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Students' mathematical ability in solving number pattern problems viewed from cognitive style

Luthfi Rahmasari[1], Sri Rejeki[2*]

[1,2] Mathematics Education, Muhammadiyah University of Surakarta, Central Java, Indonesia

[*] Correspondence: sri.rejeki@ums.ac.id

Abstract

Problem-solving skills become part of the mathematics learning curriculum, including students' mathematical abilities and cognitive activities. Number Patterns are an essential subject in mathematics learning. However, students' ability to understand the concept of Number Patterns has not been optimal. Therefore, this study aims to describe the problem-solving ability of student Number Patterns based on cognitive style. The research uses qualitative methods with a descriptive approach. The study subjects were four class VIII students at a public junior high school in Klaten Regency. The study involved all students of grade 8 who were selected by administering the GEFT test and a Number Pattern problem-solving test; then, four students were selected for an interview. Instruments used in this study include the GEFT test and the problem-solving of Number Patterns. Research data is collected through test techniques, interviews, and documentation. Method triangulation techniques validate the data. Data is processed by reducing data, presenting data, and verifying. The results showed that FD students were less able to solve problems, which was demonstrated by FD students understanding the problem, devising a plan, and carrying out the plan. However, FD students have not been able to look back at the settlements that have been made. While FI students can solve problems well, which FI shows, students can understand the problem, devise a plan, carry out the plan, and look back at solutions.

Keywords: cognitive style, mathematical ability, number patterns, problem solving

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Introduction

Mathematics learning invites students to learn meaningfully and think creatively (Damayanti & Sumardi, 2018) and have aspects of knowledge and skills (Anggraini & Rejeki, 2020). Yayuk et al. (2020) concluded that there are still difficulties for students who are low in mathematics and follow problem-solving-based learning. The ability to solve mathematical problems of Indonesian students still needs to be improved and considered further (Nur & Palobo, 2018), one of which is the ability of students to understand the concept of Number Patterns that have not been optimal (Ainun et al., 2019). Therefore, students will have difficulty establishing relationships with their environment and life in the absence of mathematical abilities.

Mathematics skills are essential for students. Problem-solving has become an integrated part of the mathematics learning curriculum (Pagiling, 2019), including students' mathematical abilities and cognitive activities (Pesona & Yunianta, 2018). In solving problems, students face complex and uncertain situations requiring analysis, reasoning, and thinking (Güner & Erbay, 2021). A problem can be a mathematical problem if the problem is non-routine (Suarsana et al., 2019).

According to Noviyanti et al. (2021), some steps must be taken in solving mathematical problems, namely the steps of solving problems by Polya (1973). The problem-solving measures by Polya (1973) include: (1) understanding the problem; (2) devising a plan; (3) carrying out the plan; (4) looking back.

In addition to the availability of related problems, problem-solving skills have a significant role in mathematics learning because in solving problems, students must be able to reason, communicate, connect, represent, and apply knowledge on five mathematical topics (Al-Mutawah et al., 2019). According to Nurojab et al. (2019), mathematical problem-solving skills are a learning approach that focuses on observation and search methods, observation of existing problems, and preparation of temporary guesses for the further re-examination of results for conclusions.

Number Pattern is an essential material in grade 8 mathematics subjects (Sari et al., 2020). Number Pattern material refers to students' inductive reasoning (Ariyanti & Setiawan, 2019) and can hone students' ability to think (Susanti & Setianingsih, 2019) and generalize number patterns (Raharjo et al., 2020).

Mathematical problem-solving skills and cognitive aspects of students are two things that cannot be separated. There are certainly differences in the way and time needed for each student in the completion process of solving mathematical problems, which is influenced by cognitive style (Indah et al., 2021). According to Kusumaningtyas et al. (2017), cognitive style is the difference between individuals compiling and processing information. There are two types of cognitive styles that are often found in research: the Field Dependent (FD) cognitive style and the Field Independent (FI) cognitive style.

According to Nur and Palobo (2018), students with field-dependent cognitive styles have global thinking, are more sensitive to social and interpersonal things, and are more likely to work in groups. Students with independent field cognitive styles tend to be separated in observing stimuli without the help of teachers, dislike social events, like abstract principles and

things, are less capable in interpersonal relationships, feel more efficient when working independently, and tend to use their abilities and do not depend on their environment (Mahfiroh et al., 2021).

