Students’ Analytical Thinking Profile Based on Reflective Cognitive Style in Solving Mathematics Problem

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Abstract. The objective of this study is to describe students' analytical thinking profile based on reflective cognitive style in solving a mathematics problem, especially in two-dimension materials. This research is a qualitative descriptive study that elaborates the characteristics of analytical thinking including; pre-analytical, analytical-partial, semi-analytical, and complete analytics. Data collection is employed through task-based interviews and data validation is done by time triangulation. The participants of this study are two students at the eleventh grade of State Senior High School (SMAN) 1 Kedungwaru, Tulungagung. They are selected based on the results in answering matching familiar figures test. The results reveal that the subjects have partial analytical thinking characteristics in solving the problem.

Keywords: Cognitive Style, Reflective, Analytical Thinking, Problem Solving

1. Introduction

Nowadays, solving problems become an important and interesting phenomenon. In solving problems, students have differences in presenting the solution. Many factors influence students' ability to solve problems, namely intelligence, ability to think logically, creativity and cognitive style, personality, values, attitudes, and interests [1]. Problem-solving in mathematics is the activity of finding a solution related to mathematics problems by using all of the knowledge and mathematics experience that has been owned [2]. Polya states that the mathematics problem-solving process is carried out through various levels, namely understanding the problem, developing plans, implementing plans, and re-examining. This level is known as Polya's technique [3].

The development of problem-solving time by time cannot be separated from education. Historically philosophical, Ki Hadjar Dewantara states that education is an effort to promote the growth of character (inner strength, character), mind, and body of a child [4]. Education must be defined as an effort to develop all domains or dimensions that exist in students. There are five domains of education that must be developed, namely the realm of thought, the realm of taste, realm of intention, the realm of religion, and the realm of the body [5]. In connection with the development of education, the main purpose of education is to produce a human personality that is mature intellectually, emotionally, and spiritually [6]. One of the learning fields that are suitable for the purpose of educational development in mathematics education.

In mathematics education, conceptual and procedural knowledge can be characterized by qualities, such as the level of thinking logically and factually [7]. During the mathematics learning process, the
teacher usually gives an example of a problem and answers it at the end of the theory. Type of example used by the teacher has several functions, such as an exploration tool, an investigation tool for justification, and as a convincing tool [8]. However, the mathematical abilities of Indonesian students are still low. Regarding a survey conducted by Trends in the International Mathematics and Science Study (TIMSS) in 2015 showed that the average score of Indonesian students at eighth grade is only 397 out of 500 and it is placed forty-fourth (44) out of 49 countries. In the same year, a survey conducted by the Program for International Student Assessment (PISA) revealed that Indonesia has ranked sixty-third (63) out of 70 countries and it has an average score of 375 [9]. In relation to these results, it shows that the mathematical ability of Indonesian students is not satisfactory and still low.

One of the materials given to students from the survey is geometry material in two-dimension. In the existing research, some high school or vocational high school students have difficulty in learning geometry, due to lack of students' understanding of prior geometry which is used as a prerequisite for studying further geometry [10]. Moreover, mathematical abilities have some standards such as representation, reasoning, and evidence, communication, problem-solving, and connection [11]. One of the most influential standards of mathematical ability is reasoning. The reasoning is the process of thinking and achieving reasonable results by considering all of the influential aspects or elements [12].

Analytical thinking is a way of mathematical ability in a form of reasoning. In the Indonesian dictionary (KBBI), the analysis means investigating an event to find out the actual situation, the explanation after review, and the solution of a problem that begins with a presumption of truth [13]. An analysis is a way to divide materials into its constituent parts and a way to find the parts which are related to each other to form a unity [14]. Correspondingly, analytical thinking skills emphasize materials into the more specific part, detect the relationship of these parts, and organize it into problem-solving [15]. Analytical thinking as a part of the problem-solving process is considered crucial to provide the skills needed in preparing children for more complex life and work environment [16].

Cognitive is divided into four groups: students with reflective cognitive style, impulsive cognitive style, fast-accurate style, and slow-inaccurate style [17]. Reflective cognitive is a disposition of thinking that interacts with knowledge, characteristics, and may play a significant role in the adaptation of different problem decision making and situations [18]. Reflective cognitive is one of many factors that can predict behavioral anomalies [19]. A person who has reflective cognitive is characterized by the fact, such as make fewer mistakes, delay their statements, and have a long response time, and all of these characteristics is intended to find the best solution [20]. So, analytical thinking with reflective cognitive style plays an important role in solving problems.

