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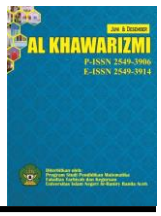

STUDENTS' MENTAL BEHAVIOR IN SOLVING MATHEMATICAL PROBLEMS BASED ON MATHEMATICAL ABILITY AND HIGH COGNITIVE STYLE

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Abstract

Mental behavior is the activities that occur in a person's mind when solving mathematical problems. These activities are important to explore in problem solving, but exploration of activities is still rarely done by lecturers. This study aims to describe mental activities in solving mathematical problems of students who have high mathematical abilities and field independent (FI) and field dependent (FD) cognitive styles. This study uses a descriptive qualitative method with the subjects of the study being mathematics education students at Syiah Kuala University in the 2023 academic year. Data collection techniques were carried out using problem-solving tests and interviews. Data analysis was carried out by data reduction, presentation, and drawing conclusions. Data validity was carried out by time triangulation. The results of the analysis obtained mental activities in problem solving displayed by students with high mathematical abilities and FI cognitive styles were more complete than students with FD cognitive styles in the activities of reading questions, understanding questions, linking information and explaining solutions, but the mental activities displayed by FI were the same as FD at the calculation and manipulation stages. Therefore, it is necessary to provide experience to FD students to improve their ability to explain, organize, and formulate formulas or concepts.

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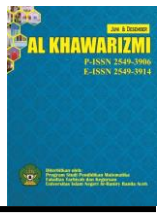


INTRODUCTION

Mathematical problem-solving is a critical component of the curriculum and learning in higher education mathematics. Das and Chandra (2013) stated that problem-solving can develop students' thinking skills, applying conceptual understanding and procedures. Lambdin (2009) emphasized that the primary goal of mathematics learning is to develop understanding and skills in problem-solving and the connection between the two, as mathematics learning with understanding is best supported by engagement in problem-solving. According to Aisyah and Novitasari (2023), the ability to solve mathematical problems is essential for students in order to face the challenges of the Industry 4.0 revolution. Therefore, solving mathematical problems is one of the most important components of mathematics learning.

One issue faced by lecturers in universities is that many students are not skilled in solving mathematical problems. Tambychik and Meerah (2010) stated that many students struggle to apply and implement concepts in problem-solving. In line with this, research by Bambang et al. (2018) showed that most students have difficulty solving non-routine mathematical problems. This is consistent with Anisah & Lastuti (2018), who noted that one of the problems in mathematics learning is the low level of students' mathematical problem-solving ability, which includes understanding the problem, planning, solving, and checking the solution. Therefore, it is important for lecturers to investigate students' mental processes in understanding, selecting concepts, integrating, applying, and explaining the problem-solving process.

The success of a student in solving mathematical problems is determined by their mental behavior in solving the problem. Mental behavior refers to the activities performed during problem-solving. Lester (2013) emphasized that a person's success in problem-solving is determined by experience, knowledge, skills, and understanding through recognizing and building solution patterns. Problem-solving behavior can determine a student's success in problem-solving (Ahmad et al., 2014). Therefore, the mental behavior of students in solving mathematical problems is important to study.

A person's mental behavior in problem-solving can be traced through the problem-solving process (Leiba, 2013). According to Pape and Tchoshanov (2001), problem-solving behavior includes reading the problem, understanding the problem, connecting information, performing manipulations or calculations, describing the final answer, and explaining it.

Mental behavior in problem-solving is influenced by several factors, such as initial mathematical ability and cognitive style. According to Adawiyah et al. (2022), initial mathematical ability impacts the understanding of new concepts because students with prior ability will find it easier to construct conceptual understanding and solve mathematical problems. Cognitive style refers to a student's thinking activity in learning. This aligns with Nurmutia's (2019) view that cognitive style is an individual's psychological process of understanding and reacting to their environment. Additionally, cognitive style is one of the

characteristics that plays an important role in problem-solving (Angeli, 2013). On the other hand, mental behavior in solving mathematical problems refers to the activities a person performs in their mind during problem-solving. Thus, one factor influencing mental activity in problem-solving is cognitive style.

