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PISA Problem-Solving of Students' Mathematical Literacy in Adversity Quotient Perspective

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ABSTRACT

This descriptive qualitative study selected three high school students to describe students' mathematical literacy skills in solving PISA model problems based on adversity quotient (AQ). Three subjects from different AQs were involved in this study based on the results of completing the Adversity Response Profile (ARP) questionnaire and good oral communication skills based on the advice of mathematics teachers. Students' AQ was collected through ARP questionnaire instrument, mathematical literacy skills were collected through providing PISA questions and interview guidelines. Furthermore, the data were analyzed based on the stages of reduction, presentation, and conclusion. The results of completing the ARP questionnaire obtained three subjects with AQ climber, camper, and quitter supported by good communication skills. The results of this study and through triangulation of techniques showed that subjects with AQ climber and camper satisfied five indicators of mathematical literacy skills, including communication, mathematization, reasoning and argumentation, using mathematical tools, and designing solution strategies. Meanwhile, AQ quitter subjects were only able to satisfy four indicators of mathematical literacy indicators, which are mathematization, representation, reasoning and argumentation, use of mathematical tools, and design of solution strategies. The findings of this study are that quitter subjects are unable to satisfy communication indicators while climber and camper subjects are able to satisfy communication indicators. In addition, quitter subjects were also unable to use symbolic, technical, formal, language and operation forms in solving PISA problems, while climber and camper subjects were able to satisfy these indicators.
Keywords**:** *camper, climber, mathematical literacy, PISA, quitter, skills.*

Kemampuan Literasi Matematis Peserta Didik Menyelesaikan Soal Model PISA Berdasarkan Adversity Quotient

ABSTRAK

Penelitian deskriptif kualitatif ini terpilih tiga siswa SMA untuk mendeskripsikan kemampuan literasi matematis siswa dalam menyelesaikan soal model PISA berdasarkan adversity quotient (AQ). Tiga orang subjek dengan AQ yang berbeda terlibat dalam penelitian ini didasarkan hasil pengisian angket *Adversity Response Profile* (ARP) dan kemampuan komunikasi lisan yang baik didasarkan masukan guru matematika. AQ siswa

dikumpulkan melalui instrumen angket ARP, kemampuan literasi matematis dikumpulkan melalui pemberian soal PISA dan pedoman wawancara. Selanjutnya, data dianalisis berdasarkan tahapan reduksi, penyajian, dan menyimpulkan. Hasil pengisian angket ARP diperoleh tiga subjek dengan AQ climber, camper, dan quitter yang didukung kemampuan komunikasi yang baik. Hasil penelitian ini dan melalui triangulasi teknik menunjukkan subjek dengan AQ climber dan camper memenuhi lima indikator kemampuan literasi matematis, yaitu melakukan komunikasi, matematisasi, penalaran dan argumentasi, penggunaan alat matematika, dan perancangan strategi pemecahan. Sedangkan, subjek AQ quitter hanya mampu memenuhi empat indikator indikator kemampuan literasi matematis, yaitu matematisasi, representasi, penalaran dan argumentasi, penggunaan alat matematika, serta perancangan strategi pemecahan. Temuan hasil penelitian ini yaitu subjek quitter tidak mampu memenuhi indikator komunikasi sedangkan subjek climber dan camper mampu memenuhi indikator komunikasi. Selain itu, subjek quitter juga tidak mampu menggunakan bentuk simbol, teknik, formal, bahasa dan pengoperasian dalam memecahkan soal PISA, sedangkan subjek climber dan camper mampu memenuhi indikator tersebut.
Kata Kunci**:** *camper, climber, kemampuan, literasi matematis, PISA, quitter.*

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1. Introduction

Now a days, education in Indonesia in the 21st century and the challenges it presents are very complex. Preparing qualified learners who are competent and literacy skills are no exception to this challenge. Literacy skills are content-specific and include language, mathematics, science, digital, health, financial, cultural and media literacy (Kim et al., 2019; OECD, 2017, 2023). One of the literacy skills taught in schools through mathematics is known as mathematical literacy.

