategy exemplified earlier. At the outset of the demonstration, the teacher delineated the pedagogical technique, thereby ensuring that the students were cognizant of the proceedings during the inaugural "definition" phase, which is delineated in part by the red rectangle in Figure 1.

Activity 1: Defining the Context of the Problem

In Activity 1, the students were tasked with defining the context of the problem. In this activity, students identified images of flat shapes in Bukit Sulap tourist park. The students, through the activity sheet, identified the problems given. Figure 2 illustrates the range of students' answers.

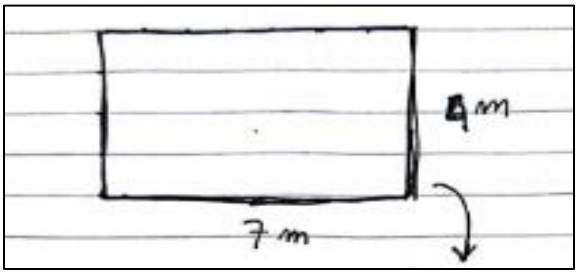


Figure 2. Representation of the surface of the retaining wall at Bukit Sulap

As illustrated in Figure 2, students created representations of the surface of the retaining wall, exemplified by the drawing created by students. In an interview with the student, it was observed that the student defined the problem related to surface area with Bukit Sulap as the context. The interview excerpt is provided below for reference. (*Note: S: Student, R: Researcher*)

S : *I attempeted to create a representation of the surface of the retaining wall. Based on my estimation, the width is approximately 4 meters, and the length seems to be around 7 meters.*

R : *If I may ask, how do you determine the surface area of the retaining wall?*

S : *As I previously described the retaining wall in my work, I made a unit square with the size* *of 1×1 using matchsticks, which represented 1 square meter. I made as many unit squares as possible* [See Figure 2].

R : *Now, please direct your attention to the lavatory. Could you please explain how you determined the surface area of the lavatory roof visible from the front?*

S : *Yes, Sir. This is what the front roof that I observed looks like...* [See Figure 3].

Figure 3. Lavatories at Bukit Sulap

Figure 3 provides context for determining the surface area of the roof of the lavatories at Bukit Sulap. Students tend to draw the lavatories into triangle shapes. An excerpt from an interview with the student related to this context is presented below. (*Note: S: Student, R: Researcher*)

R : *Could you please outline the steps you intended to take upon examining this picture?*

S : *Given that the roof surface visible from the front is triangular*

R : *Please continue.*

S : *I represented it with the area of a triangle. I can ascertain that the base has a length of a and an altitude of t, then I proceed to calculate the surface area.*

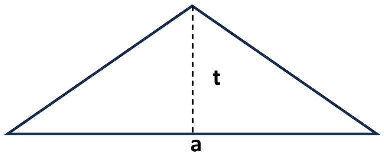


Figure 4. Representation of the roof surface

Figure 4 depicts the representation of the roof surface, which was based on the context presented in Figure 3. Student correctly interpreted the surface area problem in the context of Bukit Sulap. Student demonstrated an understanding of the vocabulary used in the questions and the meaning of the words. Furthermore, the student exhibited an accurate comprehension of the context of the problem, specifically regarding surface area in the context of Bukit Sulap Tourism. Student identify the information present in the surface area problem in the context of Bukit Sulap and ascertaining what was being inquired by the problem.

Activity 2: Self Review

The following excerpt describes the subsequent step taken by students in self-review, wherein the definition of the surface area problem in the context of Bukit Sulap was elucidated. (*Note: S:*

Student, R: Researcher).

S : *..... based on my observation, the surface of the retaining wall is rectangular in shape and the surface of the roof of the lavatory is triangular.*
R : *Could you please provide a detailed explanation?*
S : *... I estimated that the rectangle to be 7 meters long and 4 meters wide... my seatmate confirmed that my estimation was accurate. However, I was unable to estimate the altitude of the triangle, so I assigned it a symbol.... for example, the base is b meters long and the altitude is a meter long.*

As evidenced by the interview excerpts of students, the student was able to articulate the definition of surface area problems in the context of Bukit Sulap by providing an explanation to their classmates or by simplifying the problem by rewriting it in their own words.

