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Adversity quotient of Indonesian prospective mathematics teachers in solving geometry higher-order thinking skills problems

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Abstract

Comprehending and formulating strategies for geometry problems that require higher-order thinking skills (HOTS) is crucial in enhancing mathematics education. This study implements a qualitative case study approach to comprehend how prospective mathematics teachers with varying Adversity Quotients (AQ) solve geometry Higher-Order Thinking Skill (HOTS) problems. We selected 3 participants from 167 Indonesian prospective mathematics teachers to solve the three- and two-dimensional HOTS problems and were invited to an interview session. The three participants represent three types of participants: a climber student (high AQ), a camper student (medium AQ), and a quitter student (low AQ). Our findings show that each student had different responses to deal with the obstacles they faced while solving the problem. The climber student is more adept at solving problems than the camper and quitter students. In addition to identifying specific implications, this study offers a comprehensive understanding of AQ's significant role in solving mathematical problems. This knowledge serves as a concrete foundation for guiding the future advancement of curricula, assessment methods, and instructional approaches in mathematics education, particularly in the field of geometry. This research contributes to enhancing educational practices and policies on a broader scale.

Keywords: Adversity Quotient, Geometry, HOTS Problems, Problem-Solving

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Understanding and using geometric ideas is essential for students to do well in many school and work areas. However, a lot of students need help understanding and using geometric principles. This has been shown in several studies, and the problems go beyond basic ideas and include problem-solving and reasoning in the domain. The problem that students have, especially when trying to understand geometric shapes, was pointed out by Yohanes et al. (2016). However, new research has shown that these problems are even worse. Field Sudirman et al. (2023) state that students have trouble with epistemological issues when thinking about #D geometry. For example, they find it hard to switch from 2D to 3D models, compute unit cubes, and measure the sizes of 3D shapes. In addition, Kandaga et al. (2022) also showed widespread epistemological barriers at all levels of geometric thinking, which is what van Hiele's model means. Additionally, Cesaria and Herman (2019) describe two types of problems that students face: ontogenically problems that come from not knowing or understanding the material well enough beforehand and epistemological problems that happen when the teaching materials don't match up with the student's unique needs. Therefore, teachers, especially those still learning how to teach, must do more than learn geometric concepts. They also have to devise and use creative, effective ways to help their students overcome these problems.

In mathematics education, cultivating problem-solving abilities during classroom activities holds the utmost significance (Firmansyah et al., 2022). In accordance with the stated objective of the Ministry of Education in Indonesia in the Right No. 22 2026, problem-solving holds significant importance in the Mathematics Education (NCTM, 2000). It facilitates the utilization of acquired knowledge and skills in unconventional situations (Masfingatin, 2013), thereby enriching students' educational encounters (Rumanová et al., 2020). Despite being widely recognized as necessary, previous research has identified a deficiency in the preparation provided by certain teachers in equipping students with the necessary skills to solve mathematical problems. These teachers tend to place excessive emphasis on arithmetic abilities and the application of formulas, neglecting other essential aspects of the problem-solving (Misu & Rosdiana, 2013; Purnomo et al., 2021; Sa'dijah et al., 2020; Sulistyowati, 2009; Susiswo et al., 2021).

Solving mathematical problems, which are distinguishable from routine mathematical tasks, necessitates a distinct and strategic methodology due to their non-routine characteristics procedures (Sa'dijah, 2007; Siswono, 2006; Widjajanti, 2009). Polya (1962, 1971) proposed a systematic approach to problem-solving that involves four keys steps: problem comprehension, plan formulation, plan execution, and solution evaluation. Although these stages provide a framework for problem-solving processes, the difficulties that naturally emerge require individuals to process resilience and the ability to effectively address and navigate through adversity.

Within this particular framework, the concept of Adversity Quotient (AQ) becomes a relevant and significant element, shedding light on how individuals utilize their ability to stand and confront challenges to enhance their performance (Kusumadhani et al., 2015; Stoltz, 1997; Suryaningrum et al., 2020). The concept of Adversity Quotient (AQ), as categorized by Stoltz, encompasses three distinct groups: quitters (low AQ), campers (medium AQ), and climbers (high AQ). This framework aims to describe the various ways in which individuals engage with challenges, obstacles, and adverse circumstances. There is a complex and interconnected relationship between adversity quotient (AQ) and mathematics, which has been extensively investigated in multiple studies. These studies have examined different facets of this relationship, such as the understanding of mathematfical concepts (Hidayat et al., 2019), problem-solving abilities (Hulaikah et al., 2020; Sahyar, 2017), professional competence (Widodo et al., 2022), and the use of mathematical argumentation (Hidayat et al., 2018), and the effect of learning strategies on Adversity Quotient (AQ) students (Amir et al., 2021). Nevertheless, the current body of scholarly work has yet to thoroughly examine the strategies employed by students with varying Adversity Quotient (AQ) types when confronted with higher-order thinking skill (HOTS) geometry problems, which pose intricate and multifaced difficulties.

This study seeks to address the aforementioned gap in the literature by examining the strategies employed by prospective mathematics teachers, specifically those categorized as Climbers, Campers, and Quitters, when solving higher-order thinking skills (HOTS) geometry problems. This current study aims to explore the impact of AQ on problem-solving approaches and strategies in the field of mathematics. By uncovering the intricacies of this relationship, the study seeks to offer valuable insights and considerations for the design of curricula and teaching methods that effectively address the needs of diverse students. Furthermore, the research aims to promote the holistic development of problem-solving skills, particularly in challenging circumstances.