Based on the above explanations, it is concluded that there is a relationship between analytical thinking and the reflective cognitive style of people in solving the problem. The relationship is when someone does a problem-solving process by making fewer mistakes because they predict and detect the relationship between one part and another part of each process. However, it has the purpose of solving problems to be a unified structure of the whole problem to be interrelated. So, the problem-solving process causes the tendency to have a long response, but they aim to determine the best solution.

Several types of research in the field of analytical thinking have also been carried out. The other studies show that analytical thinking has four characteristics, including pre-analytical, analytical-partial, semi-analytical, and analytical (complete analytics). The indicator for pre-analytics is The subject uses the object attributes that have been made, but the conditions are defined out or not appropriate from the condition or context of the problem [21]. An analytical-partial indicator is a subject presents analytical procedures and problem solving but it is not integrated into a unified whole. The indicator in semi-analytical is the subject uses steps that should not be used "turn" or do not need to be used "vague" to be an integral part in solving the problem. The indicator of analytics (complete analytics) is the subject presents the clarity of the algorithm, provisions of reasoning, and the existence of an essential statement that underlies the process [22]. The indicators of analytical (complete analytics) are subject can distinguish, organize, and connect an object, theory, problem or event, and the subject can determine the relationship of these aspects based on reasons, principles, or certain functions [23].
The researcher conducts a trial as an initial observation. This initial observation aims to measure the analytical thinking activities of students without given a test in the form of MFFT. In the initial observation results, the researcher obtains the category of analytical thinking in the form of partial analytical characteristics. This situation is caused by the interruption of analytical steps taken by students during solving problems. In solving problems, the important one is the level of education that strongly involves the style of thinking. Therefore, researchers are highly motivated to conduct research on analytical thinking activities based on reflective cognitive style. Thus, this study aims to describe the profile of students' analytical thinking based on reflective cognitive style in solving two-dimension problems.

2. Methods
This research uses a qualitative approach because it focuses not only on the subject's mentality but also compares what is done and what is expressed. Data from this study are written and oral data. There are two types of instruments used to collect data, namely a worksheet and aids in the form of interview guidelines.

In determining the subject, they are chosen using an instrument which is developed by Warli. The instrument is called as matching familiar figures test (MFFT). There are two items of trial and thirteen items about the core questions in the instrument. This test involves selecting images among eight similar variations that are identical to the original figure. Reflective groups are taken from students who have the longest and the most accurate time in answering [24] or if they make several mistakes and show a long time [25].

In this study, the selected students were class XI majoring in Mathematics and Natural Sciences in Kedungwaru State Senior High School, Tulungagung. This study began by providing MFFT instruments on Tuesday, August 21, 2018. Based on scores of reflective cognitive styles, 14 reflective subjects were obtained. Taking the subject is also as a cause in finding other subjects, including students of impulsive cognitive style, fast-accurate style students, and slow-inaccurate students. The researchers take subjects who have a reflective cognitive style because reflective cognitive style almost has similarities with analytical thinking. Furthermore, 14 subjects were given to work with the Think Aloud method. After the data was collected, two subjects were taken into consideration when the subject's process of Think Aloud method provided a thorough explanation. Subjects with a reflective cognitive style are taken only at high and moderate levels because, in the low-level reflective cognitive style, it does not have the potential to obtain research objectives.

In this study, there are two types of instruments used to collect data. The first is supporting instruments in the form of worksheets and interview guidelines. Data are analyzed based on written tests and interviews. The worksheet consists of a series of questions as follows: 1) There are 6 right trapezoidal form a rectangle. The rectangle is 15 cm in length and 9 cm in its wide. Calculate the area of 1 trapezoid!; 2) There are 4 isosceles trapezoidal which are joined on the sloping sides to form an inner and outer rectangle. The outer rectangle has an area of 100 cm² and the height of the trapezoid is 3 cm. Calculate the area of the inner rectangle!

