Senior High School Students' Strategies for Solving Mathematical Problems Based on Their Personality Type

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Article Info	Abstract
	Problem-solving ability is a crucial thing that every student needs. Indonesia is one of the countries that shows low mathematical problem-solving ability. The way to improve these abilities is to provide suitable problem-solving strategies and appropriate teaching and learning interactions for students. A suitable teaching method is to pay attention to the psychological aspect by observing the condition of students, one of which is by providing problem-solving strategies appropriate to personality types. This study uses the problem-solving strategy described by Herman and observes the personality types proposed by David Keirsey. This research aims to reveal the strategies students use in solving mathematical problems based on their personality type so that teachers can find suitable strategies for students. This research method uses a descriptive qualitative approach with total sampling. Class X students took a strategy test about linear equations with one variable totaling 3 questions and a personality type test by Keirsey totaling 70 questions. The results of this study indicate that students with Guardian & Artisan personalities tend to use an open-sentence strategy. Students with Rational personalities tend to use the guess & check strategy. And students with Idealist personalities tend to use tables.

INTRODUCTION

A precise knowledge essential to mathematics [1]–[3]. The development of the field of education cannot be separated from the role of mathematics. Mathematical knowledge can assist other knowledge in analyzing data, recognizing existing relationships, and analyzing logical arguments. In this context, mathematics has abilities that students must have. Mathematical ability involves reasoning [4], [5], problem-solving [4], [6], [7], communication [8], connection [9], and representation [10].

In this study, the mathematical ability that will be discussed is the ability to solve mathematical problems. Because Indonesia was placed 75th (6th from bottom) in the mathematics category of the 2018 PISA study, Indonesians' ability to solve mathematical

problems is still comparatively low [11]. The Program for International Student Assessment, or PISA, is a test on an international scale that includes testing problem-solving skills as one of its goals. PISA uses questions that promote critical thinking and problem-solving abilities. Despite Indonesia's participation in PISA since 2000, the results indicate that Indonesian proficiency in solving mathematical problems remains low.

The issue that students frequently run into is their inability to solve mathematical problems when working on questions provided by the teacher [9], [12]. This leads to the mindset that mathematics is a challenging and uninteresting subject. This is reinforced by Pramesti Prasetya, who claimed that the proportion of students who still have trouble learning mathematics utilizing the concept of calculation error indicators is still rather significant [13].

The role of the teacher is necessary in the mentoring and teaching process, in training students' mathematical problem-solving abilities by teaching various problem-solving strategies, and in paying attention to the viability of supporting questions in stimulating students' mathematical problem-solving abilities. Teaching problem-solving strategies is necessary to help students' strategies [14], [15]. This can be accomplished by offering experience in solving problems that call for various approaches depending on the problem. The variety of problem-solving strategies necessitates careful consideration when introducing them to students. With so many strategies being covered, it can assist students in applying them to various problems.

The problem-solving strategy discussed in this study is the strategy described by Herman, namely Act it Out Strategy, Strategy for Making Figures or Diagrams, Strategy for Finding Patterns, Strategy for Making Patterns, Strategy for Paying Attention to All Possibilities Systematically, Strategy for Guessing and Checking, Strategy for Working Backward, Strategy for Determining what is known, asked, and the information needed, Strategy for Using Sentences Open, Changing Point of View Strategy [16]. Knowing the strategies that students tend to use in solving math problems can help teachers broaden and deepen other strategies that can be used.

Increasing the interaction between teachers and students is another way to practice solving mathematical problems. This is to Hudoyo's statement that the best approach to teaching mathematics to students is systematically and rationally arranged according to the nature of mathematics and its psychological elements [17]. Students will find it challenging to acquire methods that are not appropriate for them, which can be frustrating when learning mathematics and particularly when solving mathematical problems.

Observing the condition of students in their daily lives is one way to deliver the finest teaching method psychologically. One of them can observe students' condition by examining their personality type [18]. Personality is each person's characteristics, including attitudes, habits, thoughts, and emotions. Each student has a different personality, leading to various learning preferences, ways to absorb information, and problem-solving strategies [19], [20].

Instead of only learning that is generic by equating all students, it should be the case that students are entitled to specific attention utilizing teaching methods adapted to their personalities. Since learning styles and teaching methods reflect each student's unique personality, there is nothing wrong or right with learning styles and teaching methods. However, if students are placed in an environment where the learning style does not match their personality, this will undoubtedly affect their learning achievement [21].