Research conducted by Suhatini et al. (2019) showed that students with FD cognitive style could identify known things and ask questions. Students have not been able to write a complete plan precisely. Students can carry out the plan devised, but there are still mistakes. Students are not capable of looking back the problem-solving. Research conducted by Nuraida et al. (2022) shows that students with FD cognitive style can identify things that are known and ask questions in solving math problems. Students can devise a plan well and carry out the plan to make conclusions. However, students are less able to look back at completion.

Based on the research, it can be compared that there are changes in the mathematical ability of FD students in solving problems; namely, in the study by Suhatini et al. (2019), students can meet the indicators of solving problems at the stage of understanding the problem. However, students have not been able to meet the indicators of devising a plan, carrying out the plan, and looking back. While the latest research conducted by Nuraida et al. (2022), students can meet indicators of problem-solving ability at the stage of understanding the problem, devising a plan, and implementing the plan, students have not been able to meet indicators at the stage of looking back.

Research conducted by Nur and Palobo (2018) showed that in solving math problems, students with FI cognitive style could write down things that are known and asked in their language in the form of notation. Students can draw up plans appropriately. Students can carry out the plan that has been drawn up to obtain the right completion results. Students can study and re-examine the truth of problem-solving. Besides, research conducted by (Mahfiroh et al., 2021) showed that students with fi cognitive style could explain things that are known and ask questions. Students can draw up plans in their language. Students can implement plans with the correct formulas and procedures. Students can re-examine the plan and completion until it concludes.

Based on research conducted by Nur and Palobo (2018) and the latest research conducted by (Mahfiroh et al., 2021), students with FI cognitive style can meet indicators of mathematical problem-solving skills at the stage of understanding the problem, devising a plan, carrying out the plan, and looking back. Students with the cognitive style of FI have mathematical problem-solving skills that are evenly distributed to each individual.

Based on the importance of problem-solving skills and the importance of Number Pattern material, this study aims to describe students' mathematical problem-solving skills on number pattern problems judging from cognitive styles. With this goal, it is expected to be useful to improve students' mathematical ability to solve problems in number pattern problems and can be an evaluation in enhancing students' mathematical ability to solve number pattern problems.

Methods

The research uses qualitative methods with a descriptive approach. The author uses the descriptive approach because it describes the data that has been obtained related to the ability to solve mathematical problems of students on the problem of Number Patterns. This research was conducted at one of the state junior high schools in Klaten Regency, Central Java, Indonesia.

The subject selection procedure is carried out in stages by administering the GEFT test (Mahfiroh et al., 2021) and testing the problem-solving of Number Patterns. Four students can be selected from these stages, conducted in the interview stages. The subjects in this study were four class VIII students at one of the state junior high schools in Klaten Regency. Four students consisted of two students with Field Independent (FI) cognitive style and two with Field Dependent (FD) cognitive style. The subject was selected because it has met the criteria as a Field Independent (FI) and Field Dependent (FD) subject.

The instruments used in this study consisted of the GEFT test and the problem-solving of number pattern problems. The instrument is composed by the author. Furthermore, the instrument is validated by a lecturer and a mathematics teacher. In this study, the instrument in the form of a Number Pattern test question consists of three questions. However, one question that will be analyzed in more depth, namely:

> *An arrangement of food dishes on a plate forms an arithmetic row consisting of 10 lines. If the first row contains five dishes and the last row includes 35 plates, determine the number of dishes of food served.*

Data collection in this study was carried out using test techniques, interviews, and documentation. The data obtained is then validated by the triangulation technique of the method. Data collection was carried out in January 2022. Data analysis in this study refers to Miles and Huberman's data analysis, i.e., reducing data, presenting data, and inferring or verifying.

Results

Based on an analysis of GEFT tests from 32 students in grade 8, 20 students with FD cognitive styles were obtained, and 12 students with FI cognitive styles. After the GEFT test, a number pattern problem-solving ability test was carried out. The number pattern problem-solving ability test consists of one description question, where the problem is a non-routine problem.

Problem Solving Ability of Number Patterns in Students with Field Dependent Cognitive Style

Of the 20 FD students, two students are interviewed and described in this article. These students are FD 1 and FD 2. The results of the Number Pattern problem-solving ability test by FD 1 at the stage of understanding the problem is shown in Figure 1.

