The impact of students' personality types on the application of problem-solving strategies in solving PISA questions

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Abstract. The problem-solving strategy is one of reasons why Indonesian students competing in PISA only placed at the lowest rank. This is caused by some factors, including personality types. To indicate the effect of these types towards students’ strategies used is required more detail explanation. This research aims at investigating the strategies used by students in solving PISA questions based on personality types. There were 30 junior high school students in Banda Aceh involved in this research. Two research instruments were used, one consists of level 4, 5, and 6 PISA questions and another one is the Myers-Briggs Type Indicator questioner. The data gathered were analysed by grouping students based on the Myers-Briggs types. Afterwards, students’ answers to PISA questions were matched with the ten indicators of Posamentier and Krulik’s problem-solving. The result of this research shows that students come under 6 of 16 personality types. The result indicated that personality types impact the strategies which students applied in solving a problem in answering PISA questions. The implication of this study shows that teachers require to use combination of problem solving strategies to address different types of students’ personalities in Mathematics teaching and learning processes in order to optimize students’ achievements, particularly in problem-solving.

1. Introduction

The Programme for International Student Assessment (PISA) is one of the international student assessment programs organized by The Organization for Economic Cooperation and Development (OECD). This program aims to see the level of achievement of students around the world at the age of 15 years in order to improve educational methods and outcomes to a better way [1]. It also targets to monitor educational results in accordance with agreed education policies and to allow valid comparison of student achievement at world level [2]. PISA questions contain problems which are expected to measure the abilities and creativities of students around the world in solving problems [3].

The problems in PISA are presented in the form of routine and non-routine questions [4]. Routine questions are ordinary practice questions that can be solved by following the procedures learned in class while solving non-routine questions requires a variety of problem-solving strategies as well as further thought [5]. This is because the procedure for non-routine questions is not as clear or not identical as the procedures students have learned in class. In other words, these questions present new situations that have never been encountered by students before, in which clear objectives to be achieved exist, but how to solve them does not immediately appear in students’ minds. However, the non-routine form of PISA questions cannot be completed well by Indonesian students [6]. It happens because they have not been
able to implement appropriate strategies in solving problem, causing Indonesia to occupy a lower rank in the 2018 PISA [7].

Posamentier and Krulik mentioned that there are 10 strategies in solving the problem, specifically 1) working backwards, 2) finding a pattern, 3) adopting a different point of view, 4) solving a simpler analogous problem, 5) considering extreme cases, 6) making a drawing visual representation, 7) intelligent guessing and testing, 8) accounting for all possibilities, 9) organizing data, and 10) making logical reasoning [8].

There are various factors that influence the implementation of student strategies in PISA; one of them is a personality type which until now has not received much attention from teachers in learning practice [9-10]. In fact, differences in student personality types will have a real impact, especially in solving Math problems that truly require strategies [11]. One of the actual things that happen is that generally at school, teachers tend to think that students have the same personality, resulting in a lack of opportunities for them to develop according to their respective personalities. It is surely in a class which consisting of a group of students, most likely one student with another student will have different personalities so that the problem-solving methods and strategies used are different [12].

Jung classified personality types into two types, namely extrovert and introvert. Students with extrovert or open personalities, tend to present themselves according to what they are in their social interactions [12]. Since meeting or talking to them, the interlocutors will easily know who they are dealing with and they tend to involve many people and are more spontaneous in solving problems. It is in contrast to students with introvert or closed personalities who tend to express themselves gradually over time. They will also rely more on themselves or with those closest to them in small numbers [13].

