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Geometry Ability in Contextual Mathematics Learning in Elementary Schools

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Abstract

Purpose: Geometry ability plays a crucial role in contextual learning, especially for elementary school students who are required to solve complex problems. This study aims to: (1) describe the geometry ability of plane and space figures in the context of elementary school learning, and (2) explore how these abilities are manifested in contextual learning settings.
Methodology: This research employed a qualitative ethnographic design. The subjects consisted of the school principal, a mathematics teacher, and 17 fifth-grade students at Muhammadiyah Alam Surya Mentari Elementary School. Data collection techniques included interviews, classroom observations, and documentation of students' test results. To ensure data validity, source and method triangulation were applied. The data analysis followed the flow model involving data collection, reduction, presentation, verification, and conclusion drawing.
Results: The study revealed variations in geometry ability among students based on their performance categories. Students in the high category fulfilled all four indicators (M1, M2, M3, and M4). Those in the medium category met three indicators (M1, M2, and M3), while students in the low category only met one indicator (M2).
Applications/Originality/Value: The findings highlight the importance of differentiated instruction in teaching geometry through contextual learning. Teachers should consider students' varying levels of ability when selecting or designing instructional strategies to enhance geometry understanding effectively.

Introduction

Geometry skills are very important to learn in elementary school because they are used in various fields such as Astronomy, Architecture, Engineering, and Physics. This is in line with (Crompton & Ferguson, 2024; Kuzle, 2023) hich state that geometry skills are very necessary in elementary school. Geometry is a fairly challenging material for students, geometry material includes planes and spaces (Massarwe, 2023; Pambudi, 2022; Suliani et al., 2024). Geometric skills mainly consist of the creation and use of "conceptual systems" used to study planes and spaces (Nur et al., 2021). In the process of learning geometry, geometric skills are needed, namely the ability of students to observe objects, make definitions based on the properties of an object, understand the relationship between objects, and use them to solve geometric problems (Hamidah et al., 2024). Although geometry is important, geometry is often ignored by students because it is considered difficult.

Many students have difficulty understanding the concept of geometry, the lowest ability occurs in geometry tasks during external assessments. Based on data from the Programme for International Student Assessment (PISA) students have difficulty formulating, using, and interpreting mathematics in various contexts to describe, explain, and predict phenomena (Summary, 2018). Several studies (De Villiers, 1998; Milinković & Kadelburg, 2019) show that students face challenges in understanding geometric concepts and processes (such as visualization, grouping, proof, and others). Findings from (Juniati & Budayasa, 2022; Silmi Juman et al., 2022) revealed that students have greater difficulty in learning Geometry such as determining formulas in contextual problems. This is in line with the results of interviews with grade V mathematics teachers at SD Muhammadiyah Alam Surya Mentari who stated that students have difficulty in applying geometric formulas to contextual problems.

The low geometry ability of students is caused by several things. Students have low geometry ability because they find it difficult to solve everyday problems(Buaddin Hasan, 2020). This is caused by the lack of direction from teachers to students when discussing everyday problems (Andini et al., 2023). He learning process focuses only on the targets set by the teacher without considering students' abilities in solving mathematical problems. The implementation of mathematics learning in the classroom only focuses on achieving the target material contained in the textbook without paying attention to what has been learned by students (Hanggara et al., 2022). As a result, students only memorize concepts without understanding their meaning. In addition, another contributing factor is the lack of variation in the teaching models used by teachers. Most teachers traditionally teach the material, using the lecture method, then continue by giving practice questions from the textbook and encouraging students (Nisa & Faradiba, 2023). This causes students' motivation to learn mathematics to decrease.

