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# Analisis Karakteristik Penyelesaian Masalah Matematika Siswa Berdasarkan Gaya Kognitif di Kelas VIII

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**Abstrak**

Penelitian ini bertujuan untuk menganalisis karakteristik penyelesaian masalah matematika siswa berdasarkan gaya kognitif, yaitu: field independent, field dependent, reflekif dan impulsif. Penelitian ini dilakukan di kelas VIII di SMP PGRI 5 Denpasar sebanyak 45 siswa. Dalam penelitian ini siswa diberikan 4 soal matematika dalam bentuk uraian. Hasil penelitian menunjukkan bahwa siswa memiliki gaya kognitif field independent dapat memahami masalah dengan baik, menentukan perencanaan masalah yang tepat, kurang teliti pada proses penyelesaian masalah dan tidak memeriksa kembali jawabannya. Mampu menyelesaikan soal lebih cepat dari waktu yang ditentukan, namun jawaban kurang tepat. Gaya kognitif field dependent, dapat memahami masalah dengan baik, menentukan perencanaan masalah yang tepat, kurang teliti pada proses penyelesaian masalah dan tidak memeriksa kembali jawabannya. Tidak mampu menyelesaikan soal tepat waktu, namun jawaban cenderung benar. Gaya kognitif reflektif, kurang memahami masalah dengan baik, menentukan perencanaan masalah yang tepat, kurang teliti pada proses penyelesaian masalah dan tidak memeriksa kembali jawabannya. Mampu menyelesaikan soal lebih cepat dari waktu yang ditentukan, namun jawaban kurang tepat. Dan gaya kognitif impulsif, kurang memahami masalah dengan baik, menentukan perencanaan masalah yang tepat, kurang teliti pada proses penyelesaian masalah dan tidak memeriksa kembali jawabannya. Mampu menyelesaikan soal tepat waktu, namun jawaban cenderung salah.

**Kata Kunci**: field dependent, field independent, gaya kognitif, impulsif, karakteristik penyelesaian masalah matematika, reflektif

# *Analysis of the Mathematical Problem-Solving Characteristics Based on Cognitive Style on Students in the VIII Grade*

***Abstract***

*This study aims to analyze the students' mathematical problem-solving characteristics based on cognitive style that is field independent, field dependent, reflective, and impulsive. Fourty-five students of VIII grade at PGRI 5 Junior High School were involved. The students were given 4 descriptive math problems. The result showed that the characteristics of independent field cognitive style showed that could understand the problems, determined the right problem planning, careless in solving, and did not re-check the answer. The subject could solve questions faster than the specified time, but the answer was wrong. For the characteristics of field dependent cognitive style, they could understand the problems, determined the right problem planning, careless in solving, and did not re-check the answer. The subject could not solve questions on time, but the answers tended to be correct. For the characteristics of reflective cognitive style, they did not understand the problems, determined the right problem planning, quite careless in solving, and did not re-check the answer. The subject could solve questions faster than the specified time, but the answer was wrong. For the characteristics of impulsive cognitive style, they did not understand the problems, determined the right problem planning, quite careless in solving, and did not re-check the answer. The subject could solve questions on time, but the answers tended to be wrong.*

***Keywords***: *cognitive style, field dependent, field independent, impulsive, problem-solving characteristics, reflective*

## INTRODUCTION

In the world of education, mathematics is one of the most important subjects (Wijaya et al., 2020). The main objective of learning mathematics is to solve a problem. The problem is relative depending on the different abilities of students because they have different sight on a concept. Their different sight can lead them into different way of problem solving. Problem solving is essential for students to be owned (Hutajulu et al., 2019). To be able to solve math problems, students of course have to master the main concepts so that they are able to organize them. However, to achieve students' conceptual understanding in mathematics learning is not an easy thing because understanding a mathematical concept is done individually.

Each student has different abilities in understanding mathematical concepts. This is also in line with Candiasa's opinion (in Sudiarta, 2016) which stated that every student in learning mathematics will choose his/her preferred way of processing information in response to environmental stimuli. There are students who receive information as presented, while other students reorganize the information in their own way according to their cognitive style.