Mathematical literacy contributes to understanding mathematics in real life through real situations, problem solving, applying mathematical concepts in different contexts, and constructing relevant mathematical statements. For this reason, it is important for students to have mathematical literacy skills that are learned at school. Mathematical literacy is the ability of students to apply, understand, and think critically according to the context of mathematics which includes computation, statistics and geometry (Farida et al., 2021; Nilasari & Anggreini, 2019; OECD, 2017).

Mathematical literacy is a very essential foundation for learners as mathematics is a universal language in many fields including science, technology and economics (Delello, 2014; Fernanda, et al., 2024; Güler & Arslan, 2019; Pan et al., 2021). Through mathematical literacy, learners are practicing to acquire problem-solving skills, perform logical and in-depth analysis. In addition, this ability can help learners in understanding data because the development of the digital era requires the ability to understand data in various fields. Thus, mathematical literacy is important for every learner to have in order to help them prepare for future careers and in the life to come (Kholifasari et al., 2020; Nilasari & Anggreini, 2019).

A successful program to evaluate students' mathematical literacy skills is PISA. PISA is designed to evaluate learners' performance in mathematical literacy and each country can

determine its position in comparison to other countries (Ovan & Nugroho, 2017; Khusnah, et al., 2022). PISA focuses on four contexts, i.e. personal, work, general, and science (Domu et al., 2023; OECD, 2017, 2019; Riyanto et al., 2019). This is the basis of mathematical literacy refers to a person's ability to use, control, and communicate mathematical concepts in everyday life.

Mathematical literacy skills can assist a person to develop a better Adversity Quotient (AQ). AQ refers to a person's ability to address challenges and difficulties in life, and to learn from these experiences (Stoltz, 2000; Yunus, 2020). In solving math problems, learners must address challenges and difficulties that can help them develop AQ skills. Mathematical literacy skills can also help a person develop confidence and resilience while faced with problems involving mathematics (Mawardhiyah & Manoy, 2018; Riyanto et al., 2019).

The types of AQ as climber (high), camper (medium), and quitter (low) (Stoltz, 2000). Climber is a type of learner who never gives up and is always positive in facing the problems they face. Camper is a learner who is unable to use their full ability because they feel they cannot do it without any effort. Meanwhile, quitters are learners who give up easily in effort, especially when confronting problems.

Studies conducted on mathematical literacy involving AQ by various researchers including (Chasanah et al., 2020; Dewantara, 2018; Sonia & Prayitno, 2023; Utomo et al., 2020), and others. The study by Utomo discusses mathematical literacy skills in terms of cognitive learning styles (Utomo et al., 2020). The results of this study obtained the results of students with field independent and field dependent cognitive styles achieved the same ability level indicators, that is, at ability levels 1, 2, and 5. Field independent students are superior in representation and spatial reasoning, while field dependent students are superior in interpreting.

Dewantara (2018) had a development study to produce a series of valid and practical PISA model math questions. The results of this study produced 10 items of PISA model questions that have the potential to improve students' mathematical literacy skills through three mathematical processes. This question was then given to students and the results obtained for the interpreting category and the average student achievement reached 39.63%. The applying and formulating categories of the three processes were 40.74% and 52.55% respectively

Sonia & Prayitno (2023) reviewed the mathematical literacy skills of ninth grade students based on visual, auditorial, and kinesthetic learning styles. Visual subjects met all aspects of mathematical literacy skills compared to auditorial and kinesthetic subjects. Auditorial and kinesthetic subjects only completed the aspects of mathematical literacy skills, i.e. employing and interpreting. This shows that visual subjects have good mathematical literacy skills. Meanwhile, auditorial and kinesthetic subjects have less mathematical literacy skills.