Geometry's ability to contextual problems has been commonly studied in previous studies in several countries. Previous studies in **Germany** showed that students have different abilities in applying geometry concepts (Pielsticker, 2022). This is in line with Alessandro (Gambini, 2021) in **Italy**, students can understand the concept of plane and space geometry according to their abilities. In contrast to the results of Kemal & Gizem's research (Altıparmak & Gürcan, 2021) in **Turkey**, elementary school students still experience misconceptions about geometry material. The results of previous studies differ from those conducted, including researching geometry ability in contextual problems, and the novelty of the research conducted by measuring the abilities of elementary school students according to the level of high, medium, and low student abilities.

Based on the results of the research that have been discussed, the researcher conducted this research with the aim of 1) describing the ability of plane and space geometry in contextual learning of elementary school students. 2) exploring the ability of plane and space geometry in contextual learning of elementary school students. The material used by the researcher in this research is plane and space geometry because the material is closely related to everyday life.

Method

This research is qualitative research with an ethnographic approach. Qualitative research is a research method used to understand events about what is experienced by natural research subjects, then the facts obtained are described descriptively in the form of words and sentences (Riyanti, 2019). Ethnographic design is an approach to interpreting an action from an event that befalls students that we want to understand systematically through direct observation and interaction with research subjects (Sutama et al., 2019).

This research was conducted at SD Surya Alam Mentari. The research was conducted for approximately one week, starting from October 22 to October 29, 2024. The subjects of the study were the principal, grade V mathematics teachers, and grade V students. The respondents in this study were 17 grade V A students. The students were selected because they had participated in mathematics learning in class using contextual learning. All respondents were given mathematics problems, namely a geometry ability test instrument in the form of one descriptive question on the subject of plane and space geometry. After that, the results of the students' work were corrected to obtain students who met the problem-solving indicators. Then, students were divided into three categories, namely high, medium, and low problem-solving abilities.

Data collection techniques in this study used interviews, observations, and documentation of test results. Interviews were conducted to obtain in-depth information directly from the research subjects, namely the principal, grade V mathematics teachers, and grade V students. Observations were conducted to observe the phenomena that occurred in the research subjects. Documentation is needed to support the information obtained from interviews and observations. The documents needed are test instruments, student test results, and other relevant documentation. In obtaining the truth, this study uses triangulation of sources and methods. (Ishartono et al., 2021).

The data analysis technique in this study uses an interactive flow method. The data analysis process is through data collection from sources, namely the principal, subject teachers, students, and supporting documentation. Data reduction is carried out by correcting and assessing the results of student test work, where the test results will be used as considerations for determining subjects and interview guidelines. Furthermore, data presentation is carried out by presenting data in the form of student contextual geometry ability test results and in-depth interviews with students. Data verification is carried out to explain in depth the data presented, and conclusions are drawn by drawing core findings of facts that are associated with the underlying theory.

Result and Discussion

The results of the geometry ability test are assessed using the geometry ability indicator. The geometry ability indicator consists of four stages, namely identifying important things in contextual problems (M1), exploring mathematical concepts in context (M2), building understanding through progressive mathematization (M3), and applying geometry concepts in new situations (M4). This is in line with the geometry ability indicator according to van den Heuvel-Panhuizen (Zimmerman et al., 2016)

The results of the contextual geometry ability test are grouped into three parts, namely groups with high, medium, and low geometry abilities. The achievement of geometry ability is a conversion of the scores of students who have taken the test with the Minimum Completion Criteria (KKM) at the school, which is 70.

Table 1. Students' geometry ability categories

Value	Category
$x \geq 80$	High
$65 < x < 80$	Medium
$x \leq 65$	Low

(Hilyani et al., 2020)

Figure 1 shows the percentage of students in each category of student mathematics ability. The ability of students in the high category (H-S) is 24% or four students, the medium category (M-S) is 35% or six students, and the low category (L-S) is 41% or seven students.