Many experts categorize personality into many types, and the personality types identified by David Keirsey were used in this study. The classification by Keirsey was chosen since it encompassed all aspects. Keirsey divides people into different personality types based on how they obtain their energy (extroverted or introverted), how they process information (intuitively or sensing), how they make decisions (thinking or feeling), and how their basic lifestyle (judging or perceiving). Four personality types, comprising Guardian (The Epimethean Temperament), Artisan (The Dionysian Temperament), Rational (The Promethean Temperament), and Idealist (The Apollonian Temperament), are classified by David Keirsey & Bates [22].

According to Agustin's research, the artisan personality type has the highest mathematical thinking process compared to other personality types, according to his study titled "Students' Mathematical Thinking Processes in Solving Mathematical Problems in terms of Keirsey's Personality Type" [23]. Awi et al. reported that Guardian and Rational personality types were better able to carry out the stages of problem-solving according to Polya than Idealist and Artisan personality types in their journal article "Description of Students' Mathematical Problem-Solving Ability Given Personality Types According to Keirsey" [24].

Studying personality is essential since each person's unique personality has been attached to them since birth. All facets of life are affected by this personality, including the field of education. How a person approaches problems might vary depending on their personality, which can impact how they resolve them. Depending on their personality, each person will have a distinct approach to problem-solving, particularly in this study, namely mathematical problems. Students can approach mathematical problems in ways that work for them. This allows the teacher to map the characteristics of each student based on strategies for solving problems.

By conducting in-depth research on personality in education, teachers can consider this when developing appropriate pedagogical frameworks, how teachers classify students based on their personality types, and choosing appropriate learning approaches so that teaching and learning activities can run more efficiently and successfully.

This study intends to explain how high school students' strategies for solving mathematical problems depend on their personality types and how their approaches can support math teachers' didactic pedagogical actions.

METHODS

According to Keirsey, the descriptive qualitative method used in this study tries to identify the methods used by high school students to solve mathematics problems based on personality types. All 19 students in class X MIPA at MA Al-Ijtihad Tangerang served as research participants for this study, which involved a total sampling of this group. The researcher is the primary tool in this study, actively searching out and gathering data from sources themselves.

The instrument in this study was an essay test with three items on the topic of one variable linear equation for mathematical problem-solving strategies. The questions are made in such a way that students can respond with various strategies. The validator lecturer first validated the test instruments before administering them to research subjects. The following instrument was a

personality type test using the 70-question Keirsey Temperament Sorter personality questionnaire.

After obtaining a class and research time approved by the school principal and subject teachers, this research began on March 13, 2023. According to Herman, researchers contributed to learning on March 17, 2023, by summarizing the ten strategies mentioned. Forty-five minutes are allotted for teaching the strategy while providing supplies. The researcher found that the students did not understand the problem-solving strategies that could be developed and implemented to solve math problems. On April 5, 2023, using a 90-minute session (two hours of study) that the principal and subject teachers had approved, the research was resumed by administering a problem-solving approach exam and a personality type test. Because this study used a total sampling of all research subjects, all students participated in interviews on May 11 and 12, 2023, after the results of the strategy and personality type tests were known.

RESULTS AND DISCUSSION

1. Personality Type Test Results

David Keirsey divides personality types into four categories: Idealist, Artisan, Guardian, and Rational. The research subjects were divided into groups according to their personality types after the personality type exam. In this case, the initials of the subject's name and the number of the absence from class were used to create the name of the research subject. It was discovered that 4 of the subjects in this study had Guardian personalities, 6 had Artisan personalities, 3 had Rational personalities, and 6 had Idealist personalities.

Table 1. Personality Type Test Results

No.	Personality Type	Subject
1.	Guardian	Q12
		O18
		F06
		A02
2.	Artisan	F07
		U15
		M09
		A01
		P11
		K08
3.	Rational	Y17
		H19
		S13
4.	Idealist	S14
		V16
		B03
		N10
		D04
		D05

Following the assignment of students into groups based on personality types, the researcher then tested mathematical problem-solving strategies (one variable linear equation

questions) to ascertain the strategies each student used when approaching mathematical problems by their personality type.

2. Mathematical Problem-Solving Strategy Test Results

See if the tactics used on students with similar personality types will be employed on the students who were grouped based on personality types. The eleven Herman-described strategies—the act-it strategy, the Strategy for Making Drawings or Diagrams, the Strategy for Finding Patterns, the Strategy for Making Patterns, the Systematic Attention to All Possibilities Strategy, the Strategy for Guessing and Checking, the Strategy for Working Backward, Strategy for Determining what is known, asked, and the information needed, Strategy for Using Sentences Open, Changing Viewpoint Strategy.