Cognitive style is categorized into two types: field-dependent (FD) and field-independent (FI) (Wakit & Hidayati, 2020). It was further explained that individuals with an FD cognitive style tend to think globally, accept existing information, have a social orientation, follow established goals and information, and are motivated externally. Meanwhile, those with an FI cognitive style are able to analyze and organize objects, have interpersonal orientation, are individualistic, and prioritize internal motivation. These differences in characteristics affect individuals' thinking activities in solving mathematical problems. Therefore, exploring mental activities in solving mathematical problems based on cognitive style differences is important to study.

Several studies are related to the process of solving mathematical problems. The study by Alifiani and El Walida (2020) examined students' metacognitive processes in solving Higher Order Thinking Skills (HOTS) problems based on cognitive style. Yuniara et al. (2023) studied students' mathematical problem-solving abilities based on IDEAL Problem Solving steps in terms of Adversity Quotient (AQ). Puji Astutik et al. (2023) focused on students' errors in solving algebraic linear equations based on Newman's procedure for students with a field-dependent cognitive style. This research is focused on the mental behavior of students in solving mathematical problems related to infinite series and distance, viewed from both FI and FD cognitive styles. Mental behavior is traced through the stages of reading the problem, understanding the problem, connecting information, performing manipulations or calculations, describing the final answer, and explaining it

RESEARCH METHODS

This study employs an exploratory qualitative method to describe the mental activity of students with Field Independent (FI) and Field Dependent (FD) cognitive styles. The subjects of the study are mathematics education students at Syiah Kuala University during the second semester of the 2023 academic year. Data collection was conducted through the administration of a cognitive style questionnaire and a mathematics proficiency test in April 2023. The results of the mathematics proficiency test were classified into three groups: high, medium, and low mathematical ability. The selection of research subjects was based on cognitive style and the results of the mathematics proficiency test (KM). Data on mental activity was collected using a mathematical problem-solving test (TPMM) and interview guidelines. Data analysis was carried out by reducing the data, selecting the data, and drawing conclusions. The data was narratively structured and summarized following the procedure outlined by Miles and Huberman (2012).

Table 1. Description of Mental Behavior Aspects and Interview Questions

Indicators of Mental Behavior	Description
Reading the problem (RP)	Subject activities include reading questions, revealing important information contained in the questions, re-explaining the questions with his/her own thoughts.
Understanding the problem/question (UM)	The subject's activity is interpreting important information in the question into another form in the form of images, spoken/written, symbols, and others.
Linking information (CI)	Subject activities determine important information in questions, make connections using concepts or formulas,
Manipulation and performing calculations (MC)	Subject activities include creating patterns in the form of pictures, symbols, writing and performing calculations.
Writing the final answer (DS)	Subject activity writing down solutions to the problem solving
Explaining the solution (ES)	The subject explains the solution flow using his own mental language

RESULTS AND DISCUSSION

Results

The results of the mathematics ability test on 31 students obtained mathematics abilities into 3 groups, namely high ability, medium ability, and low ability. The grouping results are presented in Table 2 below.

Tabel 2. Frequency of Mathematical Ability

Ability Group	Frequency (Percentage)
High	5 (16,1)
Medium	17 (54,8)
Low	9 (29,1)

Based on table 2 shows the percentage of subjects in the high mathematics ability group is 16.1, medium ability is 54.8 and low ability is 29.1. From the results of the considerations that have been made, we did in order to select interview subjects for the results of cognitive style tests and mathematics ability tests on 31 students, 2 (two) subjects with high mathematics ability were selected. The results of the cognitive style questionnaire obtained subjects who had independent field and dependent field cognitive styles. The results of the cognitive style test are presented in table 3 below.

Table 3 Cognitive Style Frequency

Cognitive Style	Frequency (Percentage)
Field Independen (FI)	6 (19,6)
Field Dependen (FD)	25 (80,4)
	100

Based on the independent field cognitive style group of 2 people, namely subjects with MHS3 code as FI and MHS11 code as FD.