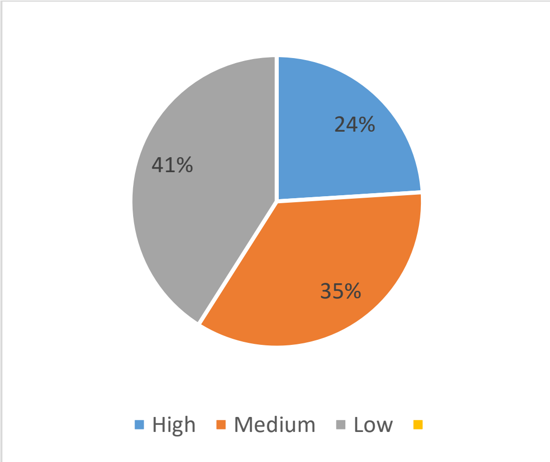


Figure 1. Percentage of students in each category

Students' geometry abilities are in the high category

The group that has a high geometry ability category has on average achieved measurable contextual geometry ability indicators. This can be seen from the results of their work which can solve the problems correctly and fulfill each contextual geometry ability indicator. The following is one of the subject's answer sheets in working on the problem.

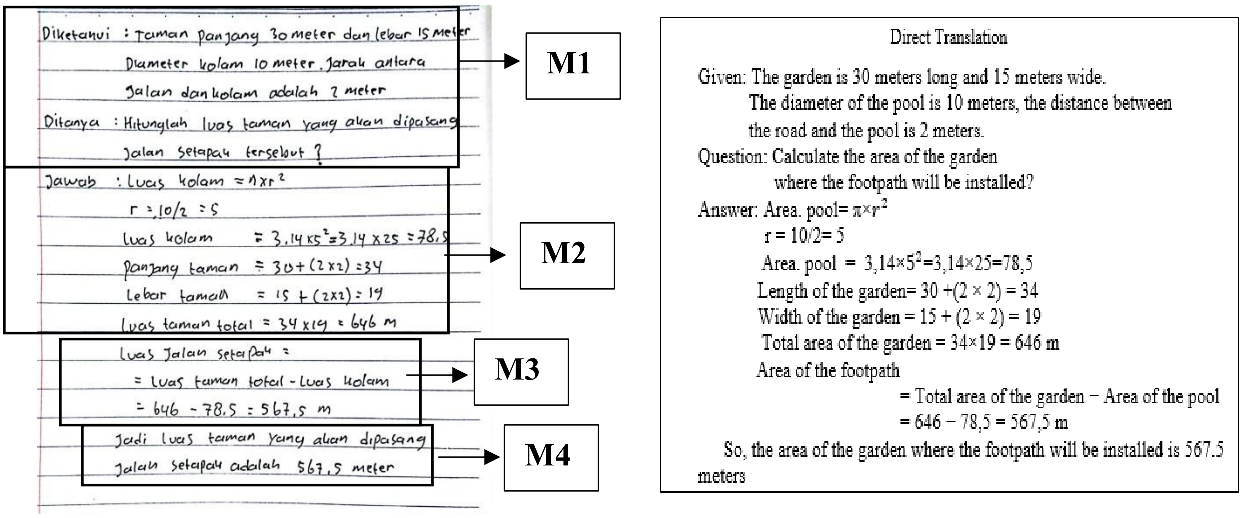


Figure 2. Answers to H-S subject questions

From Figure 2, H-S has understood the questions correctly and can carry out the problem-solving plan correctly on the questions. Overall, H-S has been able to answer the questions given. On the answer sheet, it can be seen that H-S can display what he knows and what is asked in the questions and solve the questions well. H-S's answer is supported by the following interview quotation.