This study applies content analysis techniques based on Miles and Huberman's theory with the following steps: 1) Data reduction; 2) Data display; 3) drawing conclusions [26]. The researchers take
data twice to get valid data. The obtained data is compared between the answers in the first problem and the answers in the second problem with the use of time triangulation. Time triangulation shows the collection of data on events, situations, times, and places have the same pattern in order to increase the validity of data [27]. The time range between the first meeting and the second meeting is one week. It aims to examine the consistency of analytical thinking ability indicators owned by subjects with reflective cognitive style.

3. Results and Discussions

By obtaining the research subject, the researchers give the problem-solving task to the research subject. After that, the subject is interviewed to explain the problem clearly and more openly when the subject is asked to express their ideas. In this study, researchers note what has been stated by the subject. To get valid data, the researchers take the data collection twice on each subject. The following are descriptions of written data and verbal transcripts from subject 1 (S1) in figure 1 and figure 2, while subject 2 (S2) is in figure 3 and figure 4.

![Figure 1. The answer to subject 1 (S1) in the first question.](https://example.com/figure1)

Figure 1 shows that the subject can solve the problem. Subject 1 (S1) answers with a trapezoidal shape which is turned in a right angle until it forms a rectangle. The following is a quote of verbal data after the subject answers on the answer sheet. The researchers ask the subject of understanding the problem given to subject 1 (S1). Subject 1 (S1) said, "First, the way I understood the problem by reading the question first. I get some information from this problem, it is known that 6 right trapezoidal. The trapezoidal is merged. Furthermore, the rectangle has a length of 15 cm and a width of 9 cm. What is sought is an area of 1 trapezoid. From the explanation of subject 1 (S1), the subject uses partial analytical characteristics to understand the problem because subject 1 (S1) explains that some of the procedures are not integrated into a whole unit ".

The next step is planning step, the subject explained, "As I have already understood, the first thing I do is drawing 6 known trapezoidal congruent angles. The 6 trapezoids will be flipped back and turned into a rectangle, so I draw it in an elongated shape. This rectangle has a length of 15 cm and a width of 9 cm." Based on the answer, the subject explains with sequentially, but it is not integrated into a unified whole because subject 1 (S1) has not explained the asking information from the task in detail. Thus, subject 1 (S1) has a partial analytical characteristic when he plans a solution.

When carrying out the plan, subject 1 (S1) explains, "Starting with the merging of the 6 right trapezoidal, I focus first on that picture. Because the known information is the length and width of the rectangle, then 15 cm is multiplied by 9 cm, so it gets 135. From the 135 value, it is divided by 6, so it
gets 22.5 \text{ cm}^2. \) From the explanation of the subject, it can be concluded that the subject has not explained the used procedures in detail. The characteristics of the subject are analytic-partial.

Furthermore, when the researchers ask about the way to correct the obtained answers, the subject says, "These results (pointing to the answers) are multiplied by 6, so we get 135.0. It's the same as staying behind the process, from the answer to the known one. From this explanation, the subject explained with a process that was not clear from what is used, such as number 6 that was used. So, the subject has the characteristics of analytic-partial.

Figure 2. The answer to subject 1 (S1) in the second question.

Figure 2 shows when the subject answers the second problem. The subject uses the same method as the first problem. From the answers, the subject solves the problem with a simple process. The following is a quote of verbal data of the subject. The researchers ask the subject about his understanding, "do you understand the purpose of the problem given? Explain the understanding that already exists in your mind!" The subject answered, "I read the question first. I understand the known form. In this case, it is known that 4 trapezoidal legs are joined together to form rectangles. The area of the outer square is 100 \text{ cm}^2. The trapezoid has a height of 3 cm. So, the side that has an outer square is 10 cm. The question is the area of the square inside. From the understanding of the subject, the subject has analytic-partial characteristics because the subject has not explained about the square shape of the intended rectangles.

The next step is describing the planning steps, "The first plan is drawing 4 equal trapezoidal feet which form an inner and outer square. The area of the outer square is 100 \text{ cm}^2 and the trapezoid has a height of 3 cm. The side of the outer square is 10 cm. After that, I begin to answer and I finish my answer". From the answer, it can be inferred that the subject has not planned the answer in detail because subject 1 (S1) has not explained what is asked of the given problem. Thus, subject 1 (S1) has a partial analytical characteristic when planning a solution.