METHODS

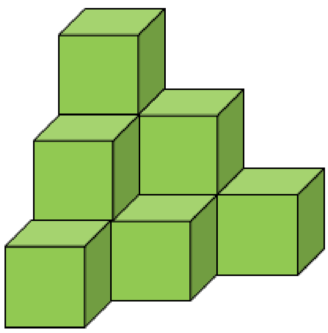
Research Design

This current study employs a qualitative case study approach to closely examine how Indonesian prospective mathematics teachers (PMTs), specifically in the second and third years of their undergraduate studies, navigate through geometry Higher-Order Thinking Skills (HOTS) problem from the lens of the Adversity Quotient (AQ). Adopting a qualitative case study is based on its ability to provide a deep, detailed, and contextualized understanding of a particular phenomenon. This is especially true when looking into the complex, multi-layered processes involved in solving mathematical problems (Creswell & Poth, 2007; Yin, 2018). Case studies, particularly in the qualitative paradigm, allow researchers to delve into the specifics of the case or cases, illuminating the complexity and uniqueness of each and enabling a richer understanding of the phenomena being explored. In the context of exploring how PMTs solve HOTS problems in geometry, the qualitative case study approach was deemed apt due to its potential to offer insights into the strategies, thought processes, and emotional and cognitive experiences of the participants within the contextual specificity of their educational and cultural environment (Creswell & Poth, 2007).

Participants and Data Collection

First, to select the participants, we invited 167 Indonesian prospective mathematics teachers in the 2nd and 3rd years to answer the Adversity Response Profile (ARP) test. We scored their AQ to classify students into AQ types using criteria developed by Stoltz (1997), which are 166≤climber≤200, 95≤camper≤134, and 0≤quitter≤59. Based on this AQ score, their willingness, and their communication skill, we chose three students as participants of this study who represented the three AQ types: 1 climber student (high AQ), one camper student (medium AQ), and one quitter student (low AQ).

A three-dimensional HOTS problem:
Maya has 10 cubes. The total volume of all 10 cubes is 10 cubic and total area of the surface of the cubes is 60 squares. If Maya arranges the cubes like the following the figure A, the area of visible surface is 36 squares.



Maya wants to arrange the ten cubes in which at least one side of a cube connects to a side of another cube such that the area of the visible surface is 32 squares. Draw the possible arrangement of the cubes!

A two-dimensional HOTS problem:
Mr. Burhan has a backyard. He wants to make playground on it by installing 120 pieces of square tiles to cover fully the backyard. Determine possible size of the length and width of the backyard!

Figure 1. The HOTS problems developed by Huljannah et al. (2018)

Then, the three participants were asked to answer individually a geometry problem-solving test consisting of two problems, i.e., three-dimensional and two-dimensional figures, developed by Huljannah et al. (2018), which has been validated by expert validators and tested by involving piloting the problem with a separate group of students and incorporating feedback to refine and clarify the problem statements before implementation in the study; see the problems in Figure 1.

After solving the problem-solving test, the participants were interviewed individually to obtain additional information and clarify their work. The participants' utterances were recorded during the interview session using the audio-video recorder. The problem-solving tests and interviews were aimed to triangulate and enrich the data (Nowell et al., 2017). We collected the participants' written answers to the problem-solving test and transcribed the students' utterances. So, the data of this study was the written answers to two- and three-dimensional HOTS problems and utterances during the interview session of three students representing the AQ types.

Data Analysis

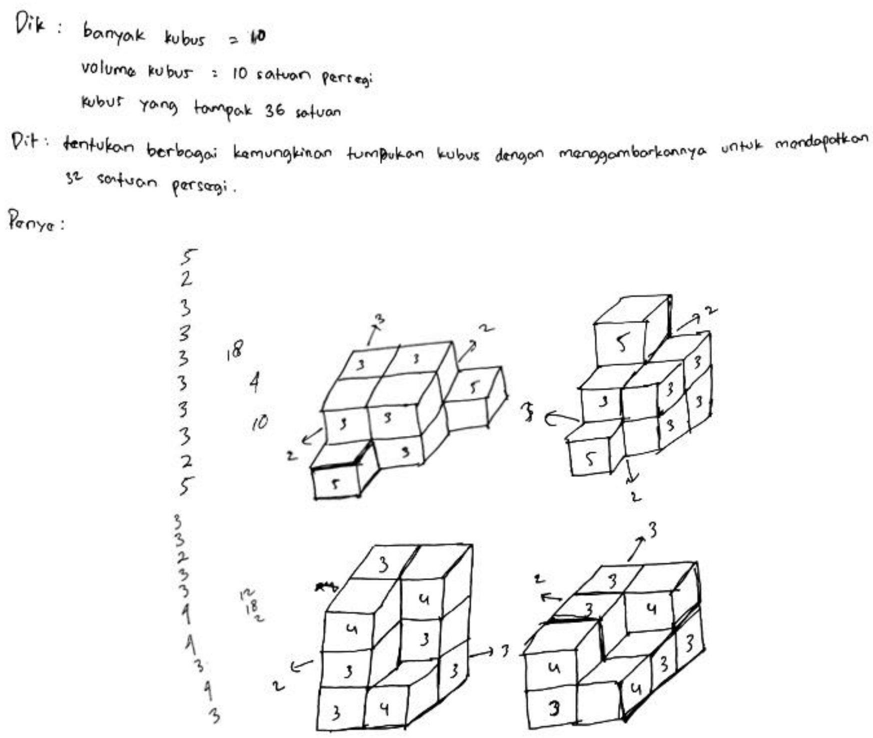
We analyzed the data through the process of reduction, data presentation, and conclusion/verification (Miles & Huberman, 1994). Mainly, we analyzed the participants' problem-solving process based on their written answers and utterances during the interview session and identified their solving steps using Polya's stages of problem-solving. The participants' utterances were transcribed. We read all transcriptions line-by-line and coded them. These codes helped us search for specific evidence to categorize, interpret, and justify the students' responses. The first author used the written answers and transcriptions to interpret and explain the conclusion as these responses represent their thinking process (i.e., triangulation sources) (Korstjens & Moser, 2018; Nowell et al., 2017). During the research team, all authors checked the interpretation and conclusion to test the credibility of findings (triangulation interpreters) by considering alternative interpretations and searching for potential disconfirming data (Korstjens & Moser, 2018; Nowell et al., 2017).