Chasanah et al. (2020) analyzed students' mathematical literacy skills in inferential statistics courses in the context of divergent, convergent, assimilation, and accommodation learning styles. The results of this study showed that students with convergent learning styles were better than students with divergent learning styles, assimilation, and accommodation. This is supported by the results of the analysis, i.e. students with convergent learning styles are able to provide evidence of the mathematical literacy process, including: formulating, employing, and interpreting. Students with divergent learning styles are capable of completing up to the formulating stage, students with assimilation learning styles are capable of completing up to interpreting but cannot be resolved successfully. Meanwhile, students with an accommodation learning style are able to complete up to interpreting but the process of employing cannot be resolved successfully.

From some of the research above, it emerged a research gap, which analyzed the mathematical literacy skills of students in the perspective of AQ. So, the purpose of this study

is to describes the mathematical literacy skills of students in solving PISA model questions from the perspective of AQ. This study focuses on seven indicators of mathematical literacy skills determined by the researcher. The situation shows the importance of students' mathematical literacy skills to solve PISA model questions in terms of AQ.

2. Method

This study used a qualitative research method using a descriptive approach. 37 students of 10^{th} class SMAN 1 Wringinanom were given the Adversity Response Profile (ARP) questionnaire modified from Stoltz (2000). 40 ARP questionnaire questions were given to get one subject with climber, camper, and quitter types. Learners were given 30 minutes to answer the ARP questionnaire and it was in the form of a 1-5 Likert scale which is positive and negative. Then the ARP data was grouped into the grouping guidelines (Stoltz, 2000) as follows.

Table 1. AQ grouping criteria

Score	AQ Categories
166 – 200	Climber
135 – 165	Transition Camper - Climber
95 – 134	Camper
60 – 94	Transition Quitter – Camper
0 – 59	Quitter

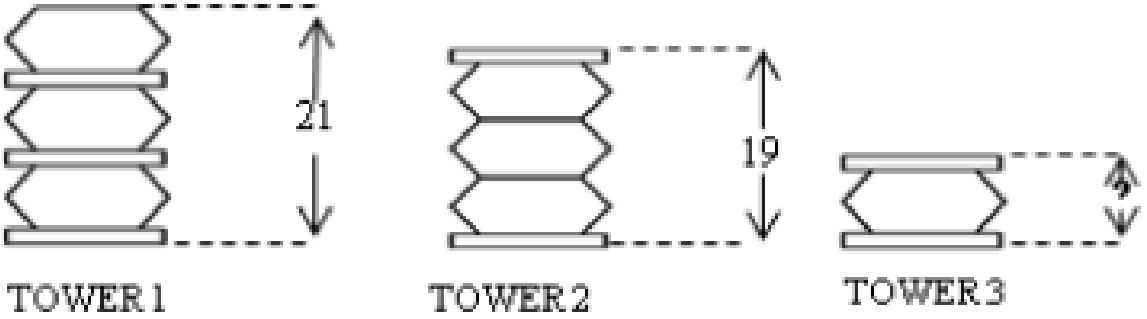
The results of distributing ARP questionnaires to 37 students showed that obtained the results there were 2 students with AQ climber, 10 students with AQ camper-climber transition, 22 students with AQ camper, 2 students with AQ quitter-camper transition, and 1 student with AQ quitter. Furthermore, researchers selected one subject from the climber, camper, and quitter categories who obtained the highest score from each AQ category at the time of completing the AQ questionnaire. Subjects in transition were not selected as subjects in this study because they could affect the validity and reliability of the research results and allow subjects to give unstable answers because they have not found a pattern that exists in themselves (Creswell & Poth, 2016). The selected subjects were coded and can be seen in Table 2.

Table 2. Subject this study

Subject	Initial	Categori
1	NS	*Climber*
2	BM	*Camper*
3	YL	*Quitter*

Each subject was given two PISA model test questions in the description form with a duration of 60 minutes. Furthermore, each subject was interviewed to obtain specific information on their mathematical literacy skills in solving the PISA model problem The PISA model test questions used in this study test questions are adopted from previous study (Mumfaza & Setyaningsih, 2024) and have been through expert validation process are presented in Table 3.