Activity 3: Designing a Resolution Plan

In Activity 3, the students devised a solution to the problem based on the representation of the roof surface. In this activity, students employed the use of unit squares in a manner that ensured the surface was completely covered. Figure 5 illustrates the way the students designed the surface area.

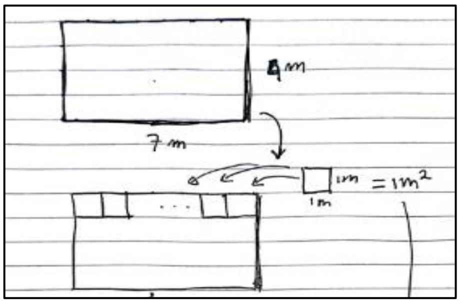


Figure 5. Problem-solving plan

This activity is described by means of excerpts from an interview with the student regarding the drafted problem-solving plan, as follows. (*Note: S: Student, R: Researcher*).

R : *What is the next step?*
S : *I began with the base. I proceeded to cover the rectangle with unit squares arranged side by side until the entire surface was completely covered without any remaining gaps.*
R : *Please describe the process you used to determine the surface area of the retaining wall.*
S : *As previously outlined in my assignment sheet, I constructed a square measuring 1×1 using matchsticks, which represents 1 square meter. I then created as many unit squares as possible [See* Figure 5*].*

Figure 5 is a problem-solving plan made by students. Based on interview, it was observed that students were able to devise plans by asking, "What can I do to solve this problem?". They were able to create tables, identify patterns, rephrase the problem into a simpler one, apply logic, conduct trial and error; create experiments, draw, and develop other possibilities to design the mathematical model.

Activity 4: Executing the Resolution Plan

In Activity 4, the students implemented the resolution plan based on the problem-solving plan. In this activity, the students were able to determine that the number of unit squares arranged to completely cover a surface was the surface area of a rectangle. Figure 6 below illustrates the students' findings regarding the surface area.

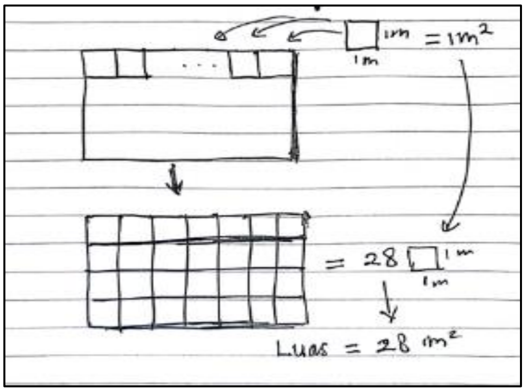


Figure 6. The completion of the plan

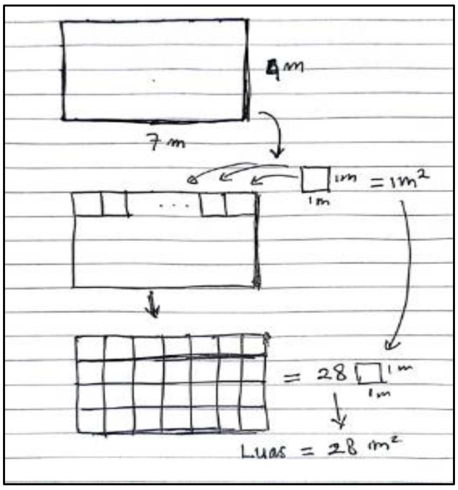
The following excerpt from an interview with students provides further insight into the execution of the resolution plan. (*Note: S: Student, R: Researcher*).