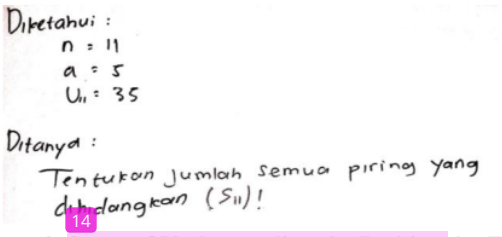

Figure 1. Stage of Understanding the Problem by FD 1

Based on Figure 1, FD 1 can understand the problem well. FD 1 can decipher the information contained in the question to write down things that are known and asked on the question. This is to the interview results, which states that FD 1 can understand the things known and asked questions. The results of the Number Pattern problem-solving ability test by FD 1 student at the stage of devising a completion plan is shown in Figure 2.

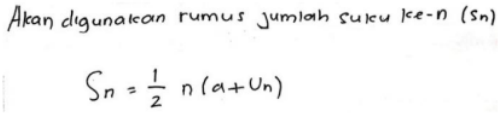

Figure 2. Stage of Devising a Plan by FD 1

Based on Figure 2, FD 1 can devise a completion plan correctly. FD 1 can connect the information on the problem with the concepts of Number Patterns and then determine the formula. The interview results state that FD 1 can draw a complete plan with the right ideas and procedures. The results of the Number Pattern problem-solving ability test by FD 1 at the stage of carrying out the plan that has been devised is shown in Figure 3.

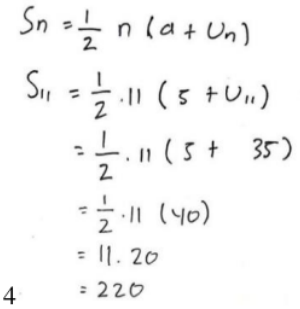

Figure 3. Stage of Carrying Out the Plan by FD 1

Based on Figure 3, FD 1 can carry out the plan that has been devised correctly. FD 1 can solve problems in problems by using concepts and formulas of Number Patterns that have been arranged. This is by the interview results, which state that FD 1 can carry out the plan devised to solve problems on problems with the right concepts and formulas. The results of the Number Pattern problem-solving ability test by FD 1 at the stage of looking back on the completion is shown in Figure 4.

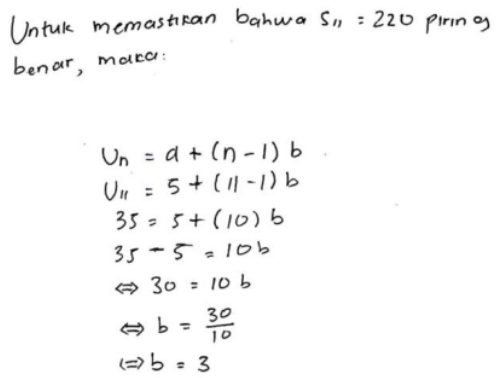

Figure 4. Stage of Looking Back by FD 1

Based on Figure 4, FD 1 cannot look back at the complete settlement. FD 1 has not been able to look back at the settlement by proving the correctness of the settlement and the results obtained. This is to the results of the interview, which states that FD 1 can look back at the stage of understanding the problem, devising a solution plan, and carrying out the plan that has been devised. However, FD 1 is not able to look back after checking the S_n formula with the given time allocation, so FD 1 is not able to make conclusions from the completion of the problem. The results of the Number Pattern problem-solving ability test by FD 2 at the stage of understanding the problem is shown in Figure 5 below.

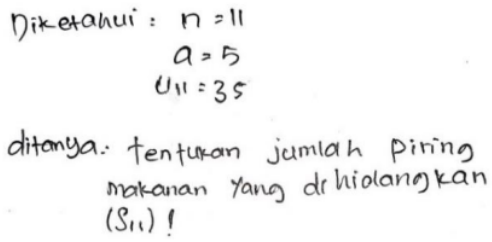

Figure 5. Stage of Understanding the Problem by FD 2

Based on Figure 5, FD 2 can understand the problem well. FD 2 can decipher the information contained in the question to be able to write things that are known and asked on the question. This is following the interview results, which state that FD 2 can understand known things and ask questions. The results of the Number Pattern problem-solving ability test by FD 2 at the stage of devising a completion plan is shown in Figure 6 below.