According to Geni et al. (2016), cognitive style is typical characteristic which is owned by one person in order to solve a problem and will not be owned by another. It is including how students process information, then store and communicate that information when completing assignments. Thus, to improve cognitive processes in students, attention to the characteristics of each individual student is needed. Characteristics in solving problems include how to see, recognize, and organize information.

This research analyzed the problem-solving characteristics of students who had a cognitive style based on conceptual and psychological tempo. Psychological types of cognitive style are field dependent and field independent. While the type of cognitive style based on conceptual tempo is reflective and impulsive. Riswan et al. (2018) stated that problem solving characteristic which related to answer a question in a slow manner, but tend to be correct is called as reflective cognitive style, while a spontaneous act of answering a question, but tend to be wrong is called as impulsive cognitive style. While the cognitive styles of field dependent and field independent of students will affect the dimensions of personality that affect attitudes and the process of solving mathematical problems.

As educators, knowing the differences in students' cognitive styles is very important in learning mathematics. Through cognitive style analysis, it can be seen how students process and accept knowledge. Some are fast, medium, and some are very slow. Therefore, they often take different ways to be able to understand the same information or lesson. If the teaching staff can understand how the different cognitive styles of each individual student are, it will be easier for the educators to guide someone to get the right learning style and give maximum results for him.

There are various studies which stated that students' cognitive styles can affect mathematics learning achievement. Letteri (1980) conducted research related to differences in students' cognitive styles in learning mathematics. The results of the study stated that students with type 1 cognitive style, that is, focused, complex, reflective, sharp, and tolerant outperformed students with type 2 cognitive style, that is, unfocused, simple, impulsive, broad-minded, and intolerant. Then, Letteri also said that students with a field independent cognitive style were superior in their achievement in mathematics. Farmani (2015) stated that students' cognitive styles and learning styles have an effect on the error rate of algebra in solving math problems. The results of this study indicated that students with a field dependent cognitive style have a higher error rate of 55.92 times than students with a field independent cognitive style.

In the research of Azari, S., et al (2013), it was shown that differences in cognitive styles affect student performance in learning mathematics. Students with field dependent cognitive styles tend to have lower performance than students with field independent cognitive styles in solving story problems in mathematics. Cognitive style also affects the nature of decision making which in turn can improve the quality of behavior change, the ability to perform better and make individuals think efficiently.

The results of research conducted by Windi, S. (2016) stated that there are differences in metaphorical thinking of students who have reflective and impulsive cognitive styles in solving math problems. Students with impulsive cognitive styles tend to give very quick answers than correct answers.

Meanwhile, students with a reflective cognitive style are very methodical and slow learners, but the answers given tend to be correct.

Based on the results of the research presented, it can be concluded that the cognitive style of students has an important role in learning mathematics. The cognitive style would affect the amount of information that students could absorb, understand, and reuse. When the learning was not in accordance with a student's cognitive style, the student would feel uncomfortable when participating in the learning process. The student's discomfort could lead to errors in understanding mathematical concepts.

There are so many studies on the relationship of cognitive styles to solving math problems. However, this study more focused on the characteristics of VIII grade students of PGRI 5 Junior High School in solving mathematical problem based on holistic-analytic, linear-flexible, meaningful-shallow, persistent-uncertain, self-confident, and conceptual-procedural, in order to look for the differences of each characteristic that were shown by the students in four kind of cognitive styles. Therefore, this study explored more deeply about the differences and characteristics of students' answers based on their cognitive style in solving mathematical problem, so that the researcher took the title "Analysis of the Mathematical Problem-Solving Characteristics based on Cognitive Style on Students in the VIII Grade, PGRI 5 Junior High School Denpasar."

## METHOD

This research is a qualitative research. The were 45 students of VIII Grade in PGRI 5 Junior High School, Denpasar, were selected as the subject of this study. Based on the interview and observation during the learning process, they were selected through purposive sampling technique because they were heterogeneous as they came from different admission pathways and had good communication skill. Besides, they were selected because they have studied the material that the researcher would use.