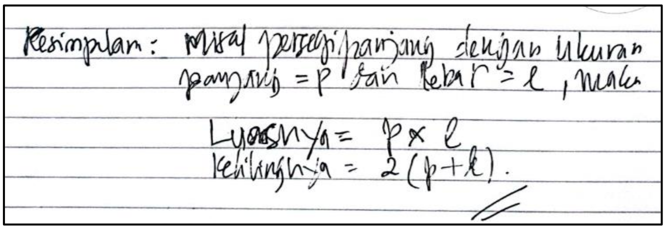
R : *What is the next step?*
S : *I began with the base. I proceeded to cover the rectangle with the unit squares arranged side by side until it was completely covered without any remaining gaps.*
R : *Please continue…*
S : *I then counted the number of unit squares, which equaled 28. This indicates that the surface area of the retaining wall is 28 square meters.*
R : *Could you please explain why the result is 28 square meters?*
S : *The reason is that one unit square represents one square meter, so 28 unit squares equal 28 square meters, Sir.*

Figure 6 depicts the completion of the plan devised by the student. Based on interview excerpts, it is evident that the students were able to implement their problem-solving plans. In this activity, the students utilized paper and pencil to perform the requisite calculations. As problem solvers, if they encounter difficulties before reaching a solution, they may need to discard their initial plan and develop a new one.

Activity 5: Reviewing the Solution

In Activity 5, the students conducted a review of the solution based on the execution of the resolution plan. In this activity, the students were able to determine the formula for the area of a rectangle in general and to calculate the surface area of the retaining wall. Figure 7 shows that the students were able to identify the surface area of the wall and to derive the formula for the area of a rectangle.





Translated into English:

Conclusion: Let the length of the rectangle be l and the width be w. Then
The area = l × w
The perimeter = 2(l + w).

Figure 7. Review and summary results

This activity is illustrated by the following excerpts from an interview with the student regarding the review of the solution. (*Note: S: Student, R: Researcher*).

R : *Could you please clarify the relationship between 28 square meters and the length and width of the retaining wall?*

S : *The length is 7 meters, and the width is 4 meters. Therefore, the surface area of the retaining wall is 7 m × 4 m, which equates to 28 square meters.*

R : *Given its length and width, could you please explain how you determined the perimeter and area of the rectangle?*

S : *As indicated on my worksheet [Figure 7], I have determined that the surface area of the rectangle is l × w.*

Figure 7 presents a review and summary of the results obtained by the student. The surface area of the retaining wall, as determined by the student, was used to calculate the surface area of the lavatory roof. Figure 8 builds upon the findings presented in Figure 4.

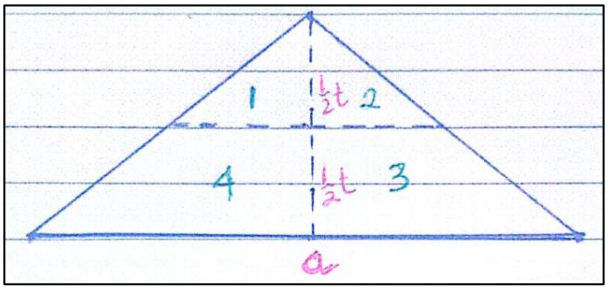


Figure 8. Triangular shape employed to represent the roof of the lavatory

Figure 8 depicts a triangular shape representing the roof of the lavatory designed by a student. The student proceeded to divide the surface area into four parts and subsequently calculated the surface area. This process is elucidated by the following interview result. (*Note: S: Student, R: Researcher*).

