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Description of Mathematics Problem Solving Ability Based on Cognitive Learning Style of XI Class Students at Senior High School 19 Gowa

Resmi Mursal[1], A. Husniati[2], Erni Ekafitria Bahar[3*]

[1,2,3]Department of Mathematics Education, Muhammadiyah University of Makassar, Indonesia

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui deskripsi kemampuan siswa kelas XI SMA Negeri 19 Gowa dalam memecahkan masalah matematika berdasarkan gaya belajarnya menjadi focus utama penelitian ini. Subjek penelitian adalah 2 orang siswa yaitu 1 siswa bergaya kognitif *field dependent* dan 1 siswa bergaya kognitif *field independent*. Peneliti merupakan instrument utama dengan instrument pendukung yaitu lembar tes GEFT, lembar tes kecakapan pemecahan masalah, serta panduan wawancara. Kesimpulan penelitian ini yaitu: (1) kemampuan pemecahan masalah subjek dengan gaya kognitif *field dependent* masih kurang karena subjek dapat mengerti permasalahan yang disajikan tetapi belum cakap dalam merumuskan rencana penyelesaian dengan tepat serta belum cakap melaksanakan rencana penyelesaian. Subjek juga belum cakap melakukan pengecekan kembali dengan cermat; (2) Kemampuaan pemecahan masalah subjek gaya kognitif *field independent* sangat baik karena subjek cakap menafsirkan permasalahan dengan apik dan mampu memformulasikan rencana penyelesaian dengan bagus, serta dapat mengaplikasikan setiap langkah penyelesaian yang sudah diraancang. Subjek juga mampu melakukan evaluasi kembali terhadap setiap tahap penyelesaian sehingga subjek yakin akan kebenaran jawabannya.

ABSTRACT

This study aims to determine the description of the ability of students of class XI SMA Negeri 19 Gowa in solving math problems based on their learning style is the main focus of this research. The research subjects were 2 students, namely 1 student cognitive style field dependent and 1 student cognitive style field independent. The researcher is the main instrument with supporting instruments namely GEFT test sheet, problem solving proficiency test sheet, and interview guide. The conclusions of this study are: (1) the subject's problem solving ability with field dependent cognitive style is still lacking because the subject can understand the problem presented but has not been able to formulate a solution plan appropriately and has not been able to implement the solution plan. Subjects also have not been able to do a careful recheck; (2) Subject problem solving ability with cognitive field independent style is very good because the subject is able to interpret the problem neatly and able to formulate a good solution plan, and can apply every step of the solution that has been designed. The subject is also able to re-evaluate each stage of the solution so that the subject is confident in the correctness of his answer.

*Corresponding author
E-mail adderesses: erniekafitria@unismuh.ac.id

INTRODUCTION

The purpose of learning mathematics from elementary school to college level is to teach students the skills to work in a structured, rational, critical, analytical, creative, and innovative manner, as well as the skills to work together with others (Rohmani & Husna, 2020). However, math is one of the lessons that is challenging for students during the learning process (Fauzi, 2018). Ruhyana in Ilmiyah et al. (2022) suggests that the purpose of learning mathematics is not only to improve students' numeracy skills, but so to enhance their problem solving ability.

The term "problem" in mathematics is defined as a condition where individuals are faced with a mathematical problem but have not been able to directly obtain a solution as stated by Aksan in Sukrening et al. (2020). Mathematical problems are conditions that link the aspects of mathematics to solve them. Thus, the ability to solve math problems is a high-level thinking ability because all aspects of knowledge (memory, understanding, application, analysis, synthesis and evaluation), as well as the readiness in accepting the challenges should be involved. Problem solving skills are needed by students, both in terms of concepts in classroom learning and those related to everyday life (Adetia & Adirakasiwi, 2022). However, students' problem-solving skills are still categorized as low. The PISA survey conducted annually on math skills shows that Indonesia ranks low and scores below the international average. Indonesia ranked 73 out of 75 countries based on the results of the PISA test in 2018 where for the math category the average score obtained was 379 which is certainly very worrying (OECD, 2019).