Furthermore, in carrying out the plan, the subject explains, "I started it with the help of a picture. With this outer square shape, the side is 10 cm from the root 100 (s = \sqrt{100} = 10 \text{ cm}) and the trapezoid has a height of 3 cm. Next, this value of 4, I get from 10 minus 3 times 2. The side of the inner square has a length of 4 cm. The square area is 42 equal to 16 \text{ cm}^2. " From this explanation, the subject has not explained the information in detail, such as area denomination. Subjects also incorrectly use the multiplication rule properties. 3 times 2 as well as 2 as many as 3, but based on the subject, it is the same. So, the characteristics possessed by the subject is analytic-partial.
At the stage of correcting the answer, the researcher asks the subject, "How do you correct this answer? It seems you are so sure of your answer. The subject explains, "I'm sure because I saw from here. The extent of the trapezoid is half of the parallel sides multiplied by the height. The alignment side is 10 plus 4, so 14. Next, 14 multiplied by 3 is 42 and 42 divided by 2, which is 21. In the problem, there are 4 trapezoid equals feet, then 21 multiplied by 4 is 84 and 84 plus the square area is 100. Proven the truth of my answer". Subjects explain the process that has not been intact, such as the appearance of values 3 and 4. Then, the characteristics possessed by the subject are analytic-partial.

Based on the test results data, the first and second verbal data, subject 1 (s1) is analyzed and triangulated to obtain valid data. Thus, subject 1 (s1) with reflective cognitive style has partial analytical thinking characteristics when planning a solution, understanding the problem, implementing a plan, and correcting the answers.

Figure 3

Figure 3. The answer to subject 2 (S2) in the first question.

Figure 3 shows that the subject can solve the problem briefly at the completion stage. However, the subject repeatedly makes an inappropriate picture of the problem. The following is a quote of verbal data after the subject answers the question. The researchers ask the subject about the subject's way of answering the question at each stage. The researchers ask about subject's understanding about the given problem, "Explain your understanding presented in this question?" Subject 2 (S2) says, "My understanding is that there are 6 trapezoidal congruent angles forming a rectangle. 2 trapezoidal combined into a rectangle. Next, the rest of the trapezoid is combined and it is similar to the 2 initial trapezoidal. The new shape is a rectangle that has 15 centimeters in length and 9 centimeters in width. Next, take 1 area on the trapezoid. With the trapezoidal formula, a half multiply by the number of parallel lengths, then it is multiplied by the height ". From this explanation, the subject has analytical-partial characteristics, because the subject has not explained in detail about the function of the described formula.

The next step is to plan a solution. The subject explains, "My plan is finding the image that will be made into a rectangle. However, I doubt with the image that I made. So, I repeatedly draw the picture until I finally find it. Then the rectangle is given the length and width. After that, I take one of the 6 right trapezoidal ". From the subject plan, the subject has not explained the length and width in the rectangle and he has not explained the asked information in the question. Thus, subject 2 has analytical-partial thinking characteristics.

After asking about the problem planning provided, the researchers ask about the implementation of the plan carried out by the subject, "After planning the problem, how do you implement the plan that you have planned before?". The subject explains, "First of all, I focus on the image I made. After finding it, I enter numbers 15 and 9 in the rectangle. Then, I take one of the six trapezoids that had been formed into the rectangle. After that, I look for the area of 1 trapezoid. The formula of the area is a half of 3 plus
6 then it is multiplied by 5. The result of the area is 22.5 centimeters square. From the answer, the subject has not explained in detail about the content of the area referred to the subject, such as values 3, 6 and 5. So, subject 2 (s2) has partial analytical thinking characteristics.

The last stage is the stage of re-correcting the obtained answers. The researchers ask how the subject corrects the answers he gets. The subject explains, "The way to correct is by multiplying 15 into 9. So, the answer is 135 as the area of a rectangle. And also I did it this way, 45 multiply 3 equals to 135. The value of 45, I got from 22.5 multiplied by 2. So, the truth of my answer is true." Based on the explanation of the subject, it can be concluded that the subject presents a correction from problem-solving, but it is not integrated into a unified whole, because the subject does not explain the origin of the used value. So, the characteristic possessed by the subject is partial analytical thinking.