RESULTS AND DISCUSSION

In this finding, we present the three participants' answers to a geometry problem-solving test and their transcripts of the dialogues between the researcher and the participants in the interview session. We interpreted and justified how prospective mathematics teachers solve geometry problem-solving based on their responses, written answer, and transcription. We use the anonymous name to name each participant. The CB name denotes the climber subject, CP is used for the camper subject code, and QT is the code for quitter students.

Climber Student (CB)

In solving the problem, CB started first by comprehending the problem. CB could restate the three- and two-dimensional figures problem in her language. This was indicated by writing down the known and questioned items on the problem of the three-dimensional figure that can be seen in Figures 2 and 3 for the problem of the two-dimensional figure. Then, it was confirmed by the interview dialogue. The following Figure 1 presents CB's answer to solving the problem of the three-dimensional figure.



Translation
Given: the number of cubes = 10
volume of a cube = 10 square units
visible cubes = 36 units
question: determine the possible arrangement of cubes by drawing it to get 32 square units.

Figure 2. CB's answer to the problem of the three-dimensional figure

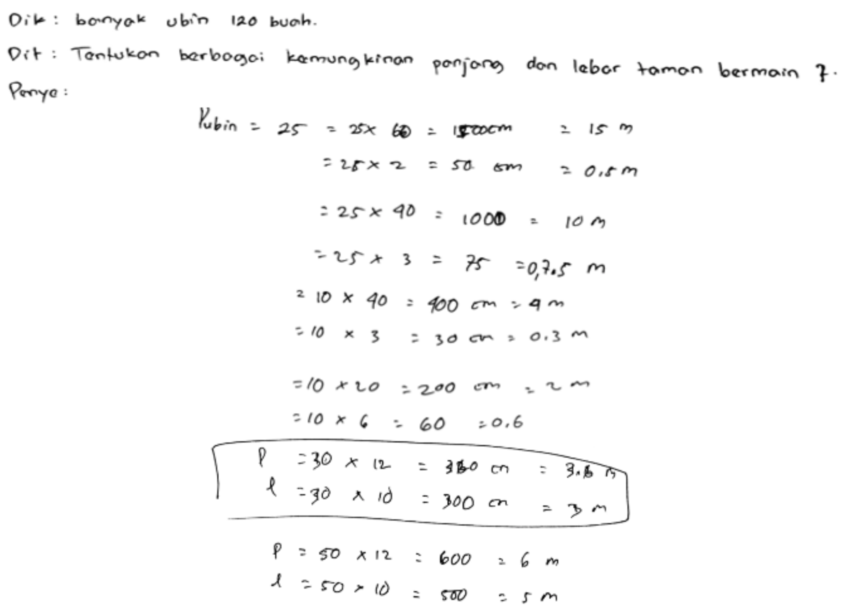
Based on Figure 2, it can be interpreted that CB could identify the given information extracted from the text and the problem that should be found in the solution. It indicates that CB understood the given problem. In the solution planning stage, CB started to construct four possible formations of cubes (i.e., one cubic unit) that might follow the condition that the surface area is 32 square units. Then, CB wrote numbers on each cube representing the number of sides that were not covered by other sides. For instance, CB wrote five on the side of a cube, meaning other cubes did not cover five sides. CB wrote a list of all of the numbers vertically and counted the total number of the visible side cubes. This indicates that CB was at the planning stage. Then, CB summed up the list of the number of visible sides to determine the area of the surface of each formation of cubes that must be 32 square units, which means, at this stage, CB executed the plan. This CB's strategy was also confirmed in the dialogue during the interview session (Transcript turn 2: CB). Some solutions written by CB indicate that SG made an excellent effort to determine all possible correct solutions using CB's plan, even though it took much time to finish it. Transcript 1 of Dialogue between the Researcher and CB shows as follows.

In the interview session, CB rechecked the answer and showed the interviewer (R) that the answer was correct (Transcript 1 turn 3-9, P and CB). It means that CB conducted all problem-solving stages by Polya in solving the three-dimensional problem.

Transcript 1		
1	R	*: What is your plan to solve this problem?*
2	*CB*	*: Counting one by one the visible sides and then sum them up. So, I get the figures like this that result 32 square units. Cube 1: 5 sides, cube 2: 2 sides, cube: 3 sides, cube 4: 3 sides, cube 5: 3 sides, cube 6: 3 sides, cube 7: 3 sides, cube 8: 3 sides, cube 9: 3 sides, and cube 10: 5 sides. If I sum it, there will be 2 sides.*
3	R	*: Beside that, is there any other answer?*
4	*CB*	*: Hmmmm…. I will try …*
5	*CB*	*: If this cube is moved here (while pointing a cube….) oo..see. I get one more.*
6	R	*: Is there any other?*
7	*CB*	*: (starting moving the cubes and recounting…) Yes miss… here I get 32 units*
8	*R*	*: Is there any other?*
9	*CB*	*: Yes... by using the previous calculation to get different figure (then drawing the cubes arrangement)*

Note: R = Researcher

Based on the following CB's answer to the two-dimensional problem, CB also involved all solving problem stages by Polya to solve the given problem. Figure 3 depicts CB's answer to solving the two-dimensional figures problem.



Translation
Given: the number of tiles is 12 pieces
Problem: determine possible sizes, length, and width, of backyard!
Solution:
P_{tiles} = 25 = $25 \times 60 = 1500\ cm = 15\ m$
…

Figure 3. CB's answer on two-dimensional figures problem

Based on Figure 3, CB understood the two-dimensional figures problem as CB could identify the given information and the problem that must be solved. After understanding the problem, CB did a problem-solving plan by doing square-size tile splitting, and then she looked for factors of 120. Then CB multiplied by the size of the tile sides that she split at the stage of executing the plan. In the final stage, CB performed the stages of rechecking and redoing. CB re-checked to see if the process was appropriate, believed that all questions had been answered, believed that the correct answer was given, and looked to see if there were other ways to get the correct answer.