The development of students' ability to solve problems must get attention, especially in learning mathematics. Because it can make it easier for students to deal with various problems in their daily lives (Akbar et al., 2018). Problem solving ability is crucial because it is a fundamental skill that is useful as an effort to improve students' competence, especially higher order thinking skills (Adetia & Adirakasiwi, 2022). Some steps in solving problems include those developed by Polya with the stages of understanding the problem, developing a solution plan, carrying out the plan and re-examine the result (Rina & Bahar, 2021). The purpose of this stage is to make students skilled when dealing with mathematical problems, particularly in applying each of these stages to the problems given accurately, thoroughly and quickly (Aspar, 2021). Problem solving indicators proposed by Polya can be seen in the following table.

Table 1. Problem solving indicator

Trouble shooting Steps	Problem Solving Stages Indicator
Understand the problem	• Focus on important information while ignoring irrelevant information • Rewrite the known elements in the problem • Understand what is asked in the question
Develop a solution plan	• Explain other requirements that are not found in the question, such as formulas or other information if any
Implementing the plan	• Implement the plan that has been arranged to solve the problem • Checking each step of the solution • Make another plan if the plan that has been developed has not been successful
Re-evaluate	• Recheck the solution obtained by using right method or steps • Feel confident about the accuracy of the solution that has been obtained

Information obtained from observations and interviews carried out at SMA Negeri 19 Gowa is that the level of students' ability to solve problems is generally not optimal; students sometimes still have difficulties in understanding the material and solving math problems. This is because majority of students only memorize the concepts and definitions in mathematics without understanding the meaning of their contents. Therefore,

when students are given story problems, they are confused because their understanding of story problems is still lacking. Students generally do not understand the meaning of the problem, making it difficult for them to convert the problem into a mathematical model. This of course has an impact on students' low ability to solve problems which is one of the causes of students' dislike of mathematics. In math learning, some students get low scores and have not reached the KKM (Minimum Completeness Criteria) that has been set. Therefore, the ability to solve problems needs more attention. Many things affect students' ability to solve problems. Ngilawajan (Rohmani & Husna, 2020) explained that in solving math problems, everyone has different thinking patterns, because all individuals do not have the same thinking abilities. Based on the observations made, it appears that students have unequal abilities in receiving learning, there are students who tend to be easier in processing information and there are also those who need more approaches from teachers and peers. In line with this, students' skills in solving math problems are influenced by many factors. One of them is the cognitive style of students (Istigosah & Noordyana, 2022). Cognitive style refers to the way individuals think, process, store, interpret, and utilize information in tasks or problems around them. Witkin (Lestari et al., 2022) explained that cognitive style is generally a person's relationship with his environment. Sternberg and Elena (Ulya, 2015) explained that cognitive style is a link between intelligence and personality. Brown (Ulya, 2015) suggests that cognitive style refers to the characteristics of a person in responding, processing, storing, thinking, and utilizing information to respond to tasks and various threatening situations around.

Witkin (Suwartia & Syaiful, 2023) categorizes cognitive styles into *field dependent* (FD) and *field independent* (FI). In responding to tasks, individuals with FI cognitive style tends to depend on themselves, while individuals with FD cognitive style tends to depend on the group. According to Abrams and Belgrave (Izzati et al., 2021) FI and FD cognitive styles are cognitive styles categorized based on general patterns in thinking, solving problems, learning, and relating to others. So explicitly can be illustrated that FI and FD cognitive styles have a relationship regarding the ability of problem solving. Ulya (2015) found that there is an influence and a positive relationship between cognitive style with skills in solving problems. Research conducted by Alifah and Aripin (2018) also concluded that there are significant differences in the way students solve problems due to unequal cognitive styles.

Based on the above explanation, the purpose of this study was to describe the ability of class XI SMA Negeri 19 Gowa students in solving problems based on their cognitive style.