Based on the two personality types developed by Jung, Myers-Briggs created a complete personality type framework, namely 1) extrovert (E) and introvert (I), 2) sensing (S) and intuition (N), 3) feeling (F) and thinking (T), and 4) judging (J) and perceiving (P) [14]. To test this personality type, Myers-Briggs created a test called the Myers-Briggs Type Indicator (MBTI) which results are the combination of four personality types which afterwards generate 16 new personality types, namely Extrovert-Sensing-Thinking-Judging (ESTJ), Extrovert-Sensing-Feeling-Judging (ESFJ), Extrovert-Sensing-Thinking-Perceiving (ESTP), Extrovert-Sensing-Feeling-Perceiving (ESFP), Extrovert-iNtuition-Feeling-Judging (ENFJ), Extrovert-iNtuition-Thinking-Judging (ENTJ), Extrovert-iNtuition-Feeling-Perceiving (ENFP), Extrovert-iNtuition-Thinking-Perceiving (ENTP), Introvert-Sensing-Thinking-Judging (ISTJ), Introvert-Sensing-Feeling-Judging (ISFJ), Introvert-Sensing-Thinking-Perceiving (ISTP), Introvert-Sensing-Feeling-Perceiving (ISFP), Introvert-iNtuition-Feeling-Judging (INFJ), Introvert-iNtuition-Thinking-Judging (INTJ), Introvert-iNtuition-Feeling-Perceiving (INFP), and Introvert-iNtuition-Thinking-Perceiving (INTP). Based on these personality types, it can be seen that extrovert and introvert personality types are basic characteristics of all personality types. In extrovert and introvert the emphasis is more on the ability to concentrate. Sensing and intuition are more concerned with the ability to understand information. Furthermore, feeling and thinking are more focused on a person's ability to draw conclusions and make decisions. Meanwhile, judging and perceiving are more oriented to a person's ability to regulate their life patterns [15].

Several studies related to personality types and problem-solving strategies have been conducted, such as Rathore (2019), Hanana, Rukmigarsari, and Fathani (2019), and Pangestu and Yunianta (2019). However, information about the impact of student personality types on the problem-solving strategies applied by students in solving PISA questions is still very limited. It is essential to know about students' strategies in answering PISA questions based on the 16 combinations of these personality types. Therefore, the researcher is interested in a further investigation of the impact of personality types towards students' strategies in solving PISA questions. This information can later be used as a guide for teachers regarding strategies applied by students in solving PISA questions so that teachers can choose the accurate way of teaching or adjust learning circumstances according to the students’ personalities. This will positively make learning more effective hence it is expected to improve students’ achievements and develop students' abilities to apply strategies in the process of solving math problems,
such as in PISA questions. For that reason, the research question of this study is what is the impact of personality types on students' strategies in solving PISA questions?

2. Methods
Penelitian ini menggunakan pendekatan kualitatif dengan jenis penelitian deskriptif. This study involved 30 students from a junior high school in Banda Aceh. Selection of subjects in this study is using a *purposive sampling technique*. The criteria that must be met by the samples in this study are 1) already used to working on PISA questions and 2) attending the age of 15 years old. Personality type questionnaires were given to 30 students in order to classify them based on personality types. The questionnaire used is the *Myer-Briggs Type Indicator* or MBTI questionnaire with an *alpha conbrach* of 0.8 [16]. Moreover, it has been translated and obtained recommendations on the appropriateness of the content from linguists. After organizing the personality type groups, one student who represents each group is selected to be given the PISA test. The data from the test will be used to investigate strategies applied by students corresponding to the indicators of problem-solving strategies of Posamentier and Krulik’s. The PISA questions adopted are PISA questions level 4, 5, and 6 in 2018 and PISA equivalent questions that have been validated [17]. Data analysis technique in this study was carried out through three stages, to be precise 1) grouping students based on personality types according to Myers-Briggs, 2) identifying problem-solving strategies applied by students in solving PISA questions according to Posamentier and Krulik’s, and 3) investigating the impact of student personality types towards students' strategies in solving the questions.

3. Result
Based on the results of grouping personality types of the 30 students surveyed, only six personality types groups were obtained, namely ENTJ, ISTP, INFT, ESTJ, INTP, and INTJ. Furthermore, the evaluation of students’ work on the PISA test is carried out. Following are the analysing results of students' strategies in answering the questions based on personality types.

3.1. ENTJ individuals

![Figure 1. An answer from the ENTJ that applied organizing data strategy.](image)

ENTJ applied several strategies to solve the given problems, namely strategies to find a pattern, make a drawing visual representations, make logical reasoning, and organize data. When answering the query, he only employed one strategy to each problem he responded to. However, in the interview session, it was found that he was able to answer the same questions using a different strategy from the one written on the answer sheet. This student also performs calculations precisely and clearly understands each step of the completion that he takes. This is in line with what Fauzi expressed that students with the *thinking* personality type tend to be more careful in solving their problems [18].
3.2. ISTP individuals

![Image of ISTP individual's solution strategy](image1.png)

**Figure 2.** An answer from ISTP using accounting for all possibilities strategy.

ISTP solves PISA question using strategies to find a pattern, make a drawing visual representation, make logical reasoning, organize data, account for all possibilities, and solve a simpler analogous problem. Nevertheless, he tends not to combine the strategies or in other words, he only applies one strategy in solving each problem. Based on the interview result, it is known that the ISTP is able to explain the steps he takes to solve the problem in his own language appropriately. This is consistent with what Yu & Lee stated that a *perceiving* individual is capable of explaining something he understands in his own words [19].