S : *Based on my observation on the roof of the lavatory in the Figure 4, I divided the surface area into four parts, by [drawing] altitude from the base [to the apex] and [drawing] a line parallel to the base at one-half of the altitude's length.*

R : *Please describe the subsequent step you took.*

S : *I then arranged the four parts into [the configuration depicted in] Figure 9, which is a rectangle.*

R : *Could you please provide further details?*

S : *This is the shape [I devised] for the lavatory roof, which is a rectangle with a width of one-half of the triangle altitude's length and a length equivalent to the base of the triangle. This allowed me to calculate the surface area."? Thus, it is the shape of the lavatory room roof surface area which is found in a rectangular shape with a width of ½t and a base length of a.*

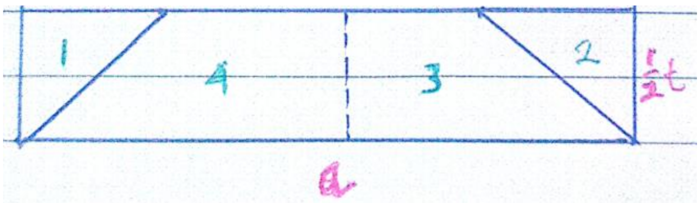


Figure 9. Student's strategy on the surface area of the lavatory roof using the area of a triangle

Figure 9 illustrates the strategy employed to ascertain the surface area of the lavatory roof utilizing the area of a triangle generated by student. The student proceeded to move triangle 1 and triangle 2 to the right and left of triangle 3 and triangle 4, as illustrated in Figure 9. This resulted in the formation of a rectangle, prompting students to apply the formula for the area of a rectangle to determine the surface area of the triangle. This is corroborated by the following interview excerpt. (*Note: S: Student, R: Researcher*).

S : *Based on the results of my previous calculation, the area of a rectangle can be determined by multiplying the length by the width, and from Figure 9 it was determined that the surface area is a x ½t = ½.a.t.*

R : *Please summarize your conclusion.*

S : *I have concluded that the surface area of the triangular roof of the lavatory with base length a and a height t is ½at.*

R : *Very well... Moving on, could you please provide me with the surface area of the gazebo roof visible in the front view?*

S : *I observed the surface area of the gazebo roof visible from the front, shown in this photograph [see Figure 10].*

Figure 10. The roof of the gazebo at Bukit Sulap

Figure 10 illustrates that the students proceeded to calculate the surface area of the gazebo roof in the front view, which consists of two shapes: a triangle and a trapezoid. Subsequently, the students represented it in a drawing, depicting the gazebo roof surface as seen from the front, as shown in Figure 11.

Figure 11. Representation of the gazebo roof surface in the front side

Figure 11 presents a representation of two flat shapes, namely a triangle and a trapezoid, based on the front view of the gazebo. It was the student activity to look at the gazebo from the front. The students were able to find its surface area based on the results of previous activities, as evidenced by the following interview excerpt. (*Note: S: Student, R: Researcher*).

S : *Based on* Figure 10*, I can include it in my answer sheet as you see here [See* Figure 11*].*
R : *Then?*
S : *Based on the drawing I created [*Figure 11*], I have divided [the structure of the roof] into two parts as follows [see* Figure 12*].*