METHOD

This research aimed at describing the students' problem solving skills based on cognitive styles at class XI of SMA Negeri 19 Gowa. To determine the subjects, the researchers selected a class and distributed a GEFT test to all students in the class. From the test results, the students were then grouped based on their cognitive style to identify students who were field dependent and field independent. The final stage is to select 2 out of the 25 students to be the subject. The main criteria for selecting the subjects were 1 student whose GEFT score was close to 0 (field independent cognitive style) and 1 students whose score is close to 18 (field dependent cognitive style). The researchers also asked for teacher's consideration regarding the students' ability to communicate both in oral and written context to obtain more in-depth information. The researcher is the main instrument in this study, while the supporting instruments were GEFT (Group Embedded Figures Test) sheets adopted from Witkin to determine the students' cognitive style and problem solving test sheets developed by researchers based on Polya's problem solving stages, and interview guidelines containing key questions to explore more deeply related to the subject's problem solving skills. The data collection process began with administering the GEFT test to select 2 subjects who met the criteria, then giving problem solving tests to the subjects, and finally conducting unstructured interviews based on the results of the problem solving test to obtain more in-depth information related to the problem solving skills of the two subjects. The data analysis used the Miles, Huberman and Saldana model with the stages of data reduction, data presentation and conclusion drawing. Data validity was carried out using triangulation method by matching the subject's problem solving test results with the interview results.

RESULTS AND DISCUSSION

Results

The result of GEFT test given to 25 students of class XI SMA Negeri 19 Gowa shows that 72% of students (18 people) met the criteria of *Field Dependent* cognitive style and the remaining 28% (7 people) had *Field Independent* cognitive style. Furthermore, 2 subjects were selected out of the 25 students, namely 1 student having *field dependent* (SFD) with GEFT score 3 and 1 subject having *field independent* (SFI) with GEFT score 16.

The selected subjects then completed a test of mathematical problem solving skills on arithmetic ranks and series material. Then an interview was conducted to collect deeper information about each subject's math problem solving skills based on Polya's steps.

1. Mathematical Problem Solving Ability of *Field Dependent* (FD) Student

a. Understanding the problem

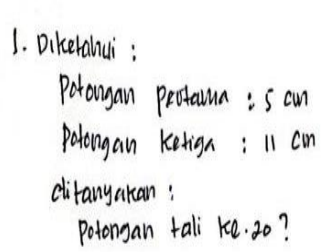

Figure 1. SFD Test Results at the Problem Understanding Stage

The data shows that SFD could write down the known and questionable elements contained in the problem. This means that the subject understands the problem presented in the problem properly. The following interview excerpt support the data.

Table 2 : Excerpt of SFD Interview about the Problem Understanding Stage

Code		Question/Answer
P1-A01	:	From the question, what do you know?
SFD1-A01	:	The known elements are 20 ropes to be cut hold 5 cm of the first piece and 11 cm of the third piece
P1-A02	:	What is asked in the question?
SFD1-A02	:	It asked what the length of the last piece of rope is.
P1-A03	:	is the information in the problem sufficient to solve the problem?
SFD1-A03	:	Yes, it is.

The interview excerpt above indicates that the subject could explain well and smoothly the information in the problem given. The subject also argued that the information was sufficient to find a solution to the problem. The test and interview results on the second problem also indicate that the subject could explain well the known information and what is asked in the problem.

b. Developing a solution plan

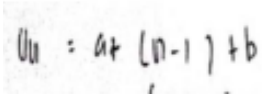

Figure 2. SFD Test Results at the Planning Stage

The test results above show that the formula to be applied by the *field dependent* subject to obtain the solution to the problem is still incorrect. Tracing through interviews shows that the subject's solution plan is to use the arithmetic sequence formula, but the formula applied is not correct because the formula explained by the subject is U_n = a + (n - 1) + b. The subject believes the formula that has been written and explained is correct.