The results of the test and interview on mental behavior in solving problems obtained mental behavior in solving problems which include the ability to read questions, understand questions, associate information, manipulate or calculate, write final answers, and explain solutions. The form of problem-solving test questions to trace mental activity in problem solving is presented as follows.

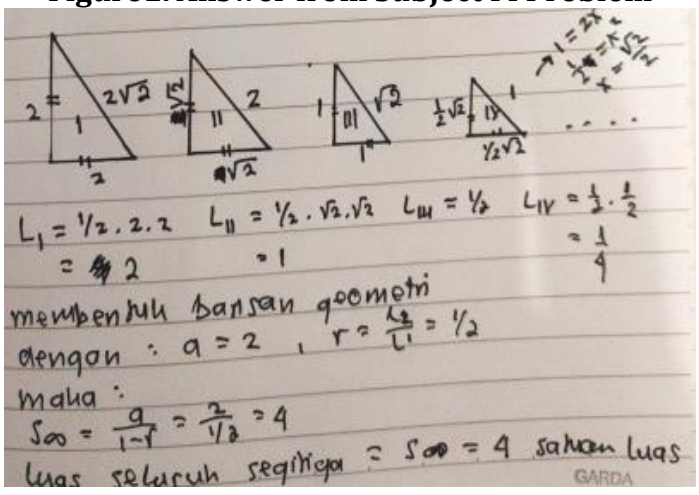
> Given the first isosceles right triangle with a side length of 2 units, an isosceles right triangle is made, the second with the length of the hypotenuse equal to the length of the right side of the first triangle, and so on, namely the length of the hypotenuse is made equal to the length of the right side of the previous triangle. What is the total area of the triangles formed? Write down the information known in the question and explain how you got the answer!

Disscussion

Mental Behavior in Solving Problems in the Subject of Higher Mathematics Ability and FI

From the observation results during the problem solving process by the FI subject, it was obtained that problem solving began with reading the question, slowing down the reading on important words, then working on it. The results of working on the problem by one of the FI subjects are presented as follows.

Figure1. Answer from Subject FI Problem



An excerpt from the interview results with subject FI regarding the results of working on problem 1 is as follows.

P01 : When you read this question, you noticed certain words in the question, why?

SFI01 : First I read, then after reading the second I paid attention to this question, for example, given the first isosceles right triangle with a side length of 2 units, a second isosceles right triangle is made with the length of the hypotenuse equal to the length

of the side of the first triangle, and so on. What is the total area of the triangles formed?

P02 : What do you mean by paying attention to these words [researcher points to the word being paid attention to]

SFI102 : oo..yes sir, so that it is easy for me to understand sir. Isosceles right triangle, the hypotenuse is the same as the right angle of the first triangle.

P03 : From this question, what information can you find and ask?

SFI103 : From the question, sir, it is known that the length of the isosceles right angle of the first triangle is equal to 2, what is asked is the area of all the triangles.

P04 : Can you explain the triangle picture shown here?

SFI104: A right triangle like this picture [subject shows Picture 1] is an isosceles right triangle, the second, third, fourth isosceles right triangle, and so on, sir [while paying attention to the problem]. The area of the first triangle is 2, the second triangle is 1, and so on, forming a geometric sequence with a equal to 2, the ratio equal to 2. We use the formula for the sum of the area series is 4.

P05 : Why do you mention geometric sequences?

SFI05 : First, sir, let's look at this picture [while showing picture 1], the first triangle, the second, and so on, the smaller the area, it forms a geometric sequence with the first term 2 and the ratio r is half.

P06 : Explain where you got your final answer from?

SFI106: because this sequence is geometric, so I use this formula S is equal to a divided by 1 minus r. a here is 2, is half, 2 divided by one minus half is equal to half, so the result is 2.

P07 : Can you explain the answer you wrote from the beginning to the final answer?

SFI07 : From this question, sir, it mentions a triangle [the subject pays attention to the triangle image], I draw a triangle, then I calculate the area, the area results form a geometric sequence, I get the total using the infinite S formula to get 4.

P08 : what does this final answer mean 4?