Table 3. PISA model test questions

PISA model test questions
Below are three towers that have different heights and are constructed of two shapes, a hexagon and a rectangle.    Determine the height of the shortest tower, and give your justification!

The data was analyzed using the stages of reduction, presentation, and conclusion drawing (Miles et al., 2014; Sugiyono, 2019). The reduction stage is used to identify the subjects with the climber, camper, and quitter types. The data presentation stage is used to explain the subject's answers connected to the interview results and is concluded with the summary stage. The indicators used by researchers in this study adapted from OECD (2019) are shown in Table 4.

Table 4. Indicators of mathematical literacy ability

Component	**Indicator**
Communication	Elaborate and interpret statements to construct mathematics models.
	Summarize and present results during the solution building process.
	Gives further explanation after acquiring the solution to the problem.
Mathematizing	Create assumptions related to the problem described
Representation	Apply multiple representations to interpret problems with graphs, tables, diagrams, drawings, equations and formulas.
Reasoning and argument	Connecting the problems to conclude a solution to the problem.
Devising a strategy	Developing a strategy is used to solve the problem.
Using symbolic, technical, formal, language and operation	Apply mathematical operations and symbols to support interpretation of solutions.
Using mathematical tools	Determine solutions to problems through tools that facilitate the application of processes and procedures

The validity of the data in this study was confirmed by examining the contents of the same data (Sugiyono, 2016, 2019). This validity is done by triangulating data from test results and interviews, so that in this study using triangulation techniques.

3. Result and Discussion

3.1. Result

The following is presented the test results of students' mathematical literacy in adversity quotient perspective of the three students who were subjected to.

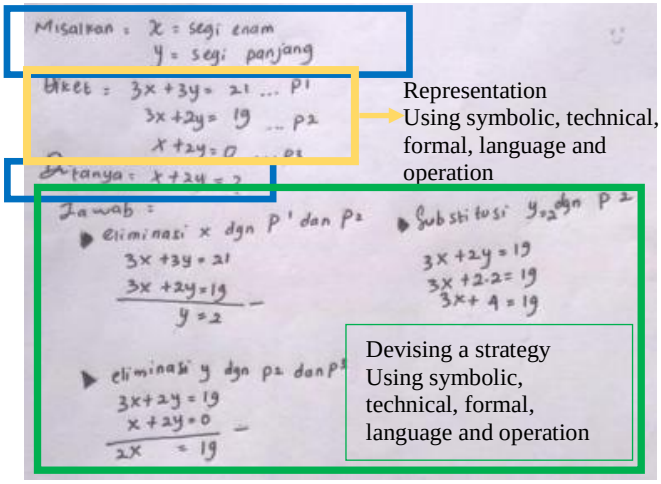
3.1.1. Adversity Response Profile Questionnaire Results

This study started by distributing ARP questionnaires to students offline and determine the study subject. Then, every subject was asked to complete one PISA model problem provided by the researcher within 60 minutes. After working on the PISA model questions, it was followed by the interview stage. The purpose of this interview is to clarify unclear points from the performance of each subject. The results of the analysis of students' mathematical literacy skills in working on the PISA model test questions in the context of AQ were described by the researcher

3.1.2. Analysis of Subject Answers based on AQ

3.1.2.1. Analysis Result of AQ's Climber Subject

The results of students' work in solving PISA model questions and also interviews, the results can be presented as follows.



Translated
Suppose x = hexagon
y = rectangle
Known : $3x + 3y = 21$ …. Equation (1)
$3x + 2y = 19$ …. Equation (2)
$x + 2y = 0$ …. Equation (3)
Asked : $x+2y = …$?
Answer:
Elimination x in Eq (1) and (2)
$3x + 3y = 21$
$3x + 2y = 19$ –
$y = 2$
Elimination y in Eq (2) and (3)
$3x + 2y = 19$
$x + 2y = 0$ –
$2x = 19$
substitution $y=2$ in equation (2)
$3x + 2y = 19$
$3x + 2.2 = 19$
$3x + 4 = 19$