Likewise, the test and interview results for problem number 2 also showed that the solution plan to be applied was not correct because the subject's solution plan for the problem was to use the arithmetic sequence formula, even though the problem presented was related to the arithmetic sequence.

c. Implementing the solution plan

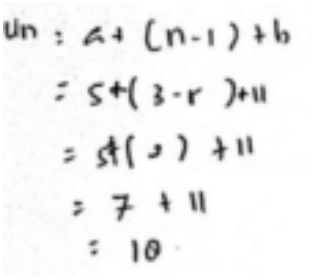

Figure 3. SFD Test Results for Implementing the Plan Stage

The field dependent subject solved the problem (implementing the plan) based on the formula written in the previous stage. The subject was not able to apply the plan well because the formula written at the planning stage was not correct. This resulted in the solution obtained was also less precise. During the interview, the subject also explained that in the process of working, the subject had difficulty in substituting the known values in the problem into the formula. The results of solving problem number 2 are also incorrect because the formula used is also wrong, where the formula used to obtain the solution to the problem should be an arithmetic sequence, but the subject uses the formula for the nth term of the arithmetic sequence.

d. Re-checking

SFD has not been able to fulfill the indicator of evaluating or re-checking. This can be seen from the SFD test sheet by obtaining a final answer that is not correct. Tracing with interviews shows that the subject conducts a re-examination by paying attention to the scribbles (scratches), but the subject has not been able to evaluate that the formula used during the planning stage to solve the two problems presented is not correct which results in the wrong final result or solution.

2. Mathematical Problem Solving Ability of Field Independent (FI) Subjects

a. Understanding the problem

SFI can understand the problem in both problems presented. This is based on the test and interview results. The subject was able to list and explain well and smoothly the known and questionable information in the problem. The subject also argued that the information was sufficient to find the solution to the problems presented in the two problems even though there was some information that was still needed to obtain the final result.

The subject stated that for the first problem, the difference (value b) of the arithmetic sequence should be informed. For the second problem, the information about the first term (value a) of the arithmetic sequence should be known. However, the subject argued that the missing information can be determined by utilizing the known things in the problem.

b. Developing a solution plan

The solution plan that SFI would do to solve the problem shown in the first problem was to first find the information that is still needed, namely finding the value of b (difference in arithmetic sequence) then determining the 20th term by applying the arithmetic sequence formula, namely $U_n = a + (n - 1)b$.The solution plan for the problem in the second problem is to find the value of first term before continuing the process. In this case, SFI explained that the formula to be used was the arithmetic sequence formula $U_n = a + (n - 1)b$ and then tried find the value of the sum of the first 12 terms of the arithmetic sequence with using formula $S_n = \frac{n}{2}(2a + (n - 1)b)$ This shows that the field independent subject fulfills indicator of formulating a solutionn plan. The subject's interview excerpt can be seen as follows.

Table 3. Excerpts of SFI Interview at the Plan Stage on Problem Number 2

Code		Question/Answer
P2-A08	:	After identifying what is known and what is asked, what is the next step?
SFI2-A08	:	I will use the formula $S_n = \frac{n}{2}(2a + (n - 1)b)$ because I need to find the total number of toys.
P2-A09	:	Can you explain the steps you will take to solve the problem?
SFI2-A09	:	First I will find the value of a (the first term because it is unknown)
P2-A10	:	How do you obtain the value of a?
SFI2-A10	:	By using the formula U_n as in number 1 so $U_{12} = a + (12 - 1)1000$ and $12.500 = a + (11)1.000$. Therefore, I can get the value of a = 1.500
P2-A11	:	Will that be the final result or are there any further steps?
SFI2-A11	:	Then I substitute the values of n (many terms), b (difference), and (first term) to the formula $S_n = \frac{n}{2}(2a + (n - 1)b)$to get final result

c. Implementing the solution Plan

The subject carried out the solution plan according to what was planned in the previous stage. The test results of the two problems can be seen as follows.