SFI08 : The area of the entire triangle, sir.

P09 : Explain the answer to the problem?

SFI09 : First, sir, make a picture of the first triangle, the second, and so on, then calculate the area of each triangle, then make a geometric sequence, then calculate the area using the series formula, you get the result, sir.

P10 : Thank you for your answer.

SFI10 : Okay sir, you're welcome sir.

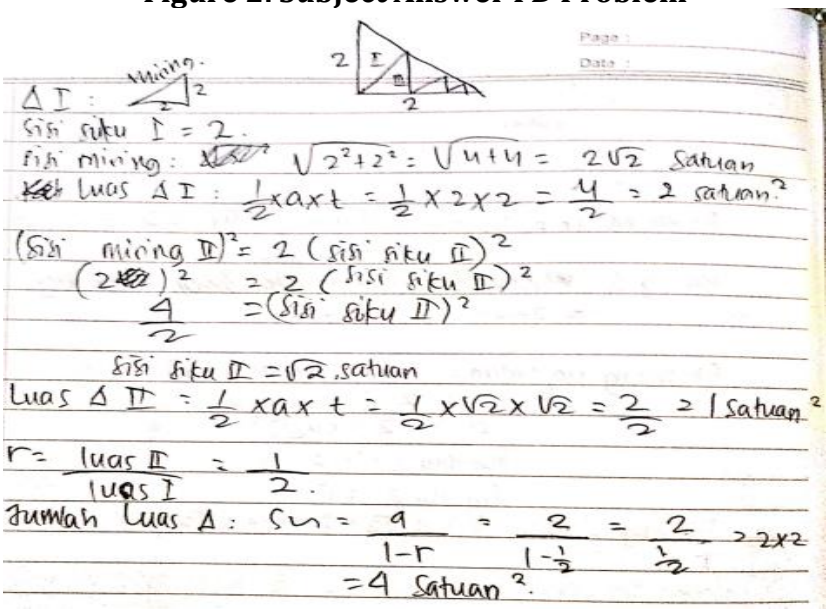
Based on the written answer data in Figure 1 and the interview results, it was obtained that the questions were understood by FI by interpreting important words in the questions into sequential images accompanied by quantities in each image, imagining in the mind of the FI subject that the images form a geometric sequence pattern because the shape gets smaller over time. This is in accordance with the research results of Abidin and Jarmita (2020) using affirmative intuition in understanding and planning problems. At the information linking stage, the activities carried out by the FI subject were in the form of determining the image of an isosceles right triangle and linking it to the area formula for each triangle. At the calculation stage, the mental activity carried out by the FI subject was to calculate the area of each triangle, then form a geometric sequence, then calculate the sum

of the areas of infinite triangles. Furthermore, the FI subject wrote down the final solution and interpreted it as the area of the triangle. The mental activity of the FI carried out at the final stage was an explanation of the steps for solving the problem sequentially and systematically. This is in accordance with the findings of Soesanto and Dirgantoro (2021) that students with high initial mathematical abilities were more likely to display problem-solving abilities.

Mental Behavior in Solving Problems of Higher Mathematics Ability Subjects and FD

From the observation results during the problem solving process by the FD subject, it was obtained that problem solving began with reading the question, then working on it. The results of working on the problem by one of the FD subjects are presented as follows.

Figure 2. Subject Answer FD Problem



Excerpts from the interview results with subject FD regarding the results of working on the problem as follows.

P01 : When you received the question earlier, you read it twice, why?
SFD01 : The first time I read it, it turned out I didn't understand it well, so I read it again, sir,
P02 : What information do you understand from the question?
SFD02 : From this question, it is known that the right triangle is isosceles with a side length of 2 units, the second triangle. The question is how much is the total area of the triangles formed.
P03 : Can you explain the triangle image?
SFD03: From the question, sir, I draw an isosceles right triangle like this picture [subject shows Picture 1], then calculate the length of this side
P04 : Explain where you got your final answer from?
SFD04: First of all, from the geometric sequence, determine the root term, then the ratio, then calculate the total area?