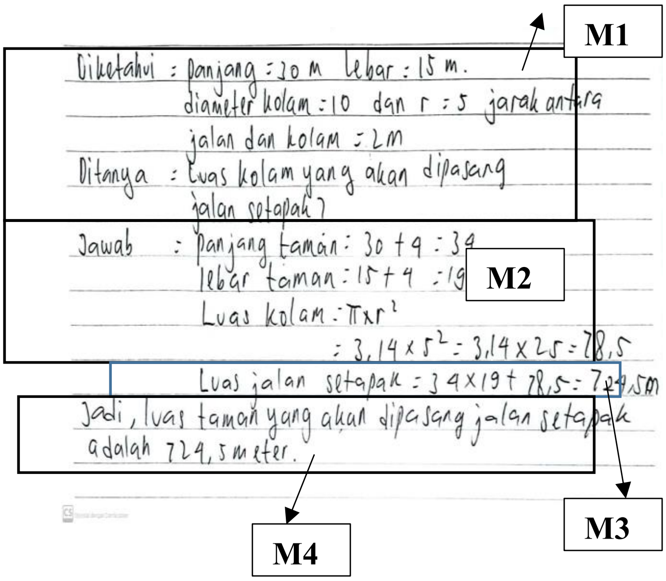
Q : "Please explain again why you wrote an answer like that?"

H-S : " I wrote down what was known and asked in the question, then I found the area of the pool using the formula $\pi \times r^2$. Then look for the radius with 10/2 =5 to get a pool area of 78.5. The length of the garden and the width of the garden were each added by 2 × 2 because there are two sides, after that, I added up the area of the garden = 34 × 19 = 646 m. "From these results, I just subtracted the area of the garden from the area of the pool to get a result of 567.5 meters."

Thus, it can be concluded that the subject can demonstrate contextual geometry abilities in all indicators M1, M2, M3, and M4 correctly. This is in line with (Irianti, 2020; Kadarisma et al., 2020) students with high abilities can identify important things in contextual problems, explore mathematical concepts in context, build understanding through progressive mathematization, and apply geometric concepts in new situations appropriately.

Students' geometry abilities are in the moderate category

The group that has the category of moderate geometry ability only achieves three indicators of contextual geometry ability. This can be seen from the results of their work which can solve problems with several errors and only meet several indicators of contextual geometry ability. The following is one of the M-S answer sheets in working on the problem.



Direct Translation

Given: Length = 30 m width = 15 m.
Pool diameter = 10 then r = 5 distance between road and pool = 2 m
Question: Calculate the area of the garden where the footpath will be installed?
Answer:
Garden length = 30 + 4 = 34
Garden width = 15 + 4 = 19
Pool area = $\pi \times r^2$
= $3{,}14 \times 5^2 = 3{,}14 \times 25 = 78{,}5$
Area of the footpath = 34 × 19 + 78,5 = 724,5 m
So, the area of the garden where the footpath will be installed is 724.5 meters.

Figure 3. Answers to M-S subject questions

From Figure 3, M-S understood the question correctly but there was an error in indicator M4. Overall, M-S has been able to work on the questions given. On the answer sheet, it can be seen that the subject can display what he knows and what is asked in the question and solve the question well even though there is an error in understanding geometry. M-S's answer is supported by the following interview excerpt.

Q : "Please explain again why you wrote an answer like that?"

M-S : "In this question, I know what information and what is asked in the question, then find the radius first with 10/2 = 5. For the length of the garden 30 + 4 = 34 and for the width of the garden 15 + 4 = 19. Next I find the area of the pool = $\pi \times r^2$ = $3{,}14 \times 5^2 = 3{,}14 \times 25 = 78{,}5$. Then the area of the footpath = 34 × 19 + 78,5 = 724,5 m."

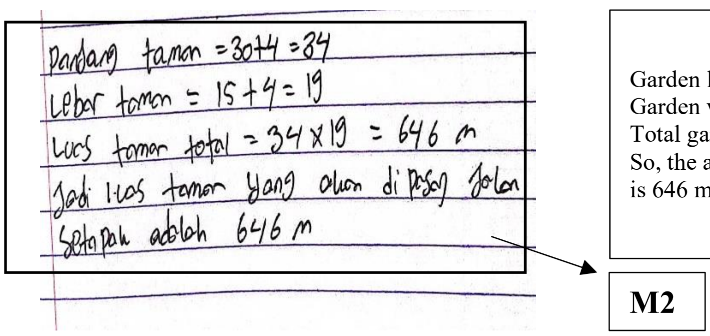
Q : "Are you sure about your answer?"