In Figure 3, it can also be seen that CB had many correct answers, indicated by the many possibilities of the length and width of the backyard she wrote. In addition, there were various ways used by CB in answering this problem. Initially, she assumed the size of 25cm × 25cm tiles, and then from the size, she obtained two different lengths and widths (Transcript 2 turn 2 & 3). Next, CB used a 10 cm × 10 cm tile size and got one length and width only because she thought the tile size was too small (Transcript 2 turn 5). Then, since she had not given up, CB tried to split the size of another tile. She assumed the size of the tiles to be 30 cm × 30 cm and 50 cm × 50cm, so she obtained two different lengths and widths of the backyard. Here's what CB's said about it.

Transcript 2		
1	*R*	*: What do you plan to solve the problem?*
2	*CB*	*: Hmm…. It is a square tile, so the length and the width are the same. For example, I take the size of the tile is 25 cm x 25 cm then I determine the factors of 120, that is 60 x 2 and I multiply it to the tile's size. So, I get 60 x 25 cm = 1500cm and 2 x 25 cm = 50 cm. Then, there is 40 x 3, so the length is 40 x 25 cm = 1000cm and 3 x 25cm=75 cm*
3	*CB*	*: I take an example of the tile's size is 25 cm x 25 cm, then I determine the factors of 120 that is 60 x 2 and I multiply it to the tile's size. So, I get 60 x 25 cm = 1500cm and 2 x 25cm = 50 cm =. Then there is 40 x 3, so the length is 40 x 25cm = 1000cm and 3 x 25 cm = 7 cm.*
4	*R*	*: is there any other way?*
5	*CB*	*: Again, for example the size of tile is 10 cm x 10 cm then multiply it to 40 x 3, so the length is 40 x 10 cm = 400 cm and x 10cm = 30cm. But it's too small Sis.*
6	*R*	*: if it is so, Is there any other?*
7	*CB*	*: For example, I take the tile's size is 30cm x 30 cm then I multiply it to the factors of 120 that is 12 x 10, so the length is 12 x 30cm = and 360 cm and 10 x 30cm = 300 cm.*
8	*R*	*: Beside that, is there any other?*
9	*CB*	*: For example, the tile's size is 50cm x 50 cm then I multiply it to the factor of 120 that is 12 x 10, so the length is 12 x 50 cm = 600cm and 10 x 50 cm = 500 cm*

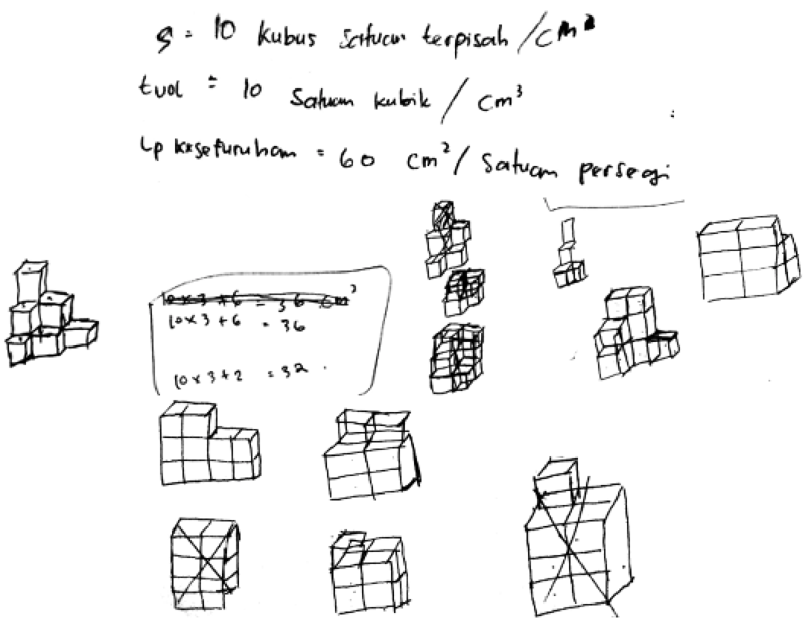
In solving the three and two-dimensional problems, the climber student (CB) started to solve the problem by identifying the given information and the problem. The Climber student restated problems using their language, which indicated that she understood the problem. This result is in line with the study conducted by Sari et al. (2016); in understanding the problem, climber subjects present information about the problem in their language. In addition, in line with the research results conducted by Yani et al. (2016), the climber subject could reveal known and asked information from the problem given correctly and fluently. After understanding the problems, the climber student executed her problem-solving plan by applying the correct information/data to solve the problem. In line with these findings, a study conducted by Yani et al. (2016) revealed that the climber subject could confidently name and decide the chosen strategy and select the data to solve the problem. The climber type of AQ is more dominant than the camper and quitter (Fauziah et al., 2020).

The climber student solved the problem of three-dimensional figures by calculating the cube's sides one by one and imagining the arrangement of the cubes she made. In implementing the plan, the climber student calculated correctly by adding the visible sides to get the surface area of 32 square units. The climber student determined other possible solutions by moving the cube's position, following the criteria, and calculating its surface area repeatedly until it got the correct answer. In the two-dimensional problem, the climber student planned to solve the problem by first determining the tile's size and the factors of 120. Then climber student multiplied the size of the tile with the factor of 120 that she got. These findings follow a Field Sari et al. (2016) study. They stated that the climber subjects modified their scheme by designing a more effective plan for the solution and implementation. The subject also developed the plan through trial and error. Ratna et al. (2020) unpacked that climber students can analyze the situation in depth and determine systematic and specific steps. The findings also show that in solving the problem of three-dimensional figures and two-dimensional figures, climber students conducted the last step in the problem-solving stage: looking back at the answer by rechecking the solutions. Besides that, she also believed the truth of the answer she had made. This result is supported by Isnaen and Budiarto's (2018) research that the climber subjects performed the stage of looking back in solving the given mathematical problems. The type of climber AQ has divergent thinking skills are better than others (Murwaningsih & Fauziah, 2022).