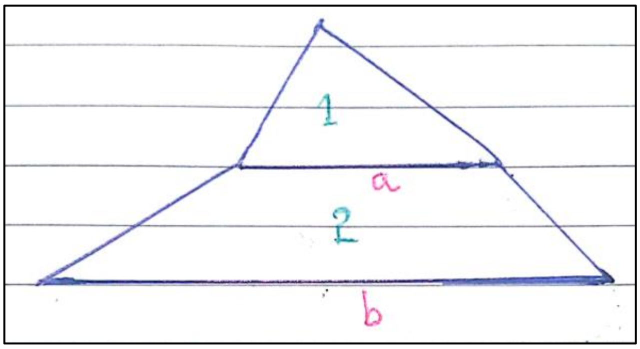


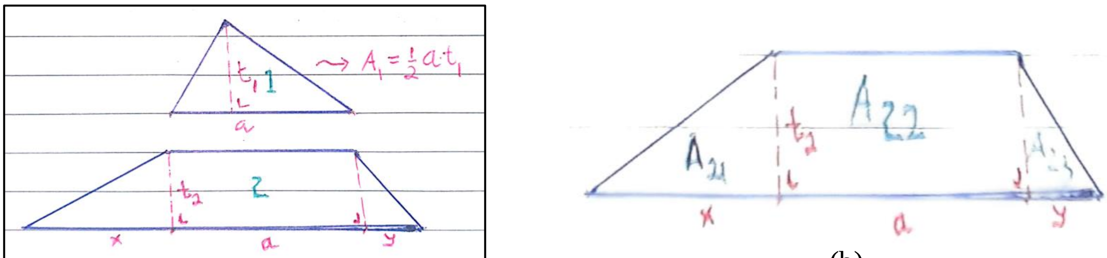
Figure 12. Gazebo roof surface drawing

Figure 12 depicts the roof surface of the gazebo as illustrated by the student. The interview results indicated that the students were able to determine the surface area of the gazebo in the front view. The roof, as observed from the front, resembles a combination of a triangle and a trapezoid. The students were able to calculate the surface area using the drawing they had created. This is corroborated by the following interview excerpt. (*Note: S: Student, R: Researcher*).

S : *I defined Section-1 as a triangle with a base of a and an altitude of t1, and [I defined] Section-2 as a trapezoid with an altitude of t2 and two parallel sides of a and b.*

R : *Very well. Please continue.*

S : *As illustrated in* Figure 13*, Section-2 is subdivided into three sections, A21, A22, and A23 [see* Figure 13b*].*



(a) (b)

Figure 13. Gazebo roof drawing sections

Figures 13(a) and (b) present drawings by the student in which Section-2 was divided into three sub-sections. From these drawings, the principle of surface area for a combination of two different shapes was derived. The student developed a method for calculating the combined area of a triangle and a trapezoid, which is detailed in the following interview excerpt. (*Note: S: Student, R: Researcher*).

R : *Could you please explain your works?*

S : *Each section is comprised of two triangles, A21 and A23, and a rectangle, A22 [See* Figure 13b*].*

R : *Okey, then?*

S : *Based on Figure 13b, the trapezoid area (Section-2, A2) was calculated. It is known that* $b = x + a + y$*;* $A2 = A21 + A22 + A23 \rightarrow A2 = ½xt2 + at2 + ½yt2 \rightarrow A2 = ½(x + 2a + y)t2 \rightarrow A2 = ½(a + (x + a + y))t2 \rightarrow A2 = ½(a + b)t2$.