Table 2. Mathematical Problem-Solving Strategy Test Results

No.	Personality Type	Subject	Strategies
1.	Guardian	Q12	S8, S9
		O18	S9
		F06	S4, S8
		A02	S8, S9
2.	Artisan	F07	S9
		U15	S8, S9
		M09	S9
		A01	S5
		P11	S8, S9
		K08	S9
3.	Rational	Y17	S6
		H19	S4
		S13	S6
4.	Idealist	S14	S6
		V16	S2, S4
		B03	S5
		N10	S8, S9
		D04	S4
		D05	S4

Notes:

S1   : the Act it Out Strategy
S2   : the Strategy for Making Drawings or Diagrams
S3   : the Strategy for Finding Patterns
S4   : the Strategy for Making Patterns
S5   : the Systematic Attention to All Possibilities Strategy
S6   : Strategy for Guessing and Checking
S7   : Strategy for Working Backward
S8   : Strategy for Determining what is known, asked, and the information needed
S9   : Strategy for Using Sentences Open
S10   : Changing Viewpoint Strategy

According to the table, students with the Guardian & Artisan personality type tend to use strategies to determine what is known, asked, and required information and strategies to use open sentences. Additionally, the Rational personality type tends to use the guess-and-check strategy. Students with the Idealist personality type use a wider variety of mathematical problem-solving techniques but tend to use the strategy of making tables.

3. Results of Mathematical Problem-Solving Strategies Based on Personality Types

Because this study used total sampling and because of the limitations of researchers in describing the 19 research subjects, the researchers chose two samples for each personality type to be described in this journal.

a. Students with Guardian Type

The following images represent student worksheets of the Guardian type (A02, F06, Q12, and O18), where two research subjects, A02 and Q12, were chosen.

Figure 1. Strategy Test Result A02 Subject

In this strategy test, Subject A02 used strategies to ascertain what was known, asked for and needed information and used open sentences. The interview with Subject A02 explained:

Researcher : *When you initially read this question, was this strategy the first thing you thought of? Is the strategy you are using effective and successful?*
Subject A02 : *I immediately thought of using this strategy because it is the most popular, and I frequently use it. It was successful, in my opinion, because I could find the solution.*
Researcher : *Do you believe any further approaches or strategies may be used to solve this problem?*
Subject A02 : *Maybe there is, but I am better equipped to employ this strategy.*

In this study, Subject A02 felt more suited to himself in terms of his personality (Guardian) because he was used to using both of these strategies to solve mathematics problems.

Figure 2. Strategy Test Result Q12 Subject

In this strategy test, Q12, the subjects use an open-sentence strategy to ascertain what is known, what is being requested, and what information is required. The following interview with Subject Q12 explained:

Researcher : *Do you consider this question to be challenging? And when you observe this problem, what strategy come to mind first?*

Subject Q12 : *Not really, since we only study this equation-related material. Yes, employing this strategy immediately sprang to mind because it's more accessible, and I always do.*

Because they are more straightforward to comprehend and use, subjects A02 and Q12 are accustomed to adopting these methods while addressing mathematical problems. Therefore, based on the findings of a study done on Guardian subjects, it seems that Guardians will employ typical techniques or strategies [25].

b.   Students with Artisan Type

The following images represent student worksheets of the Artisan type (A01, F07, K08, M09, P11, and U15) where two research subjects, P11 and U15, were chosen.

Figure 3. Strategy Test Result P11 Subject

In this strategy test, the P11 subject used an open sentence strategy but made a mistake. The following interview with Subject P11 explained:

Researcher   :   *In your opinion, is your response accurate or not?*
Subject P11 :   *I think it is true ... What's wrong?*
Researcher   :   *Try to focus on the problem once more. Knowing that length equals width plus eight. What does that mean?*
Subject P11 :   *Oh, that means the length needs to be changed. I'm not careful, Sis. Hehe.*

Subject P11 may complete the task after being instructed to modify it using the same strategy: open sentences. It is only that P11 gave an inaccurate response on the last test because she didn't carry out ultimately.

Figure 4. Strategy Test Result U15 Subject

In this strategy test, subject U15 used the open sentence strategy again, and it was discovered that the number 3 should have been written with the number 8. Subject U15 explained it in the following interview:

Researcher   :   *Your response is accurate if you can see it at a glance. However, let me ask you first. Where did you come 3 from all of a sudden?*
Subject U15 :   *Oh, wait, Sis, I believe I miswrote it; it should have been eight, but I wrote three.*
Researcher   :   *Yes, but downhill still holds true. Why did you decide to use this strategy? Don't you want to attempt a different strategy?*
Subject U15 :   *Because in my opinion, this strategy is the easiest, Sis.*

In this case, P11 and U15, who are subjects of the artisan type are in line with the characteristics stated by David Keirsey, that the Artisan type wants to do everything quickly, tends to be in a hurry and is not thorough [26].

c.   **Students with Rational Type**
    The following images represent student worksheets of the Rational type (Y17, H19, and S13) where two research subjects, S13 and Y17, were chosen.