Regarding solving the three-dimensional and two-dimensional figures, the climber student spent much time as the climber students tried to get complete answers to the given problem by executing her plan. Related to this, Stoltz (1997) suggested features owned by climbers that welcomed the challenge well, had a target, and achieved it; they could strive persistently and not give up easily. Then, Bennu (2012) said that if those climber types found mathematical problems challenging, they would try their best and not give up until they solved the problems. This result also follows Fauziyah's (2013) research, which stated that the climber subject had an attitude that was not easily discouraged when experiencing difficulty or making mistakes.

Camper Student (CP)

The following Figure 4 presents the CP's answer to the three-dimensional problem. It can be seen that, firstly, CP wrote, "S= 10 cubes/ cm^3, $t_{vol} = 10cm^3$, $surface\ area\ total = 60\ cm^2$". It shows that CP started to understand the problem by identifying and writing the given information using CP's own words/symbols. Even though CP did not explicitly write the problem to be solved, CP's figures of formations of cubes indicate that CP knew the problem and that CP was asked to find the combination of cube formation to follow the criteria. This interpretation is also justified by the transcript of the dialogue between CP and the researcher during the interview session (Transcript 3 turns 2 and 4, P and CP).



Translation
S = 10 single cubes/cm^3
t_{volume} = 10 cubic unit/cm^3
$L_{surfacearea\ total}$ = 60 cm^2/square unit
…

Figure 4. CP's answer in three-dimensional figures problem

In Figure 4, it also can be seen that CP wrote some calculations "$10 \times 3 + 6 = 36$" and "$10 \times 3 + 2 = 32$". At this stage, CP started to find the solution to the problem through calculation and then found the formation of cubes following the calculation. It is confirmed by the interview excerpt (Transcript 3 turn 6, CP). Based on CP's explanation (Transcript 3 turn 6, CP), firstly, CP developed and applied a formula "the number of cubes $\times$ the height of pile $+$ the number of the visible surface of cubes" to find the formation of the cubes. For instance, the CP's mathematical statement $10 \times 3 + 6 = 36$ means if one wants to get cube formation where the surface area is 36, the height of the pile should be three cubes, and there are only six visible cubes (Transcript 3 turn 8, CP). In fact, CP could not find the right arrangement of the cube by following these two calculations/formulas. It might be caused by CP missing some conditions/criteria or misinterpreting the calculation formula. This evidence shows that, in solving the problem, CP made a plan/formula (i.e., devising a plan) and applied the formula through the arrangement process (i.e., carrying out the plan).

Transcript 3		
1	R	*: Do you understand this three-dimensional figure problem?*
2	*CP*	*: I understand when I look at the figures*
3	R	*: What is known and asked in this problem?*
4	*CP*	*: it is known that the total volume of the cube is 10 cube units, then the surface area is 60 square units. Then, it is asked to arrange 10 cubes tightly so it will get surface area of 32 square units.*

5	R	*: then, what is your plan to solve the problem?*
6	CP	*: I plan to use a formula. In the formula, the numbers of cubes are 10 the it is multiplied to the height of the pile, then it is added to the visible cubes.*
7	R	*: Can you explain it more?*
8	CP	*: I mean…in the item test it is known that the surface area is 36 square units which is gained from 10 known cubes multiplied to 3 because the cubes piles become 30. Then there are 6 visible cubes so that 30 added by 6 are equal to 36. So, I use that way to draw the cubes arrangement with the surface area 32 square units. So, I will find the cubes pile with 3 piles and only two visible cubes.*
9	R	*: Oo… I see. Do you get the picture?*
10	CP	*: I have tried many figures, but I cannot find cube piles with 2 visible cubes.*
11	R	*: Is there any other way? Why don't you try to sum up the sides?*
12	CP	*: No… what I understand is like this.*
13	R	*: Are you sure there is no other concept?*
14	CP	*: Yes*

At the end, after making some cube arrangement by following the formula, CP realized that CP could not find the cube arrangement following CP's formula, (Transcript 3 turn 10, CP). Even CP knew that the plan/formula failed to solve the problem, CP did not find other plans to find the solution, CP might know only one plan to find the solution and was quite confident with the plan will work, (Transcript 3 turn 12 & 14, CP). Regarding the Polya' stage, at this step, CP conducted the last stage of Polya's stage of problem solving namely looking back. Here is the interview excerpt.

In contrast to the problem of three-dimensional figures, CP did not have any problems in solving the problem of two-dimensional figures. Figure 5 presents CP's answer to the problem of two-dimensional figures.