Figure 1. The work of subjects with AQ Climber category

Figure 1 can be explained that the subject performs the communication stage by describing and interpreting the statements in the PISA model problem so as to form an appropriate mathematical model. Furthermore, at the mathematization stage, the subject generalizes using the alphabet correctly and completely, i.e. x = hexagon and y = rectangle. The representation stage, the subject only explains what is known and asked by writing

$$3x + 3y = 21; 3x + 2y = 19; and\ x + 2y = 0; x + 2y = \cdots?$$

The stage of designing a strategy to solve the problem was carried out by the subject by writing two solution plans to solve the problem, using the elimination of x in equations (1) and (2) followed by the substitution of the value of $y = 2$ in equation (2).

At the stage of using symbols, workings, formal language, and operations, the subject used several symbols in each equation made, i.e. "$3x + 3y = 21$" into equation (1), "$3x + 2y = 19$" into equation (2), and "$x + 2y = 0$" into equation (3). At the stage of using mathematical tools, the subject uses tools that help to determine the solution. Meanwhile, at the stage of reasoning and argument, the subject is able to connect problems so as to make conclusions about the solution to the problem. This is shown from the written answers and interviews where the subject can answer the problem using the right steps even though it is not completed. This is confirmed in the researcher's interview with the following NS subject.

A : What are the first steps you took to use this idea?
NS : Generating equations mam
A : What equations did you create?
NS : Three x added to three y equals two one equals equation one, then three x added to two y equals nineteen equals equation two, x added to two y equals zero equals equation three.

3.1.2.2. Analysis Result of AQ's Camper Subject

The following are the results of working on the PISA model test questions by subjects with the AQ camper category.