Figure 5. Strategy Test Result S13 Subject

The guess and check strategy, which students have just acquired and are aware of, is used in the S13 subject on this strategy test. Subject S13 explained it in the following interview:

Researcher : *Why did you use the strategy you just learned?*
Subject S13 : *Because I think it's fun, Sis.*
Researcher : *You merely made two guesses on the answer sheet and discovered the solution, right?*
Subject S13 : *Actually, sis, there are quite a few scribbles.*
Researcher : *Is there another fascinating strategy you could try besides the one you just tried?*
Subject S13 : *I think I can use the table strategy later, Sis.*

Subject Y17 was also observed using the guess and check strategy, in addition to subject S13. As seen in the worksheet that follows:

Figure 6. Strategy Test Result Y17 Subject

Researcher : *Do you think the guess and check strategy effectively solves this problem?*
Subject Y17 : *Yes, Sis. Because the solution was correct when I applied this strategy and the open sentence strategy, respectively.*
Researcher : *Oh, right? You use two strategies to make sure it matters, correct?*
Subject Y17 : *Yes, Sis. Because this is a new strategy, I was unsure about the answer either.*

Research between Rational S13 and Y17 subjects has shown that Rational may easily accept and apply new ideas to issues. This is consistent with David Keirsey's explanation, in

which the Rational prefers logically based explanations, can comprehend complicated concepts, and tends to identify issues more quickly [26]. Because Rational uses random numbers to guess pairs of numbers, the guess and check strategy might be categorized as abstract.

d.   Students with Idealist Type

The following images represent student worksheets of the Idealist type (S14, V16, B03, N10, D04, and D05) where two research subjects, V16 and D04, were chosen.

Figure 7. Strategy Test Result V16 Subject

The table technique used in Subject V16 of this strategy test is one that students have learned and are familiar. Subject V16 clarified it in the following interview:

Researcher   : This is the strategy that we just learned, right? Why did you decide to use this strategy?
Subject V16 : I used a fresh strategy using Figures, Sis. Like in number 1, I decide to use a strategy that involves making patterns and diagrams. I believe it's easier if there are illustrations.
Researcher   : Oh … so you are a visual type, yeah …

Subject D04 uses tables in this strategy test, just like subject V16.

Figure 8. Strategy Test Result D04 Subject

Researcher   : How did you decide to start this table with the number 7?
Subject D04 : At first, Sis, because I started with the number 7. Although it began with the number 3, the circumference was too small. Finally, I began at number 7, and it turned out that my initial guess was incorrect. An even number, not an odd one.
Researcher   : But you did find it, ok? Do you think your answer is accurate or not?

Subject D04 :   That's correct, Sis. When I tried again to enter the circumference formula using the width and length values I had obtained from the table, the result was 72.

When working on problem number 2, subjects V16 and D04 of this Idealist type frequently use table techniques, and subject V16 also does so on problem number 1. According to David Keirsey, idealists like to write in a schematic or diagrammatic form [27], keeping with his assertion.

Based on the results of this study, students with the Guardian & Artisan type tend to use open sentence strategies, students with the Rational type tend to use guess and check strategies, and students with the Idealist type tend to use table strategies. The results of this study are not in line with the research conducted by Kasriana, that Guardian and Idealist will choose a method that is commonly used and accepted by most people. At the same time, the artisan and rational will seek the most effective method without considering whether the method is acceptable to others [25]. In this study, Guardian and Artisan chose to use methods/strategies that are commonly used, while Rational and Idealist used methods/strategies that had just been learned and were abstract.

CONCLUSION

Based on the results of research conducted in class X MIPA MA Al-Ijtihad Tangerang, high school students with Guardian and Artisan personality types tend to use open sentence strategies, high school students with Rational personality types tend to use guess and check strategies, and high school students with Idealist personality types. Tend to use the table strategy. After knowing the personality types and strategies that students tend to use, the teacher can focus more and provide more in-depth explanations and questions that can stimulate problem-solving skills; this can play a role in the teacher's pedagogical-didactic actions in teaching mathematics in pedagogical actions, the teacher-student relationship by paying attention to their personal or psychological aspects. Of course, this will be more on target because the teacher is more familiar with and knows the methods suitable for teaching students with their respective personality types. Whereas in didactical action relationships between students and materials, this will also be useful when students know what methods suit their personality so that they can solve mathematical problems.

The researcher only used one example out of the three questions to restrict the strategy the individuals used, so the outcomes of this study were still limited. Future researchers can use this as a guide to explore strategy studies based on this personality type more thoroughly and intricately.

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