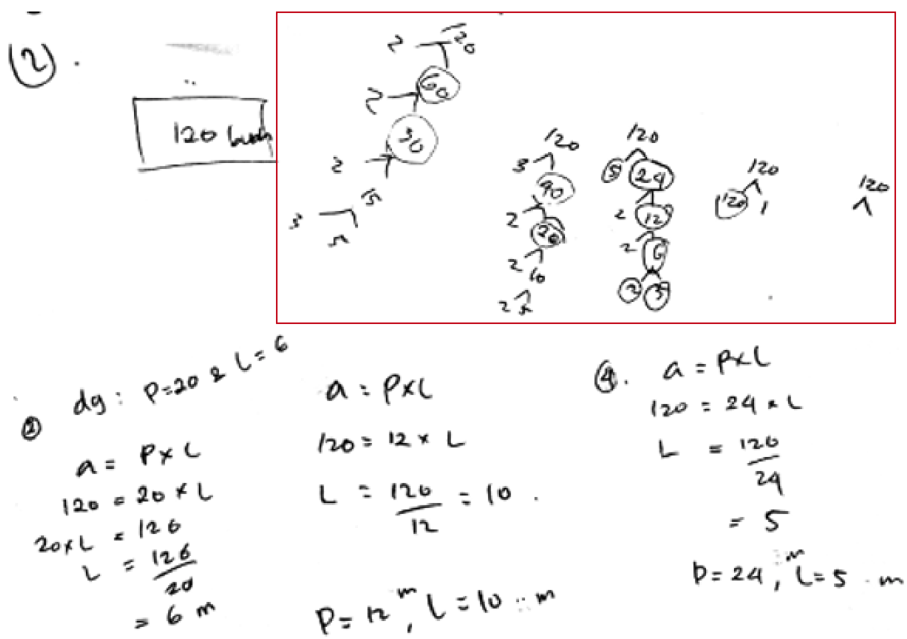


Figure 5. CP's answer on the two-dimensional problem

In Figure 5, it can be seen that CP drew a rectangle and wrote "120 pieces" in the rectangle. It can be interpreted that CP assumed that the shape of the backyard is rectangle which 120 pieces of tiles will cover. It shows that CP could identify the given information using CP's own words and figures. Even though, CP did not write explicitly the problem to be solved, CP's explanation (Transcript 4 turn 2, CP) and written answer about the given information indicate that SC understood the problem. Then, SC determined the factor of 120, i.e., 6 and 20, 12 and 10, 24 and 5, see red rectangle in Figure 4 and Transcript 4 line 2. CP, then wrote a formula for the area of the rectangle "$a = pxl$" (i.e., a is area, p is length, and l is the width). At this stage, CP planned to use concepts of factorization of 120 and the area of the rectangle to find the solution (i.e., Planning stage). Then, CP executed the plan by multiplying the width of the backyard by the factors of the 120 obtained. Here, CP assumed that the tile size is 1 square meter (Transcript 4 turn 4, CP). So, CP found three combinations/pairs of length and width of the backyard; 6m and 20m; 12m and 10m; 24m and 5m. When the researcher, in the interview, asked about other possible answers, CP said "No," meaning that there are other possible backyard sizes. Some reasons might cause it firstly, CP did not realize there are various sizes of square tiles in real life (30 cm x 30 cm, 1m x 1m, etc.), and CP was used to work with a meter as a unit measurement when CP learned the area of geometry objects. Based on the steps used by CP in solving the problem, it can be concluded that CP performed all steps of Polya's problem-solving, which are understanding the problem, planning the solution, executing the plan, and doing the stages of checking back.

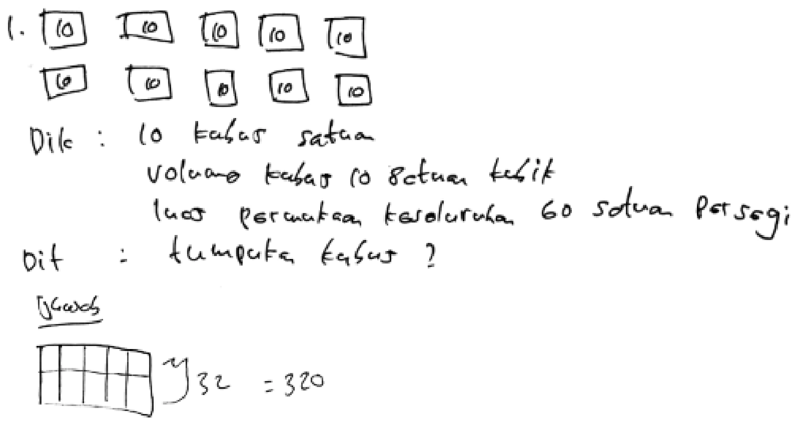
Transcript 4		
1	R	*: What is your plan to solve the problem?*
2	*CP*	*: In my mind, a playground is in the form of rectangle, so I try to find pairs of numbers such that the multiplication of the pair is equal to 120. Then I use the rectangle formula in which the area is 120 and the length is 2. So, I get the width is 60. Then there is a length of a playground 20, so the width is 2*
3	R	*: What is the size of the tile?*
4	*CP*	*: 1m x 1m*
5	R	*: Is there any other length and width?*
6	*CP*	*: Hmmmm…. Yup. The length of the playground is 12 so that the width is 10, then there is other size in which the playground length is 10 so the width is 12*
7	*R*	*: is there any other?*
8	*CP*	*: Yes… if the length is 24 so the width is 12.*
9	*R*	*: others?*
10	*CP*	*: that's all*
11	*R*	*: how about the measurement units?*
12	*CP*	*: Meter (while writing the units)*
13	*R*	*: beside your way here, is there any other way?*
14	*CP*	*: No*

Camper students could understand both problems in solving three-dimensional and two-dimensional figures. However, particularly in the three-dimensional problem, she made an incorrect formula as a plan to solve the problem. However, she did not realize the mistakes in the executing plan stage and kept using the formula. Consequently, the camper student produced an arrangement of cubes that did not follow the solution's criteria. Then, the Camper student tried other possible cube configurations using her formula, but none followed the requirements. In the end, even though she realized that all the cube arrangements she described were incorrect. She did not want to change her plan to find the correct solution. This evidence follows the characteristics of camper type according to Stoltz (1997), i.e., individuals who did not want to take risks too significant and often felt satisfied with self-sufficiency and did not want to develop themselves. They were reluctant to make a maximum effort. Thus, they let the opportunities go forward even though the right option is in front of them. Related to this, Bennu (2012) said that in learning Mathematics, someone in the camper type does not want to try maximally; they try as they can when facing a problem.

In contrast, in solving the two-dimensional problem, camper students could choose a plan and execute it using their previous knowledge fluently and correctly. This fact is in line with Sari et al. (2016) in their research that the camper subject could plan problem-solving by linking information based on prior knowledge and using mathematical symbols to execute the plan. The finding also shows that the camper student conducted the final step in the problem-solving stage of reworking. The Climber student rechecked their answers and was convinced of the truth of the answers she produced. This finding aligns with the research results of Isnaen and Budiarto (2018); Yani et al. (2016) showed that the camper subject looked back and felt confident in the answer. Then Stoltz (1997) added that this camper type showed some enthusiasm and effort.

Quitter Student (QT)

The Figure 6 presents the QT's written answer of three-dimensional problem. It can be seen from the Figure 6 that QT drew 10 rectangles an wrote 10 on each rectangle. QT wrote given information (read "Dik", translation: "given/informed") that are "10 cubes cubic, volume of a cube is 10 cubic, area of total surface is 60 square measurement unit". QT also explicitly wrote the problem to be solved "configuration of cubes?". Based on this written information, it seems QT understood the problem.