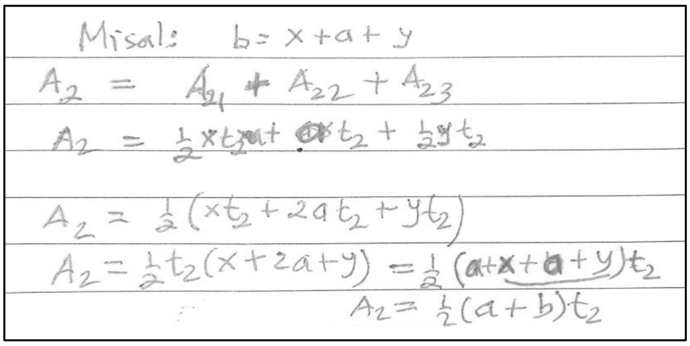


Figure 14. The surface area calculation results for section A2

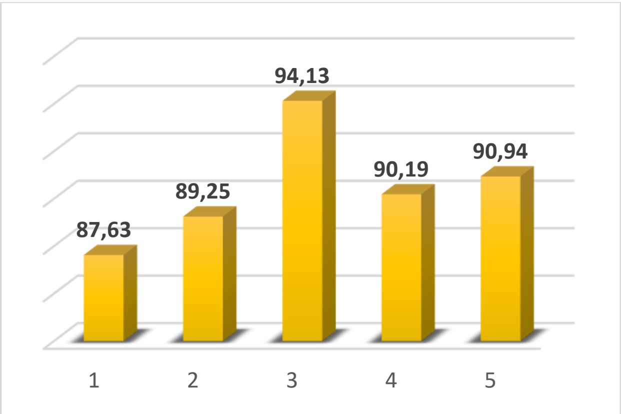
Figure 14 represents the result of the calculation of the surface area of the components identified by the student. The students' conclusion pertains to the principle of the surface area, which they determined to be a combination of the surface areas of a triangle and a trapezoid. This conclusion is supported by the following interview excerpt. (*Note: S: Student, R: Researcher*).

R : *Please summarize your conclusion.*

S : *I conclude that the surface area of the gazebo roof seen from the front can be represented as* $A = A1 + A2 = ½at1 + ½(a + b)t2$.

As evidenced by the interview excerpts, the students reviewed the surface area problem in the context of Bukit Sulap and evaluated the accuracy of their answers to the problem. This process facilitated their understanding of the concepts and principles associated with the surface area of geometric shapes.

The findings of this study can be corroborated through an observation of the students' activities during the learning process, utilizing HLT with Bukit Sulap as the learning context to ascertain the principles of surface area. The observational results are presented in Figure 15.



Note:
1. *Defining the contextual problem*
2. *Self-reviewing*
3. *Designing a completion plan*
4. *Executing the completion plan*
5. *Reviewing*

Figure 15. Implementation of HLT using tourism as a context

As illustrated in Figure 15, the results of the observation of the implementation of HLT in learning, with Bukit Sulap as the context for understanding the concept of surface area, revealed that 85% of the students were able to complete Activity-1 (Defining the contextual problem), and 89.25% of the students were able to complete Activity-2 (Self-review). A total of 94.13% of the students demonstrated proficiency in Activity-3 (Designing a completion plan), 90.19% in Activity-4 (Executing the completion plan), and 90.94% in Activity-5 (Reviewing). This demonstrated that, on average, 90.94% of the students were able to complete all learning activities through the application of HLT using Bukit Sulap as the context for learning the external principles of the surface of a geometric figure.

This indicated that the learning trajectory for problem- solving regarding surface area using Bukit Sulap as the context was effective for teaching the principles of surface area of geometric shapes. This corroborated the findings of previous studies that have demonstrated the efficacy of tourism as a learning context in facilitating students' acquisition of mathematical concepts and principles, (Sukasno et al., 2024), and that the integration of local culture facilitates students' learning of geometric concepts and principles (Nugroho et al., 2023; Widada et al., 2020; Quiroz et al., 2015). Other studies demonstrated that students were able to achieve the correct abstraction process through the influence of local culture (Sukestiyarno et al., 2023; Anggoro et al., 2023).

In these studies, the students demonstrated the ability to integrate disparate pieces of information to achieve a solution, conceptualizing the problem as pertaining to the sides of a right triangle and the area of a square with sides equal to the sides of a right triangle. The students were able to correctly connect three square areas, demonstrating an understanding that the area of a large square is equal to the sum of the areas of two small squares. A study by Sukasno et al. (2024) employed the context of tourism at Lake Gegas, Musirawas Regency, and succeeded in identifying the cognitive processes by which students understand mathematical principles within a tourism context. At the outset, students demonstrate their understanding of the problems. Subsequently, they construct mathematical models based and complete them in accordance with the context. Then, they devise solutions to the contextual problems and draw mathematical conclusions. Using tourism as a learning context, students have been found to be able to solve problems in a more appropriate manner (Widada, et al., 2020; Herawaty et al., 2021; Lubis et al., 2021).