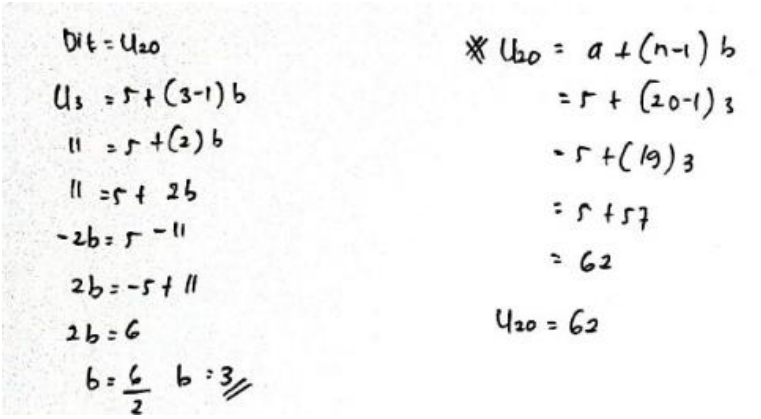

Figure 4. SFI Test Results for Implementing the Plan Stage on Problem Number 1

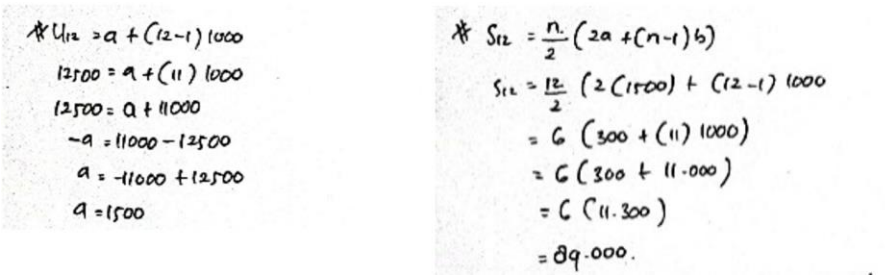

Figure 5. SFI Test Results for Implementing the Plan Stage on Problem Number 2

The test results indicate that the subject is able to solve problems based on the planned procedure. The results of the data collection through interviews revealed that the subject also could explain well and smoothly every solution procedure that has been written down. The subject explained the initial steps in solving the problem by first finding the information needed (difference and first term of the arithmetic sequence) to solve the problem, and then substituting the known elements into the formula so that the accurate solution could be obtained.

d. Re-checking

The subject evaluated or re-examined the result by looking back at each solution procedure that has been applied. In addition, the subject also re-checked at the scribbles carefully to see whether he made a miscalculation or not. Based on the re-examination, the subject was confident that the solutions obtained for the two problems were correct.

Discussion

a. Field Dependent Subject

Field dependent subjects are able to understand the problems given. The subject could identify the known and questionable elements in the two problems presented. In addition, the subject was able to smoothly explain these elements during the interview. Based on the results of this identification, the subject argues that the data contained in the two problems is sufficient to find the solution. This is in line with Rohmani and Husna (2020) research which concluded that a field dependent makes a global adaptation to interpret the problem and process information so that it can write down what is known and what is asked in the problem.

However, the aspect of formulating a solution plan has not been fulfilled by the field dependent subject. In the first problem, the subject was able to relate the known and questioned data so that the solution plan to be carried out by the subject was to apply the formula for finding the nth term of the arithmetic sequence. However, the subject was wrong in writing the formula. The subject wrote the formula for the nth term as U_n = a + (n - 1)+ B; in fact, it should be U_n = a + (n - 1)b. The result of the interview also indicated that the subject was confident with formula that has been written down. This was the case in the second problem given. The subject's solution plan was to keep using the formula to find the nth term of the arithmetic sequence which should apply the formula to find the sum of the first n terms (arithmetic sequence). This means that the subject has not been able to relate between what is known and what is asked so it is concluded that the field dependent subject has not been able to make the right solution plan. Purnomo's research, et al (2017) also concluded that FD students are less capable of determining strategies well to obtain solutions to problems.