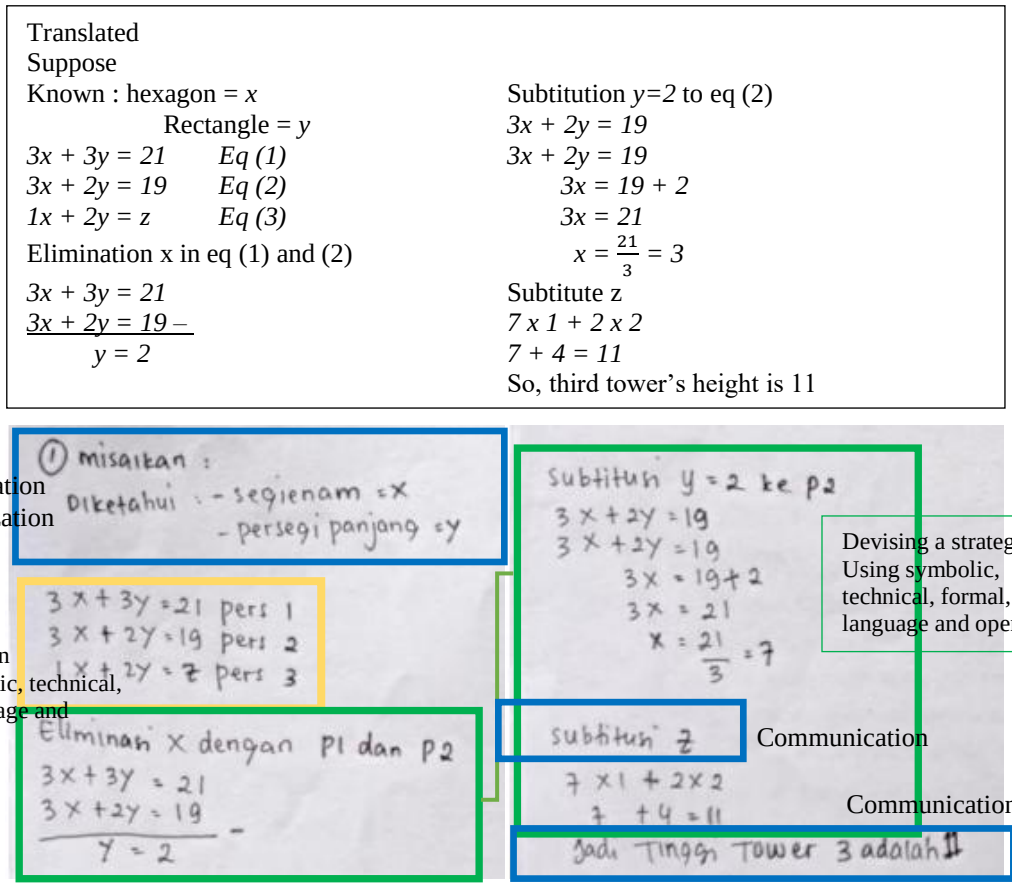


Figure 2. The work of subjects with AQ Camper category

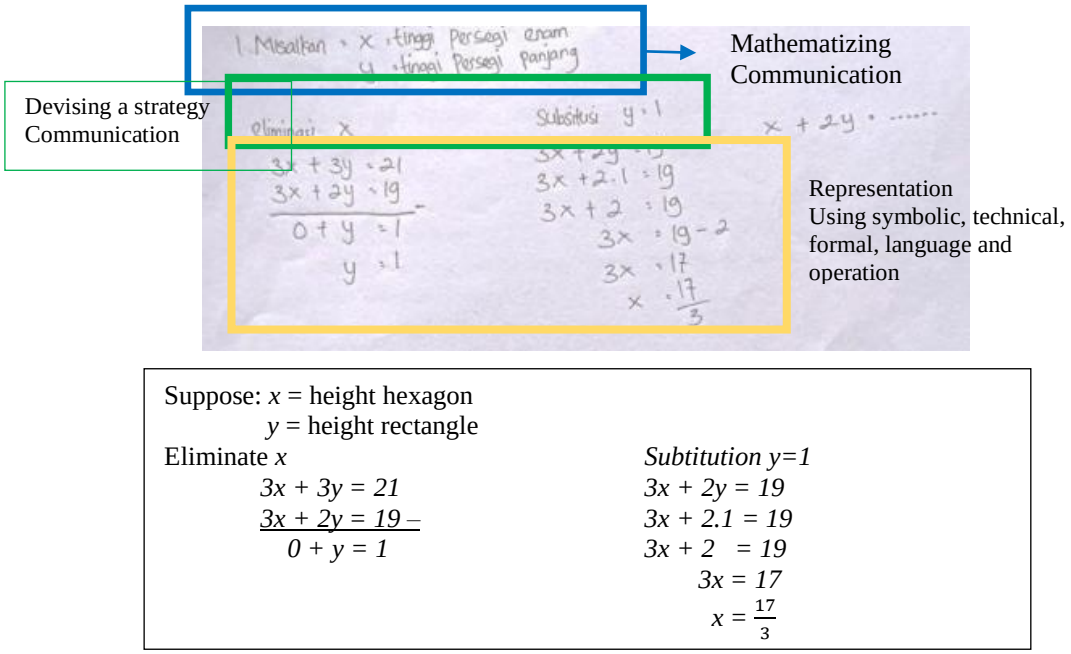
The answer of the subject with the AQ camper category in the Figure 2 can be explained that: At the communication stage, the subject only provides the results while solving the problem. However, the explanation sentence given by the subject is incomplete and ambiguous, for example "*substitute z*". The subject explained the solution to the problem completely but obtained the incorrect value, ie: third tower height = 11. At the mathematizing stage, the subject generalizes using letter symbols, ie "*x = hexagon*" and "*y = rectangle*". At the representation stage, the subject only explained what was known and asked by writing "*3x + 3y = 21*", "*3x + 2y = 19*", and "*x + 2y = z*". This also applies to the devising a strategy for solving problems stage, the subject wrote three solution plans to solve the problem, which are eliminating x in (P1) and (P2), substituting the value of y = 2 into (P2), and substituting the value of z.