Figure 4 shows the results of subject 2 (S2). The subject resolves the problem as he had done in the first problem. The subject solves the problem by experimenting with the image based on the written result of the subject. The following is a quote of verbal data after answering the question. The researchers ask about understanding into subject 1 (S1), "Do you understand the purpose of this problem? Explain the understanding that already exists in your mind!" The subject explains, "I understand the purpose of this problem. There are 4 trapezoidal feet that the height is 3 centimeter. The 4 trapezoidal is combined to form an outer and inner rectangle. The area of the outer rectangle is 100 centimeters squared. After that, I look for the area of the inner rectangle. From this explanation, it can be inferred that the subject explains inaccurately about the meaning of inner rectangle. So, subject 2 (s2) has partial analytical thinking characteristics.

Furthermore, the subject explains the stage of planning a solution, "the first plan is finding information inside the question, such as there are 4 trapezoidal with its height is 3 centimeters, and the area of the rectangle is 100 centimeters squared. Next, I find an image that suitable for the requested conditions by the question. After that, I look for the area of the small rectangle." From the explanation of the subject, he has analytical-partial characteristics, because he has not planned about the asked information on the given problem in detail.

At the plan implementation stage, subject 1 (S1) explains, "I run what I understand by determining the outer side of the rectangle first. I get the outer side from the root of 100 centimeters squared. So, the outer side has a value of 10 centimeters. After that, I get the inner side of the value by diminishing 10 centimeters minus 3 centimeters and 3 centimeters. So, I get 4 centimeters as the side of the inner rectangle. The conclusion is the area from the inside rectangle is 42 or equal to 16." From the
explanation of the subject, the subject has partial analytical characteristics because the subject has not explained comprehensively about the origin of value 3 which is used to describe the answer.

The re-correcting phase of the answer is the last stage. The researchers ask, "How do you correct whether your answer is correct or not?" The subject explains, "I correct by means of 4 plus 3 and add 3 so that I get 10 scores. Then, 10 multiply by 10 equals to 100. It proves that my answer is correct". The explanation of the subject categorized into an analytical-partial characteristic because the subject has not explained in detail the relationship between the subject's answer and evidence of correctness.

Based on the test results of the first and second verbal data, subject 2 (s2) is analyzed and triangulated to obtain valid data. Thus, subject 2 (s2) with this reflective cognitive style has analytical thinking characteristics, namely analytical thinking-partial when understanding the problem, planning a solution, implementing a plan, and correcting the obtained answers. The valid data can be explained in Table 1 as follows:

| Stages          | Subject 1                                      | Subject 2                                      |
|-----------------|------------------------------------------------|------------------------------------------------|
| Understanding Problems | Subject has not explained the intended forms. | Subject has not explained the intended function/formula in detail. |
| Planning Steps  | Subject has not planned yet in detail.         | Subject has not explained the asked information in the question. |
| Implementing Plan | Subject has not explained comprehensively, such as the area denomination. | Subject has not explained the detail the origin of a value which is described as the answer. |
| Re-correcting    | Subject has explained the unclear process.     | Subject has not explained the correctness of described answer in detail. |

Based on Table 1, the researchers compare the results with the indicators of analytical thinking ability that has been described. The presentation of the results will be described as follows:

1. At the stage of understanding the problem, subject 1 (S1) has not been detailed in explaining the masked shape and subject 2 (S2) has not been detailed in explaining the asked function. The characteristics of subject 1 (S1) and subject 2 (S2) are analytical-partial thinking.
2. In the stage of planning a solution, subject 1 (S1) and subject 2 (S2) have partial analytical thinking characteristics. It can be seen from the way they plan the problems. They have not described yet related to the asked information in the question.
3. The next stage is the stage of implementing the plan. In this stage, subject 1 (S1) and subject 2 (S2) have the same analytical thinking characteristics. Subject 1 and subject 2 have partial analytical thinking.
4. Correcting the obtained answers is the last step. Subject 1 (S1) and subject 2 (S2) has a different way of correcting answer, but Subject 1 (S1) and subject 2 (S2) have the same characteristics, namely analytical-partial.

4. Conclusion
Based on the analysis and explanation in the four stages of problem-solving, it can be concluded that the tendency of students' thinking characteristics with reflective cognitive style in solving mathematics problems is partial-analytical thinking.

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