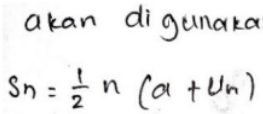

Figure 6. Stage of Devising a Plan by FD 2

Based on Figure 6, FD 2 can devise a completion plan. FD 2 can connect the information on the problem with the concepts of Number Patterns and then determine the formula. This is

following the interview results, which states that FD 2 can devise a completion plan with the correct concepts and procedures. The results of the Number Pattern problem-solving ability test by FD 2 at the stage of carrying out the plan that has been devised is shown in Figure 7.

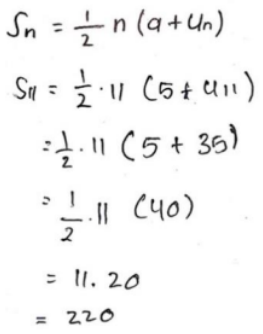

Figure 7. Stage of Carrying Out the Plan by FD 2

Based on Figure 7, FD 2 can carry out the plan that has been devised correctly. FD 2 can solve problems in problems by using concepts and formulas of Number Patterns that have been compiled. The interview results state that FD 2 can carry out the plan devised to solve problems with the right concepts and formulas. The results of the Number Pattern problem-solving ability test by FD 2 at the stage of looking back on the completion is shown in Figure 8.

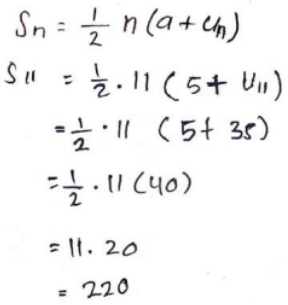

Figure 8. Stage of Looking Back by FD 2

Based on Figure 8, FD 2 cannot entirely look back at the settlement. FD 2 cannot look back at the settlement by proving the correctness of the settlement, and the results obtained and only write back the answers when carrying out the plan that has been devised. This is following the interview results, which show that FD 2 can look back at the stage of understanding the problem, devising a settlement plan, and implementing the plan that has been devised. However, FD 2 could not look back after checking the S_n formula because they felt confused. Hence, FD 2 was unable to make conclusions from the completion of the problem.

Problem Solving Skills of Number Patterns in Students with Field Independent Cognitive Styles

Of the 12 FI, two students were interviewed and described in this article. The students are FI 1 and FI 2. The results of the Number Pattern problem-solving ability test by FI 1 at the stage of understanding the problem is shown in Figure 9.

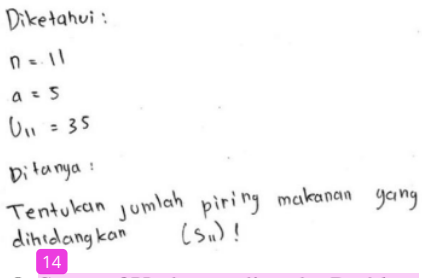

Figure 9. Stage of Understanding the Problem by FI 1

Based on Figure 9, FI 1 can understand the problem well. FI 1 can re-decipher the information contained in the question to write down known and asked things on the question. The results of the Number Pattern problem-solving ability test by FI 1 at the stage of devising a completion plan is shown in Figure 10.

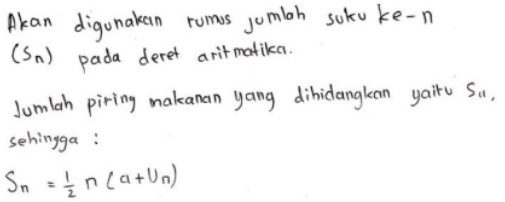

Figure 10. Stage of Devising a Plan by FI 1

Based on Figure 10, FI 1 can devise a settlement plan appropriately. FI 1 can connect the information on the problem with the concepts of Number Patterns and then determine the formula. The results of the Number Pattern problem-solving ability test by FI 1 at the stage of carrying out the plan that has been devised is shown in Figure 11.