The design of the learning trajectory regarding problem-solving in the context of the geometry topic, surface area, using Bukit Sulap as the learning context, has been finalized and comprises five activities. The initial activity, Activity 1, involves defining the contextual problem. In the present study, one of the subjects demonstrated an ability to learn vocabulary in the questions and comprehend their meaning. Furthermore, the subject demonstrated an understanding of the context of the problem, specifically regarding surface area in the context of Bukit Sulap. Subsequently, the subject identified information related to surface area problems within the context of Bukit Sulap and discerned the specific inquiries posed by the problem. The subsequent activity, designated as Activity 2, is a self-review. In this activity, students are expected to elucidate the definition of the surface area problem in the context of Bukit Sulap. This may entail either explaining the problem to their classmates or simplifying it by rewriting it in their own words. Thereafter, Activity 3, entitled "designing a resolution plan," is conducted. This activity requires students to engage in problem-solving by posing the question, “What can I do to solve the problem?” Students are expected to demonstrate proficiency in the following skills: table creation, pattern identification, problem rephrasing into a simpler form, logical reasoning, trial and error, experimentation, drawing, and the development of alternative possibilities for the design of the mathematical model. Upon completion of this activity, Activity 4 is initiated. This activity pertains to the execution of the resolution plans developed in Activity 3. In other words, students are required to implement the problem-solving plans they have devised. In this activity, students utilize paper and pencil to perform the requisite calculations. As problem solvers, students may encounter difficulties in finding solutions and may therefore need to abandon their initial plan and develop new ones. The final activity, Activity 5, is a review of the surface area problem in the context of Bukit Sulap. Students evaluate the accuracy of their solutions and learn to apply the concept and principle of surface area of geometric shapes.

The findings of the present study indicate that the use of contextual problems as a starting point for mathematical learning can enhance the perceived meaningfulness and engagement of students in the topic of surface area. Several studies have demonstrated the advantages of employing contextual problems to enhance students' mathematical understanding and critical thinking skills (Muslimahayati et al., 2020). A central tenet of PMRI is the prioritization of utilizing real-world, contextual problems as the basis for mathematical concept acquisition. The problems are derived from students' personal experiences and are crafted to resonate with their lived realities. By engaging with these contextual problems, students can discern the practical applications of mathematics and perceive its relevance to their daily lives. This facilitates the establishment of a more relatable subject matter and motivates students to engage in learning (Muslimahayati et al., 2020).

The utilization of contextual problems also permits students to actively participate in the learning process, as they work to understand and resolve real-world problems utilizing mathematical concepts and skills. Furthermore, PMRI provides a more student-centered approach to learning, where the teacher assumes the role as a facilitator in lieu of being the exclusive repository of knowledge. Considering the elaborations, the present study proposes five activities within the student learning trajectory regarding problem-solving skills in the topic of surface area in geometry, with Bukit Sulap serving as the learning context (Herawaty et al., 2020; Agusdianita et al., 2021).

CONCLUSION

Bukit Sulap, a tourist destination in Lubuklinggau city, has been demonstrated to provide an effective learning context for local students to gain an understanding of the principle of surface area. The learning trajectory (LT) design has been implemented with great efficacy (90.94%), alligning closely with the cognitive processes of students in uncovering the principle of surface area. The learning trajectory is comprised of five activities. The activity begins with defining the contextual problem, followed by a self-review. This is then followed by the design of a resolution plan, execution of the resolution plan, and a review of the solutions proposed. Finally, a mathematical model about surface area is created within the context. The findings of this study indicate that student learning trajectory regarding problem-solving skills in the topic of surface area in geometry using the context of tourism, exemplified by Bukit Sulap in this study, is an effective approach for teaching the principles of surface area of geometric shapes. Consequently, it is recommended that mathematics teachers consider utilizing tourist destinations in proximity to their students as a context, particularly as a starting point for learning geometry. The potential avenue for future research is the dissemination of the findings from the learning design study on surface area in the context of Bukit Sulap in Lubuklinggau City. Additionally, further studies employing an appropriate quasi-experimental design are necessary to investigate the effectiveness of this approach across a broader range of subjects.

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