Translation
Given: 10 cubic unit
volume of the cubes is 10 cubic unit
the area of the surface is 60 square unit
Problem: configuration of cubes?
Solution:

Figure 6. QT's answer on the three-dimensional figures problem

However, QT's utterances during the interview session (Transcript 5 turn 1-18, R and QT) indicate that QT might understand the problem nor misinterpret/misunderstand the problem. At this stage, QT tried to understand the problem (i.e., the first stage of Polya) by presenting the given information based on QT's interpretation, even though QT made misinterpreted/ misunderstood the problem. It indicates that QT did not understand the problem.

Then, QT drew a rectangle consisting of 10 squares on it and wrote "32 = 320" next to the rectangle. Here, QT multiplied 32 (i.e., the total surface area) by the number of squares in the rectangle (10), and QT got 320. It can be interpreted that QT just multiplied the numbers mentioned in the text. The CP's utterance confirms this during the interview session (Transcript 5 turn 12). In solving the problem, the quitter student did Polya's stages. In the planning stage and executing the plan, QT used a "gambling" plan to solve the problem by multiplying all the numbers mentioned in the text. It might be caused QT did not understand the problem, which was confirmed by QT's written answer and utterance during the interview (Transcript 5 turn 13-18, R and QT).

Transcript 5		
1	R	*: What is known and asked in the given problem?*
2	*QT*	*: Maya has 10 separate cubes unit and the total surface area is 60 square units. It is asked about the possibilities of cube arrangements by drawing it.*
3	R	*: What is your plan to solve it?*
4	*QT*	*: These cubes. Firstly, the 10 separate cubes will be united to get 32 square units.*
5	R	*: Then, what is the answer?*
6	*QT*	*: I drew like this*
7	*R*	*: what 10 in these boxes?*
8	*QT*	*: it is the volume of each box*
9	*R*	*: then, what is the meaning of 32 here?*
10	*QT*	*: it is the surface area square units to be found*
11	*R*	*: then, why is it 320?*
12	*QT*	*: I multiplied 2 to 10*
13	*R*	*: Why do you multiply it?*
14	*QT*	*: ….. (keep silent)*
15	*R*	*: How is your understanding about the problem?*
16	*QT*	*: I understood that the cubes the separate cubes are going to be united.*
17	*R*	*: Is there any other understanding or other answer?*
18	*QT*	*: I only understand it so that is all my answer.*

QT's written answer and the interview indicate that QT did not understand the whole problem because she made misinterpretation of the problem. Then, in the solving problem process, QT multiplied all the numbers stated in the text without knowing what exactly the problem is and what the numbers mean. It can be interpreted that QT's problem-solving ability is weak. QT's utterance also confirmed this claim (Transcript 6 turn 4, QT).

Transcript 6		
1	R	*: Are you sure that your answer is correct?*
2	*QT*	*: Not really*
3	R	*: Why?*
4	*QT*	*: I do not really understand about Mathematics problem*

In answering the two-dimensional problem, QT wrote the given information "There are 120 square tiles to be installed" and problem to be solved "$p \times l$?", as shown in Figure 7. In the interview session, when QT was asked to explain what the given information and problem, QT said "*It is known that there are 120 tiles. It is asked about the length and the width of the playground.*" These QT's written answer and explanation indicate that QT understood the problem. Then, QT wrote "$p \times l = 120$". It can be interpreted that QT used formula of rectangle area as a plan to solve the problem. Then, QT executed the plan by substituting p and l with numbers 2 and 60. Here, QT thought a pair of numbers in which the multiplication of both numbers equals 120 (i.e., factors of 120), see Transcript 7 line 4 by QT. QT also made a plan correctly. Firstly, QT determined the factors of 120 that is 60 and 2. In this case, QT only had one solution of the problem that the measure of the backyard is $2\ meter \times 60\ meter$, (transcript 7 turn 5-12, QT and R). here, QT assumed that the size of the tile is $1\ meter\ \times 1\ meter$. The explanations of why QT had one solution are that (1) QT did not know or remembered that there are some pairs of factors of 120 and (2) QT did not know/remembered that there are some size of square tiles in reality.

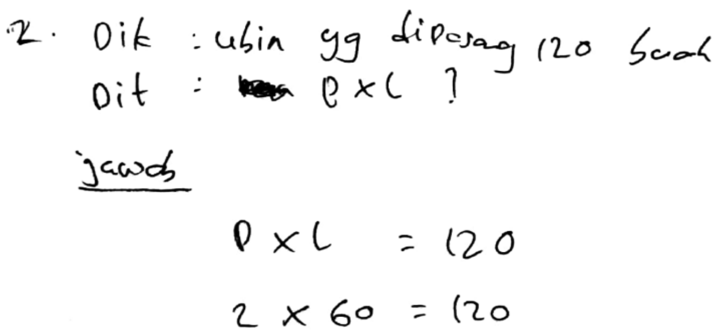


Figure 7. QT's answer on the two-dimensional figures

Addressing problem-solving strategies employed by the quitter student in both two- and three-dimensional problems reveals that the initial steps involve the identification of given information and posed questions. Consistenly, the quitter student demonstrated an understanding of both problems, aligning with Yani et al. (2016) which asserted the ability of quitter student to distinguish known variables and identify the questions within given problems. Within the domain of two-dimensional figure problems, she adeptly formulated a solution by employing a precise plan or formula. However, her ability to derive further solutions was hindered by an inadequate comprehension of the factors of 120 and the potential dimensions of square tiles. When faced with the problem involving a three-dimensional figure, the quitter student acknowledged that the arrangement of ten separate cubes was intended to produce a surface area of 32 square units. However, she encountered difficulties in determining the subsequent steps for problem-solving and instead relied on rudimentary, randomized calculations, resulting in no correct answers. Suhandoyo and Wijayanti (2016) resonate with these findings, observing the quitter student, mired in unfamiliarity with applicable formulas or strategies, ultimately find themselves unable to discern final solution. In a study conducted by Suryaningrum et al. (2020), a notable distinction was observed between camper student and quitter student in terms of their problem-solving strategies. Camper students displayed four identifiable characteristics, as outlined in the study. These characteristics were found to be associated with a preference for self-sufficiency and a tendency to avoid significant risks, which contrasted with the strategies adopted by quitter students (Stoltz, 1997). The potential divergence in problem-solving strategies between camper and quitter students can be attributed to intrinsic factors such as intuition and clarity. According to Ďuriš et al. (2019), these factors are essential to geometric thinking and methodology, influencing students' tendency to make logical inaccuracies and mistakes. Consequently, these factors contribute to the nuanced observed among different types of students in the field of mathematics education.