After selecting the subject, they would be given instrumens. The instruments in this study were a test on the functional material, the GEFT (Group Embedded Figures Test) with 7 questions in first phase and 8 questions in second phase, the MFFT (Matching Familiar Figure Test) test with 10 items, and interviews. GEFT was provided to figure out students' cognitive style, whether they had field independent or field dependent cognitive style, while MFFT was provided to find out whether the students had reflective or impulsive cognitive style. Then the characteristics of students' mathematical problem solving could be seen from the essay questions of the function material that had been made and analyzed. The questions of the essay had several indicators, those were having more than one solving process, having more than one answer, involving logical thinking and reasoning, reflecting real situation and students' interest, and consisting of non-routine questions which needed more than a procedure or formula to solve them.

After the data were collected through the instruments, an analysis from the results of the math tests was conducted by seeing how students solve math problems in the function material based on the type of cognitive style they have. Data analysis was performed using the Miles and Huberman model. In this case, the stages of data analysis were data reduction, display data, and conclusion drawing/verification.

## RESULTS AND DISCUSSION

Based on the results of the essay test, it was found that the characteristics of solving mathematical problems were based on the field independent, field dependent, reflective, and impulsive cognitive style. In this study, the characteristics of solving mathematical problems were taken according to Malloy, et al. (1998) and Polya.

The results of the analyzed students' answers were then grouped based on their cognitive style. From each cognitive style the student has, it was continued by taking the subject for an interview. This interview was conducted to strengthen the results of the analysis of students' mathematical problem-solving characteristics based on their cognitive style.

Based on the results of the analysis of the characteristics of students' mathematical problem solving based on cognitive style, the general characteristics of problem-solving were obtained which can be seen in Table 1 below.

 

Table 1 Characteristics of Mathematical Problem Solving based on Cognitive Style

| Cognitive Style | Characteristics of Mathematical Problem Solving according to Malloy, et al. (1998) | | | | | |
|---|---|---|---|---|---|---|
| | **Holistic-Analytical** | **Linear - Flexible** | **Meaningful -Shallow** | **Persistence-Uncertain** | **Self Confidence-Not** | **Conceptual-Procedural** |
| Field Independent | Analytical | Linear and Flexible | Meaningful | Persistent | Confidence | Conceptual and Procedural |
| Field Dependent | Analytical | Linear | Meaningful | Uncertain | Confidence | Conceptual and Procedural |
| Reflective | Holistic | Linear | Meaningful | Persistent and Uncertain | Confidence | Procedural |
| Impulsive | Analytic | Linear | Shallow | Persistence | Confidence | Procedural |

The following would describe the results of students' answers in answering each cognitive style that the students had. Subject 1 (S1) is a student who has a Field Independent cognitive style.

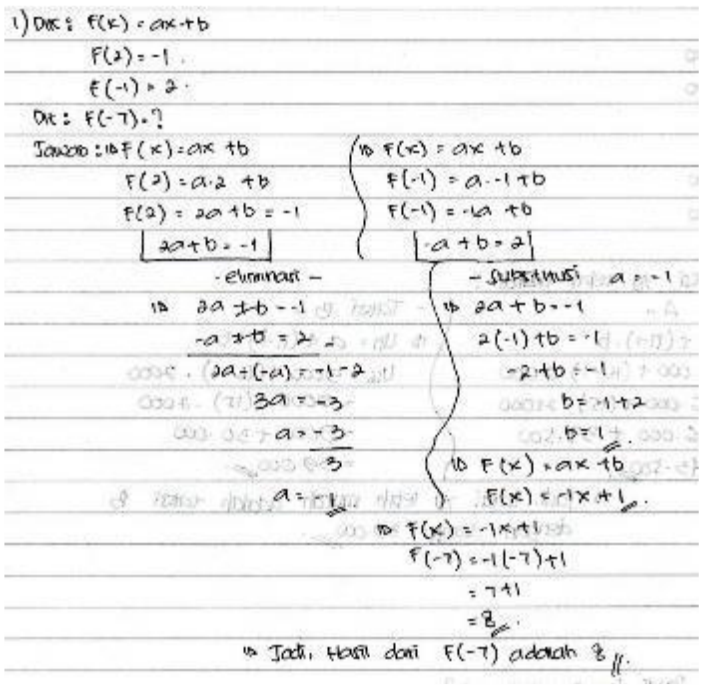


Figure 1 The Sample Work of Subject 1

Based on the results of the instrument for Subject 1 which is also can be seen on the sample work above, in understanding the problem, S1 was able to retell what was known and what was being asked in the questions correctly which could be seen in the transcript of the interview below:

Teacher : How is the formula to solve the problem in the first question
S1 : Firstly, I make the general form of f(x) = ax + b, then I decide the value of a and b so then I can get the result from f(-7).
Teacher : What are the steps which can be done to get the value of a and b?
S1 : Making the equation of f(2) = -1 and f(-1) = 2. Those two were substitued to f(x) = ax + b, so then we can get the equation which can be eleminated

This is because the FI subject was able to organize objects that were not well organized (Andriyani, 2018). So that the FI subject had no difficulty in understanding the problem. The step of planning the problem was also done well, S1 could determine the solution plan very well and was able to link mathematical concepts that could be used in solving problems. S1 could restate the information provided in the questions. S1 was also able to use graphics as a model and action in understanding problems and finding solutions. However, at the implementation stage of the plan, there were errors in the algebraic calculation operations and errors in entering data, where the data written at the beginning was different from the data processed at the time of the calculation. From this it can be concluded that S1 did not check the answer again so that an error occurred at the end of the answer. S1 also concluded that the answer was not in accordance with the results obtained, where there were several steps that were not written down but S1 came up with the correct conclusion.

If it is related to the characteristics of problem solving according to Malloy, et al. (1998), S1 has problem solving characteristics which are: (1) Analytical, because the problems solving starts from specific things to the general, where the answers written directly lead to the things being asked and focus find the answer without writing down what is known and asked for the question. This is in accordance with the explanation from Rahman (2013) which stated that the independent field subjects have analytical properties, so that their perceptions are not affected by changes in context. (2) Linear and Flexible, Linear means that S1 solves the problem in one way that is shown from the same solution method as the teacher's explanation, then S1 also has the characteristic of being flexible because it is able to find a different way from the teacher's explanation. (3) Meaningful, because the completion is in accordance with what is asked in the questions and has the right procedure. (4) Persistent, because in some questions S1 could solve problems faster than the specified time. (5) Confidence, because S1 felt confident that the answer made is correct. (6) Conceptual and Procedural, because S1 was able to link the concepts needed to solve the problem correctly. S1 is also able to understand mathematical ideas and mathematical concepts for solving a problem.

Subject 2 (S2) is a student who has a Field Dependent cognitive style. Based on the results of research and interviews, in understanding the problem, S2 was able to determine what is known, and to mention / write about what was being asked in a verbal sentence, but it was not accurate. The subject FD replaced what was known and what was asked into mathematical sentences, but not all of them were successfully translated, some were still ordinary verbal sentences. This is because the FD subject was not guided in doing problem-solving tests, while the FD subject liked to seek guidance from the teacher (Yasa, et al, 2002). S2 could convey information in questions a unique language. The step of planning the problem was also done well, S2 could determine the solution plan very well and was able to link mathematical concepts that can be used in solving problems. However, at the implementation stage of the plan, there were errors in the algebraic calculation operations due to inaccuracy and lack of time to answer questions. Furthermore, the FD subject took quite a long time to solve the problem. This is in line with the results of previous research, FD students are not yet complete in developing strategies (Geni et al., 2017). The plans and actions decided to use the FD subject did not lead to the correct solution, this was because the FD subject received information globally so that it was less able to organize information independently and used incorrect solutions (Haryanti & Masriyah, 2018; Hardianto, 2018). Therefore, the FD subject is categorized as lacking in planning steps to solve the problem. At the re-examination stage, S2 did not check the answer again because he/she was sure and had confidence in what was made.

If it is related to the characteristics of problem solving according to Malloy, et al. (1998), S2 has problem solving characteristics that are: (1) Analytical, because solving problems starts from specific to general matters, where the answers written directly lead to the things being asked and focus find the answer without writing down what is known and asked for the question. 2) Linear, which means that S2 solves the problem in a way that is shown from the same solution as the teacher's explanation. (3) Meaningful, because the completion is in accordance with what is asked in the questions and has the right procedure. (4) Uncertain, because in several questions S2 made irrational and incorrect calculation errors. (5) Self-confidence, because S2 felt confident that the answer made is correct. (6) Conceptual and Procedural, because S2 was able to link the concepts needed to solve the problem correctly. S2 was also able to understand mathematical ideas and mathematical concepts for solving a problem.