b. Field Dependent Subject

The test and interview results indicated that the field independent subject was able to understand the problem well. The subject could explain the elements that were known and asked about the two problems presented. The subject was also able to explain that there was some information that was still needed to find a solution to the problem. However, the subject explained that the missing information could be obtained based

on the elements known in the question. This means that the subject understands the problem given well and understands the relationship between the elements known and those asked about. The research results of Estiningrum, et al (2019) also concluded that field independent subjects were able to write down and explain in verbal language the things they knew and were asked about in the questions completely.

Based on the subject's understanding of the two problems given, the subject prepared a solution plan. First, the subject tried to find the information that was not included in the problem but was needed to solve the problem. AAccording to the subject, in the first problem, the value of b (the difference in the arithmetic sequence) was needed to be able to determine the 20th term of the sequence. Thus, the first step that would be taken to solve the problem was to find the value of b based on the information known in the problem and then find the value of the 20th term of the sequence. The formula written by the subject to find the solution was correct. Likewise, in the second problem, the subject explained that the first step in solving the problem was to find the value of the first term of the sequence and then find the sum of the first 12 terms of the arithmetic sequence. This means that field independent subjects can utilize the information contained in the problem to search for or determine other unknown information which is a requirement to be able to find a solution or resolution of the problem. In this case, the subject could also explain in detail each stage of the solution that would be applied and the formula used was correct. Based on this, it can be concluded that the subject can prepare a resolution plan well. This finding is in line with the research by Sukrening (2020) which states that field independent subjects are able to choose the resolution plan that will be carried out to find solutions to problems and the subjects are also able to explain the procedures used.

The test and interview results showed that the field independent subjects were able to write down completion procedures well based on what had been planned in the previous stage. In the first problem, the subject first figured out the value of b (the difference in the arithmetic sequence) using the formula for the nth term of the arithmetic sequence. After obtaining the value of b, he continued to apply the formula for the nth term the subject determines the value of the 20th term of the sequence. In the second problem, according to the solution plan, the initial step taken by the subject to find the solution to the problem was to apply the formula for the nth term of an arithmetic sequence so that the value a (first term) could be obtained. Next, the subject used the formula for the sum of the first n terms of an arithmetic series to obtain the sum of the first 12 terms. Each solution step written for these two problems on the test results sheet could be explained by the subject well and fluently during the interview. Subjects were also able to explain the reasons for using the formula applied to each problem solution. This finding is in line with Sukrening (2020) research which states that field independent subjects were able to choose a solution plan that would be carried out to find a solution to the problem and the subject was also able to explain the procedure used.

The evaluation stage is carried out by the subject by looking back at each step of the solution. The subject looked back at the known and questioned information and the link between the two. The subject also checked the formula used whether it was correct or not. In addition, each scribble (scratch) is also checked to find out whether there is an error in calculating. After doing this, the subject explained that the solutions to the two problems that had been written were correct.

Based on the explanation above, it is concluded that field independent subjects have good problem solving skills. Field independent subjects can obtain solutions to problems given based on Polya's problem solving stages. Subjects can understand the problem well and are able to identify information that is considered lacking or not contained in the problem but is needed to find the final solution to the problem. The subject can also describe the solution plan well and apply the formula correctly so that the right solution is obtained.

CONCLUSIONS

From the data analysis it can be concluded that: (a) the problem solving skills of the subject with field dependent cognitive style is still lacking because the subject can understand the problems presented but have not been able to formulate a solution plan appropriately and have not been able to apply the solution plan. Subjects also have not been able to evaluate the result carefully. (b) the problem solving ability of the subject with field

independent cognitive style is very good because the subject is able to interpret the problem well and able to formulate a solution plan properly, and able to apply every step of the solution that has been designed. The subject is also able to re-evaluate each stage of the solution so that the subject is confident in the accuracy of his answer.

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