3.3. Students with the INFJ personality types

![Image of INFJ individual's solution strategy](image2.png)

**Figure 3.** An answer from INFJ by combining problem-solving strategies in answering PISA question.
INFJ solves PISA question by using finding a pattern, making a drawing visual representation, making logical reasoning, organizing data, solving a simpler analogous problem, and adopting different points of view. Students with this personality have a tendency to combine these strategies to solve the same problem. According to the interview result, it is known that the purpose of combining these strategies is to simplify and accelerate the problem-solving. It is shown in figure 3 that the INFJ integrates multiple strategies in solving question number 1 by applying the strategy of making a drawing visual representation, finding a pattern, and making logical reasoning. He first creates an illustration in the form of a seal movement. Later on, he continues with making the movement pattern until reaching the position as the requested time in the question. In determining the seal movement patterns, he relates his previous experience or knowledge of seal sleeping time, which is 30 minutes. So that the pattern found becomes complete.

3.4. INTJ individuals

INTJ solves PISA problems by employing finding a pattern, making a drawing visual representation, making logical reasoning, organizing data, and accounting for all possibilities strategies. The student with INTJ tends to associate problem-solving strategies in answering a question. The calculation made is accurate, and he could explain each step of solving the problem according to what he wrote on the answer sheet. It is seen in Figure 4 that the INTJ obtains making logical reasoning strategy. He assumes that seal belongs to mammal’s family, hence, in general, it can survive holding its breath for only 1 hour. The answer was chosen by him, therefore, is that in the next hour, the seal will be on its way to the surface to take a breath. This is in line with what Hall, Gunnery, Letzring, Carney and Colvin stated that individual who has a judging personality has a tendency to make decisions based on logic [20]. However, in the interview term, he repeated the process of finding a solution to the problem by creating a pattern of the seal movement. This result, nevertheless, is different from the thought written on the previous answer sheet. This happened because there was a miscalculation and he did not double-check the results of his work before stating that his work was finished. This is consistent with what Azwanto said that students with judging personalities tend to be less careful in the problem solving process [21].

3.5. INTP individuals

INTJ solves PISA problems by employing finding a pattern, making a drawing visual representation, making logical reasoning, organizing data, and accounting for all possibilities strategies. The student with INTJ tends to associate problem-solving strategies in answering a question. The calculation made is accurate, and he could explain each step of solving the problem according to what he wrote on the answer sheet. It is seen in Figure 4 that the INTJ obtains making logical reasoning strategy. He assumes that seal belongs to mammal’s family, hence, in general, it can survive holding its breath for only 1 hour. The answer was chosen by him, therefore, is that in the next hour, the seal will be on its way to the surface to take a breath. This is in line with what Hall, Gunnery, Letzring, Carney and Colvin stated that individual who has a judging personality has a tendency to make decisions based on logic [20]. However, in the interview term, he repeated the process of finding a solution to the problem by creating a pattern of the seal movement. This result, nevertheless, is different from the thought written on the previous answer sheet. This happened because there was a miscalculation and he did not double-check the results of his work before stating that his work was finished. This is consistent with what Azwanto said that students with judging personalities tend to be less careful in the problem solving process [21].
In the analysis of the answer sheets, it is found that the INTP personality wrote correctly the information that was known and was asked in the questions. Moreover, in the interview session, it was found that he was able to understand the problem by explaining the meaning using his own words even though it was not complete. When answering questions, he did not apply the planning stage strategy. This can be seen clearly from the answer sheet, which shows that he did not write down the formula or mathematical model that will be used to solve the problem. However, from the interview, information was obtained that he did not write it down because he did not know what formulas or concepts should be used in answering it. This is due to the limitation of knowledge or experience he has; henceforth he cannot link the information that is known to what is being asked in the question (Barczyk & Duncan, 2017). Knowledge limitation also has an impact on the number of questions which can be completed. Apart from limited knowledge, the INTP also revealed that he had problems with time management which affected him that he could not manage enough time to answer questions. This is consistent with what Manjunatha, Chandrakumar, Devi, Shekar, Murthy, and Prashantha stated that individuals with a perceiving personality experience problems in memory, handling problem, budget management, and time management in their everyday lives. Additionally, the strategies used in solving these problems are strategies to find a pattern, make a drawing visual representation, make logical reasoning, and organize data. When answering a question, he only applies one strategy to each problem. However, after implementing a problem-solving strategy, he made several mistakes in the arithmetic operation process; hence the final result gained was still incorrect. In Figure 5, it is visible that the INTP applies images as a visual representation in answering that question. By firstly he draws the sides of dice in the shape of cube nets with its corresponding dots. Then he started filling in the dice numbers requested in the question. However, he still made a mistake in calculating the number of dots, as a result that the final output produced is still incorrect.