At the stage of using symbolic, technical, formal, language and operation, the subject used several symbols in each equation made, among others: "*3x + 3y = 21*" into equation (1), "*3x + 2y = 19*" into equation (2), "*1x + 2y = z*" into equation (3). Using mathematical tools, the subject used tools in the form of blank paper and ballpoint pens to help him calculate. Furthermore, at the reasoning and argument stage, the subject is able to connect problems to conclude the solution to the problem. This is shown from the written answers and interviews where the subject can answer the problem using the right steps to completion even though there are some values that are not correct. This is confirmed in the researcher's interview with the following BM subject.

A : What is your idea to solve this problem?
BM : Suppose the hexagon = x and the rectangle = y

3.1.2.3. Analysis Result of AQ's Quitter Subject

The following are the results of working on the PISA model test questions by subjects with the AQ quitter category.



Suppose: x = height hexagon
y = height rectangle

Eliminate x

$3x + 3y = 21$
$3x + 2y = 19$ –
$0 + y = 1$

Subtitution y=1

$3x + 2y = 19$
$3x + 2.1 = 19$
$3x + 2 = 19$
$3x = 17$
$x = \frac{17}{3}$

Figure 3. The work of subjects with AQ Quitter category

The answers of subjects with the AQ quitter category in the Figure 3 can be explained that: At the communication stage, the subject has not described and interpreted the statement in the problem in the form of a mathematical model. The mathematizing stage, the subject generalizes using letter symbols, ie x = the height of the hexagon and y = the height of the rectangle. The representation stage, the subject wrote it in the form of equations "*3x+3y = 21"*, "*3x + 2y = 19*", and "*x + 2y = ...*". Furthermore, devising a strategy for solving problems, the subject wrote two solution plans, ie: eliminating x and substituting the value of $y = 1$.

At the stage of using symbolic, technical, formal, language and operation, the subject used no symbols or operations in the equation made to help interpret the solution. The subject YL used tools that helped to determine the solution, such as using paper and ballpoint pen (Using mathematical tools). Furthermore, at the reasoning and argument stage, the subject connected the problems to conclude the solution of the problem. This is shown from the written answers and interviews where the subject can answer the problem using the right steps to completion

even though there are some values that are not correct. This is confirmed in the researcher's interview with the following YL subject:

P : What is your idea to solve this problem?
YL : Suppose x as hexagon height and y as rectangle height

The results of the analysis of the answers to the PISA model questions on subjects categorized as AQ climber, camper, and quitter can be summarized in Table 5.

Table 5. Analysis of subject question answers

Stage	Climber	Camper	Quitter
Communication	The subject was able to elaborate on the question by explaining what was known and asked completely, was able to present the results during the process of finding a solution, and provided further explanation of the solution obtained.	The subject was able to elaborate on the question by explaining what was known and asked completely, was able to present the results during the process of finding a solution, and provided further explanation of the solution obtained.	The subject was able to elaborate on the question by explaining what was known and asked, unable to present the results during the process of finding a solution, and unable to provide further explanation of the solution obtained.
Mathematizing	The subject is able to make assumptions or simulations related to the problem	The subject is able to make assumptions or simulations related to the problem	The subject is able to make assumptions or simulations related to the problem
Representation	The subject is able to translate problems into the form of mathematical equations	The subject is able to translate problems into the form of mathematical equations	The subject is able to translate problems into the form of mathematical equations
Reasoning and argument	The subject is able to associate information from the problem to obtain a solution but not optimally.	The subject is able to associate information from the problem until the solution is maximally obtained	The subject is able to associate information from the problem to obtain a solution but not optimally.
Devising a strategy for solving problem	The subject is able to solve problems but not optimally by applying several solution plans or strategies.	The subject is able to solve the problem optimally by applying several solution plans or strategies.	The subject is able to solve problems but not optimally by applying several solution plans or strategies.
Using symbolic, technical, formal, language and operation	The subject is able to use symbols in the equations created to support the problem-solving process.	The subject is able to use symbols in the equations created to support the problem-solving process.	The subject is unable to use symbols in the equations created to support the problem-solving process.
Using mathematical tools	The subject is able to determine the solution of the problem by applying tools	The subject is able to determine the solution of the problem by applying tools	The subject is able to determine the solution of the problem by applying tools