 

Subject 3 (S3) is a student who has a reflective cognitive style. Based on the results of research and interviews, in understanding the problem, S3, was able to tell what was known and what was being asked in the questions correctly. The step of planning the problem was also done well, S3 could determine the solution plan very well and was able to link mathematical concepts that can be used in solving problems. However, at the stage of implementing the plan, there was an error in the algebraic calculation operation. From this, it can be stated that S3 did not check the answer again so that an error occurred at the end of the answer. S3 also could not solve one problem because it was too slow to solve questions that are in accordance with the characteristics of the reflective cognitive style. However, the answers given tend to be correct.

If it is related to the characteristics of problem solving according to Malloy, et al (1998), S3 prefers to work on questions starting from general to specific things which are marked by writing answers from what is known and asked in the questions. Then from the problem-solving process, S3 did what was asked in the questions. Based on this, S3 has the characteristics of solving problems that are: (1) Holistic, because solving problems starts from general to specific things, where the answers are written starting from things that are known and asked. (2) Linear, Linear means that S3 solves the problem in a way that is shown from the same solution method as the teacher's explanation. (3) Meaningful, because the completion is in accordance with what is asked in the questions and has the right procedure. (4) Persistence and uncertain, because in some questions S3 could solve the problem faster than the specified time, but there is 1 question that could not be solved because time ran out. (5) Self-confidence, because S3 felt confident that the answer made is correct. (6) Procedural, because S3 was more oriented to process and problem-solving steps.

Subject 4 (S4) is a student who has an Impulsive cognitive style. Based on the results of research and interviews, in understanding the problem, S4 was able to retell what was known and what was asked, but there were some facts that were known in the questions which were not written in the answer. S4 in this study did not conduct an in-depth study of the adequacy of the facts given in solving the problem. However, S4 could convey information in questions in their own language.

The step of planning the problem was also done well, S4 could determine the solution plan very well and was able to relate mathematical concepts that can be used in solving problems. However, at the implementation stage of the plan, there was an error in the algebraic arithmetic operation because S4 was rushing to work on the questions so that the answers tended to be wrong. This is consistent with the impulsive cognitive style which tends to answer questions quickly but the results tend to be wrong. At the re-examination stage, S4 did not check the answer again because the subject was already confident and confident about what the subject was doing.

If it is related to the characteristics of problem solving according to Malloy, et al. (1998), S4 has problem solving characteristics which are: (1) Analytical, because solving problems starts from specific things to the general, where the answers written directly lead to the things being asked and focus find the answer without writing down what is known and asked in the problem .. (2) Linear, Linear means that S4 solve the problem in a way that is shown from the same solution method as the teacher's explanation. (3) Superficial, because the solution that was done was not in accordance with what was asked in the question and had an inappropriate procedure. (4) Persistence, because in some questions S4 could solve the problem faster than the specified time. (5) Confident, because S4 felt confident that the answers made are correct. (6) Procedural, because S4 as able to understand mathematical ideas and mathematical concepts for solving a problem.

## CONCLUSION

In general, Subject 1 could understand the problem well. The S1 also could determined the right problem planning, however, they were careless in the problem-solving process. Besides, they did not re-check the answer. Even though they solved the question faster than the specified time, the answer was not quite right. Besides, Subject 2 could understand the problem well. The S2 also determined the right problem planning, however, they were careless in the problem-solving process. They did not re-check the answer again. Even though they could solve questions on time, but the answers tended to be correct. Moreover, Subject 3 did not understand the problem well and determined the right problem planning. However, they were careless in the problem-solving process and did not re-check the answer.

Even though they solved the question faster than the specified time, but the answer was not quite right. Therefore, Subject 4 did not understand the problem well. The S4 determined the right problem planning, however, they were careless in the problem-solving process. They did not re-check the answer. Even though they could solve questions on time, but the answers tended to be wrong. Even though this reasearch had been completed, there is still a lack of study scope that occurs. Other researchers who are interested to study on similar field are suggested to be able to develop a wider scope of material because the material used in this research was only limited to VIII grade functions. Whereas for teachers, especially teachers of mathematics, the learning process needs to understand the cognitive style of students in solving problems, so that they can provide the treatment needed by students to improve their ability in solving problems.

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