3.6. ESTJ individuals

![Figure 6. An answer from ESTJ individual using organizing data strategy](image)

In accordance with the answer sheet analysis result, it was detected that the ESTJ individual did not write down information related to what was known and what was asked about in the questions. From the interview term, it was perceived that he was likely to be able to fully describe the information on how he answered the question. This proves that he can understand the problem he is working on. In answering it, he does not apply the planning stage plans in advance but instead immediately implemented the strategies. This is relevant with DiTiberio and Jensen, who said that individuals who have a combination of thinking and judging tend to do the point in solving problems. When facing a problem, the individual immediately arranges a strategy to manage a problem-solving strategy in mind, which direct him to find the right solution in a short time. The strategies used by ESTJ student in solving this question are strategies to find a pattern and organize data by not combining them together. As in Figure 7, one of the ESTJ students responded to the question by employing the organizing data strategy
which helps him obtaining the right solution, which is finding a pizza with a 40cm diameter for Rp.40,000 is more economical than the one with a diameter of 30cm which costs Rp.30,000.

4. Discussion
This research aims at investigating the strategies used by students in solving PISA questions based on personality types. According to the findings of the study, it is attained that students who are in introvert combination personality cluster fulfil 7 out of 10 problem-solving strategies, while students with extrovert personalities only accomplish 5 out of 10 strategies, according to the research results. The same thing was also stated by several previous researchers, namely by Dannar (2016), O’Connor, Gardiner, and Watson (2016), Pangestu and Yunianta (2019), and Sari, Munawaroh, and Raharjo (2020) [25-28]. They revealed that the introverted personality type has a very good ability in using problem-solving strategies to solve a problem. They are also very careful in choosing the appropriate strategy to make it easier to find the best solution. Besides the introvert personality, judging also plays a role in the implementation of the problem-solving strategy. This is consistent with what Borzumato-Gainey expressed that individuals with judging personalities can solve problems in different ways [29].

Furthermore, from the research results, it is also known that students with a combination of introvert-judging personality types tend to combine several strategies in solving a PISA problem. This is in accordance with what was stated by Purnamaningsih that students who have the intuition personality type elaborate strategies in solving problems [30] Prayitno said that students with a combination of intuition-judging personality types could solve math problems using several innovative strategies compared to students with other personality types [31].

5. Conclusion and Suggestion
After all data analysis above, it can be concluded that the impact of the different personality types of each student on the strategies applied by students in solving PISA questions is as follows 1) ENTJ students use four problem-solving strategies and combine strategies in solving PISA questions; 2) ISTP individuals use six problem-solving strategies but do not combine strategies in solving PISA questions; 3) INFJ students use six problem-solving strategies and elaborate strategies in solving PISA problems; 4) INTJ students use five problem-solving strategies and perform a combination of strategies to solve PISA questions; 5) INTP individuals use four troubleshooting strategies but do not combine strategies in solving PISA problems; 6) ESTJ students only use two problem-solving strategies and do not integrate strategies in solving PISA questions.

It is hoped that the teacher can pay more attention to the differences in each student’s personality types and it is necessary to collaborate students with different personality types in the mathematics learning process to maximize students’ achievement, especially in problem-solving. Meanwhile, students are advised to understand their strengths and weaknesses based on their personality type to find a more appropriate way of learning so that learning can be more meaningful.

The limitation of this study is that the subjects obtained only from 6 personality types due to the less extensive research scope. It is recommended for further researchers to obtain more complete personality types.

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