3.2. Discussion

Table 5 can be concluded that subjects with the AQ climber and camper categories were able to fulfill five indicators of mathematical literacy skills, among others: 1) communication, 2) mathematizing, 3) reasoning and argument, 4) devising a strategy for solving problems, and 5) using mathematical tools. The results of this study are similar to previous studies (Baharuddin et al., 2022; Pertiwi et al., 2020) that high mathematical literacy skills can fulfill five indicators, including: being able to identify problems, use appropriate solution plans, propose formulas, determine solutions to problems, and can solve problems coherently. Also,

supported other study that the higher the level of ability of students, the higher the percentage of correct answers (Kholid et al., 2022; Mutianingsih et al., 2020; Rifai & Wutsqa, 2017).

Subjects with the AQ quitter category were able to fulfill 4 indicators of mathematical literacy ability, among others: 1) mathematizing, 2) reasoning and argument, 3) devising a strategy for solving problems, 4) using mathematical tools. This is in line with the previous study in which subjects with low mathematical ability communicated in understanding the problem inaccurately (Chabibah et al., 2019; Pertiwi et al., 2020; Pujiastuti & Haryadi, 2023). This is shown through writing the necessary formulas only and the solution steps are not systematic (Mutianingsih et al., 2020; Prayitno et al., 2020, 2022).

The results of the analysis of the responses in Table 5 above, show that there are similarities, that is, the three subjects are able to satisfy the mathematizing indicators. This is in line with the previous study (Lestari & Effendi, 2022) where subjects with AQ climber, camper, and quitter categories can transform problems into the form of variables, and students can represent problems in the relationship between variables. The three subjects were unable to fulfill the representation indicator. The subjects are less able to translate problems using mathematical equations because students do not correctly write permissions. The students lack understanding of the questions in the problem, leading to difficulties in making mathematical models, especially in the form of story problems (Agustin & Prayitno, 2023; Akbar et al., 2017).

All of the subjects were able to fulfill the indicator of devising a strategy for solving problems. The subjects were able to choose a strategy or solution plan to solve the problem (Chasanah et al., 2020; Wicaksana et al., 2017). In addition, the three subjects were able to fulfill the reasoning and argument indicators and the three subjects were able to reason and provide logical opinions (Ovan & Nugroho, 2017; Utomo et al., 2020).

In this study, in combination with the above similarities, the results of the answer analysis showed differences. The first difference is that quitter subjects are unable to fulfill communication indicators while climber and camper subjects are able to fulfill these indicators. In their study explained that students solve problems directly because they are not used to writing information such as known and asked from the problem (Akbar et al., 2017; Tak & Kim, 2020). Supported by previous study, lower ability subjects were unable to identify problems or plan solutions (Baharuddin et al., 2022).

The second difference is: climber and camper subjects on the indicators of using symbolic, technical, formal, language and operation are said to be less capable while quitter subjects are unable to fulfill these indicators. This is in line with the study that students with AQ climber, camper, and quitter are not maximized in using mathematical symbols in the solution process (Chasanah et al., 2020; Wicaksana et al., 2017).

4. Conclusion

Based on the results of the analysis and discussion that has been carried out, it can be concluded as follows. Subject with AQ climber and camper are able to satisfy five indicators of mathematical literacy skills, among others: 1) communication, 2) mathematizing, 3) reasoning and argument, 4) devising strategies for solving problems, 5) using mathematical tools. Subject with AQ quitters are able to satisfy four indicators of mathematical literacy skills including: 1) mathematizing, 2) reasoning and argument, 3) devising a strategy for solving problems, 4) using mathematical tools.

The first difference, quitter subjects are less able to satisfy communication indicators. This is because they do not have a good understanding related to the problem and more often solve directly. The second difference is that the climber and camper subjects on the indicators of using symbolic, technical, formal, language and operation are said to be uncapable, while the

quitter subject is unable to satisfy it. This is because the three subjects have not been maximized in using mathematical symbols in the solution process..

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