P05 : Can you explain the answer you wrote from the beginning to the final answer?
SFD5 : From this question, sir, it mentions a triangle [the subject pays attention to the triangle image], I draw a triangle, then I calculate the area, the area results form a geometric sequence, I get the total using the infinite S formula to get 4.
P06 : what does this final answer mean 4?
SFD06 : The area of the entire triangle, sir.
P07 : Explain the answer to the problem?
SFD07 : First sir, make a picture of the first triangle, the second, and so on, [the subject pays attention to the solution], then calculate the area of the triangle, after that calculate the number of geometric sequences, you get the result sir.
P08 : Thank you for your answer.
SFD08 : Okay sir, you're welcome sir.

Based on the written answer data in Figure 2 and the interview results, it was obtained that the reading activity carried out by subject FD was that the subject read the questions twice to make them easier to understand, to express information that was known and asked. At the stage of understanding the questions, the activity carried out by FD was to interpret the information in the questions into the form of a triangle image. Furthermore, at the information association stage, the activity carried out by FD was to associate a right triangle with the formulation of the length of the hypotenuse with the sum of the squares of each side of the right angle. At the calculation stage, the activity carried out by subject FD was to calculate the area of each triangle, then form a geometric series. At the final solution stage, the activity of subject FD wrote down the final geometric solution.

These findings are in accordance with the opinion of (Puji Astutik et al., 2023) who stated that people who have an FI cognitive style respond to a task tend to refer to the conditions from within their own minds, while people who have an FD cognitive style see environmental conditions as a guide in responding to stimulus.

Based on the results of the analysis of written data and interviews, there are differences in mental activities carried out by FI and FD in solving mathematical problems. The reading activity carried out by FI is reading slowly on important information words, systematically organizing important information contained in the questions, in the interview it is explained with his own thoughts. So, FI responds to questions by analyzing and being systematic, tending to refer to the conditions in his own mind. This is in accordance with the findings of Alifiani and El Walida (2020) FI involves analysis and paying attention to detail in solving HOTS questions. Meanwhile, the reading activity carried out by subject FD is reading the questions up to 2 (two) times and mentioning important information from the questions in general and less systematically and important information is explained focused on the question text. This finding is in accordance with the statement of Wakit and Hidayati, 2020) that FI has the characteristic of thinking in responding to a problem that tends to refer to the conditions from within one's own mind, while subject FD has the characteristic of thinking in responding to a problem by looking at environmental conditions as a guide in responding to a stimulus. At the stage of understanding the question, the activity carried out by FI is interpreting important information into the form of images by forming certain patterns and equipped with quantities. Subject FI interprets the question by interpreting it with his own mind, not influenced by the thoughts of others. Meanwhile, subject FD needs help from others in interpreting the given question. This result is in accordance with the

findings of Nurafni (2016) that FD interprets the question by focusing on the symbols given in the question.

The mental activity carried out by subject FI at the information association stage is using the Pythagorean equation to find the hypotenuse of each right triangle, and using the triangle area formula to find the area of each triangle. This illustrates that FI uses the triangle area formula to calculate the area. Likewise, the mental activity carried out by FD in making connections by using the area formula to calculate the area of the triangle. At the manipulation and calculation stage, the mental activity carried out by subject FI is thinking about calculating the area, then thinking about formulating geometric sequence patterns, and calculating using the geometric series sum formula. Mental activities carried out by FI on the final solution and explanation are carried out by explaining the steps according to their own language that is thought, but subject FD explains the steps of solving fixated on the writing on the answer sheet. This finding is in accordance with the results of the study.

SIMPULAN

Based on the analysis and discussion of the results, it can be concluded that the mental behavior exhibited by students with high mathematical ability and FI cognitive style is more complete than the mental behavior displayed by students with high mathematical ability and FD cognitive style in solving mathematical problems. This is characterized by their mental behavior in understanding problems, which is described through restating the problem in their own words, visualizing the situation by representing and establishing the formula for the volume of a box, performing calculations, and explaining the obtained results. It is hoped that other researchers can explore the mental behavior of students with low mathematical ability in both FI and FD cognitive styles.

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