Transcript 7		
1	R	*: What is known and asked in this item test?*
2	*QT*	*: It is known that there are 120 tiles. It is asked about the length and the width of the playground.*
3	R	*: What is your plan to answer this test?*
4	*QT*	*: Because the tiles are 120 so I will find what times what is equal to 120 and I get 2 x 60. 2 is the length and 60 is the width.*
5	R	*: what are the measurement units of the length and the width?*
6	*QT*	*: Meter*
7	*R*	*: What tile size that you use?*
8	*QT*	*: Oh.. I see 1 meter x 1 meter*
9	*R*	*: Is there any other answer beside that?*
10	*QT*	*: No*
11	*R*	*: May you have other plans?*
12	*QT*	*: No*

The investigation into the problem-solving experiences of students categorized as Climber, Camper, and Quitter reveals noteworthy pedagogical ramifications. Educators must design learning experiences that accommodate the unique needs and challenges of each typification/category. Enriched and multi-layered problems that present challenges to climbers have the potential tp facilitate the development of their strategic and resilient problem-solving abilities, thereby promoting cognitive and effective growth. In order to facilitate the growth and development of campers, it is imperative to incorporate mechanism that gradually encourage them to engage in risk-taking behavior. Similarly, for individuals who tend to quite easily, it is crucial to provide them with structured and supported learning experiences that effectively assist them in navigating the process of problem formulating and solution strategies. Educators have the potential to create a dynamic learning environment in which problem-solving strategies are thoroughly analyzed, assessed, and improved upon through collaborative efforts. This approach allows students to observe and actively participate in diverse problem-solving methods. Moreover, establishing a safe and supportive atmosphere where mistakes are viewed as chances for educational advancement could be particularly beneficial for individuals who are hesitant to take or give up easily. This approach would motivate them to step outside their comfort zones and actively participate in problem-solving activities.

The current study aims to shed light on the intricate problem-solving paths that are specific to different student types. By doing so, it provides educators with a perspective that can help them comprehend and address the diverse strategies and difficulties that students encounter when solving mathematical problems. The study emphasizes the importance of employing a variety of instructional strategies to effectively support each student type, as it examines the cognitive and affective strategies utilized by the Climber, Camper, and Quitter types. Furthermore, this prompts additional investigation into the creation of instructional models and interventions tailored to the distinct requirements, capabilities, and difficulties of individual student types across diverse mathematical disciplines. This research aims to connect theoretical foundations of problem-solving strategies with real-life classroom situations. By doing so, it seeks to narrow the divide between theoretical concepts and instructional methods. The findings of this study provide practical guidance for educators to create inclusive and simulating learning environments that cater to a variety of student profiles.

CONCLUSION

This study aimed to explore the various response employed by students–as classified as Climber, Camper, and Quitter–when confronted with High-Order Thinking Skills (HOTS) geometry problems. The findings of this research shed light on the diverse responses utilized by students in navigating the complex landscape of problem-solving dynamics. The spectrum of observation encompassed the diligent and detail-oriented approach of a Climber student, as well as the minimalist and risk-averse strategies employed by a Quitter student. The pivot findings revolve around the personalized approaches and cognitive resilience exhibited by different typologies of students during problem-solving activities. Climber students demonstrated a heightened resilience and a comprehensive, albeit time-consuming, approach towards problem-solving, substantiating a robust intrinsic motivation and strategic methodology. Camper students exemplified a content and moderate risk-averse strategy, illustrating a comfort within their extant knowledge perimeter and hesitancy toward expansive developmental strides. In contrast, Quitter students exhibited a glaring propensity towards the least resistive path, embodying a "gambling" approach that avoided complexity and sought straightforward solutions.

However, our findings might be limited to the characteristics of our participants. In this study, we selected the three participants based on their ARP test, willingness, and communication skills. The three participants are female. Our findings and conclusions might be a relationship between gender issues. Acknowledging the homogeneous gender composition among the participants involved in the study naturally leads to a thoughtful consideration of the potential impact of gender on problem-solving abilities and the ability to handle challenges. Potential future research directions could investigate the interplay between gender and AQ, potentially revealing subtle discrepancies or confirming the insignificance of gender within this particular domain.

This study offers some educational suggestions and recommendations. Firstly, it is advisable to conduct an ARP test to classify them at the beginning of teaching. So, the educator can choose the correct approach to support their learning. This test result is also helpful for the students because they know their weaknesses and anticipate obstacles they will face, particularly in mathematical problem-solving. Our findings provide some considerations for the school curriculum developers to design the curriculum that supports all these three types of students.

The present study was conducted with rigorous commitment to employing trustworthy methodological procedures, which involved thorough triangulation the analysis of written answers and interview dialogues. However, this study faces certain limitations, primarily the lack of an external interpreter and the restricted demographic consisting of only female participants. These limitations may inadvertently introduce a gender bias into the findings. The interpretations were thoroughly validated by the research team through careful examination of alternate possibilities and potential conflicting evidence. Future research endeavors may involve the inclusion of diverse participants, spanning various demographic background. These studies could focus on examining the impact of specifically designed teaching interventions on the development of problem-solving skills among students categorized as Camper and Quitter. This research would particularly emphasize the students' ability to tackle complex three-dimensional problem.

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Declarations

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