M-S : "Yes, I am, I am sure the area of the garden where the footpath will be installed is 724.5 meters."

Thus it can be concluded that subject M-S can only show contextual geometry abilities on indicators M1, M2, and M3 correctly, but on indicator M4 subject M-S experiences a misunderstanding in determining the final result. The geometry ability of students in the medium category is not better than students with geometry abilities in the high category (Rosneli et al., 2020; Trisnani & Utami, 2020).

Students' geometry abilities are in the low category

Based on the results of students' work with low mathematical problem-solving skills, L-S only meets the indicator of understanding the problem. The subject is still lacking in solving the problems from the questions given because he is not used to working on contextual problems and does not understand the concepts mastered. The following is one of L-S's answer sheets in working on the questions.



Direct Translation

Garden length = 30 + 4 = 34
Garden width = 15 + 4 = 19
Total garden area = 34×19 = 646 m
So, the area of the garden where the footpath will be installed is 646 m

Figure 4. Answers to L-S subject questions

From Figure 4, subject L-S has not been able to solve the given problem correctly. L-S's answer is supported by the following interview excerpt.

Q : “Please explain again why you wrote that answer?”

M-S : “The length of the garden is 30 + 4 = 34 and the width of the garden is 15 + 4 = 19. Then the total area of the garden = 34 × 19 = 646 m. So, the area of the garden where the footpath will be installed is 646 m.”

Q : “Why did you only calculate the total area of the garden?”

M-S : “I'm still confused about this question, sis.”

Thus, it can be concluded that subject L-S can only demonstrate contextual geometry abilities on the indicator of exploring mathematical concepts in context. Students who do not understand the meaning of the question cause errors in understanding the problem in solving contextual questions (Oktaviana, 2018). Many students have difficulty solving contextual geometry questions (Kenedi et al., 2019).

Judging from the category of student abilities, contextual geometry abilities are quite good. Students in the high, medium, and low ability categories have differences in processing skills and problem-solving abilities. At the stage of identifying important things in contextual problems, H-S can already understand contextual problems in geometry correctly. This can be seen that they can already write solutions sequentially according to the indicators of identifying important things in contextual problems, exploring mathematical concepts in context, building understanding through progressive mathematization, and applying geometric concepts in new situations correctly. The application of contextual learning to students helps students understand the material more easily (Afifah & Hartatik, 2019; Masruroh, 2022).

In the results of the M-S answers, they answered the problem solving well, although there was a misunderstanding in the indicator of applying geometric concepts in new situations. Students wrote the answer by identifying the problem, then at the re-application stage, students made mistakes. This is in line with Farida et al. (2019) which shows that some students are still lacking in re-applying because students do not fully understand the concept of geometry.

Different from the results of L-S's answers, who had difficulty in solving contextual geometry problems. Subject L-S was not yet able to identify important things in contextual problems, build understanding through progressive mathematization, and apply geometry concepts in new situations. Three indicators were not achieved by L-S because students only focused on finding the final answer so they were not used to writing answers in detail. (Efriani et al., 2019).

Conclusion

Geometry ability in contextual learning is grouped into three categories, namely high, medium, and low. In the high category, students fulfill all indicators of identifying important things in contextual problems (M1), exploring mathematical concepts in context (M2), building understanding through progressive mathematization (M3), and applying geometric concepts in new situations (M4). In the medium category, students only fulfill three indicators of identifying important things in contextual problems (M1), exploring mathematical concepts in context (M2), building understanding through progressive mathematization (M3), only the indicator of applying geometric concepts in new situations (M4) is not fulfilled. In the low category, students only fulfill one indicator of exploring mathematical concepts in context, three indicators are not fulfilled identifying important things in contextual problems (M1), building understanding through progressive mathematization (M3), and applying geometric concepts in new situations (M4).

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