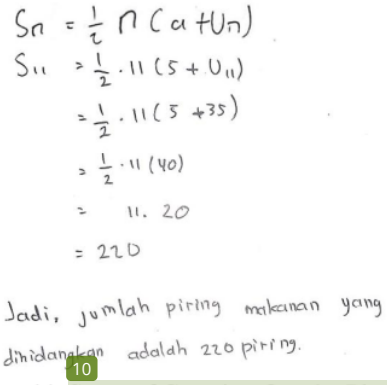

Figure 11. Stage of Carrying Out the Plan by FI 1

Based on Figure 11, FI 1 can carry out the plan that has been prepared correctly. FI 1 can solve problems in problems by using concepts and formulas of Number Patterns that have been compiled. The results of the Number Pattern problem-solving ability test by FI 1 at the stage of looking back on the settlement is shown in Figure 12.

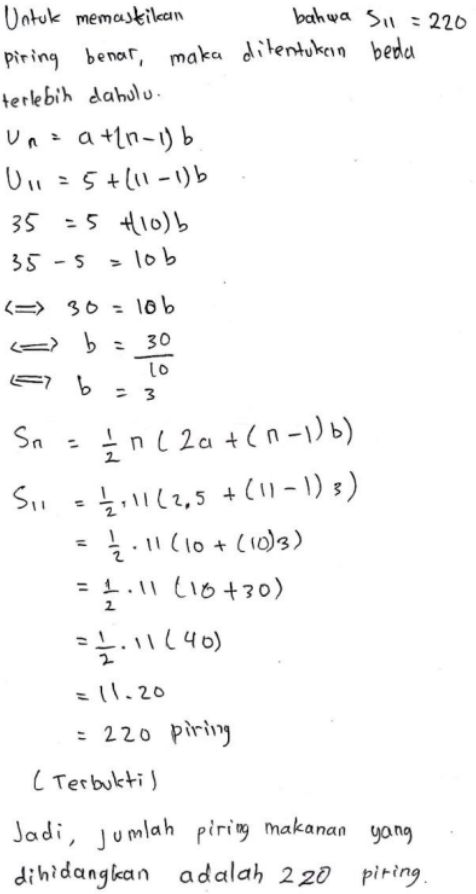

Figure 12. Stage of Looking Back by FI 1

Based on Figure 12, FI 1 can look back at the total completion. FI 1 can look back at the settlement by proving the correctness of the settlement and the results obtained. This is by the interview results, which state that FI 1 can verify the correctness of the settlement by checking the S_n formula. The student can make conclusions from the completion of the problem. The results of the Number Pattern problem-solving ability test by FI 2 at the stage of understanding the problem is shown in Figure 13.

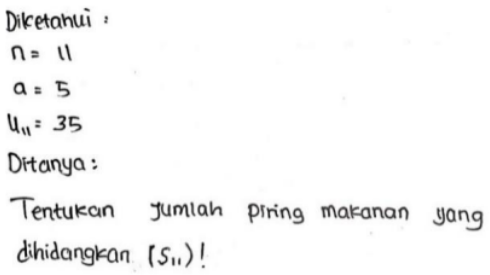
Diketahui :
n = 11
a = 5
U_{11} = 35
Ditanya :
Tentukan jumlah piring makanan yang dihidangkan (S_{11}) !

Figure 13. Stage of Understanding the Problem by FI 2

Based on Figure 13, FI 2 can understand the problem well. FI 2 can re-decipher the information contained in the question to be able to write things that are known and asked on the question. The results of the Number Pattern problem-solving ability test by FI 2 at the stage of devising a completion plan is shown in Figure 14.

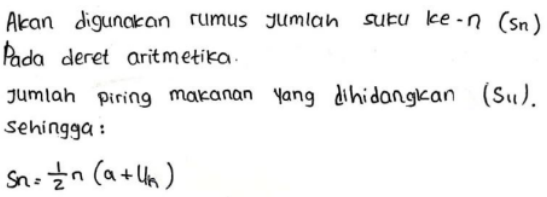
Akan digunakan rumus jumlah suku ke-n (S_n)
Pada deret aritmetika.
jumlah piring makanan yang dihidangkan (S_{11}).
sehingga :
$S_n = \frac{1}{2} n (a + U_n)$

Figure 14. Stage of Devising a Plan by FI 2

Based on Figure 14, FI 2 can devise a settlement plan appropriately. FI 2 can connect the information on the problem with the concepts of Number Patterns and then determine the formula. The results of the Number Pattern problem-solving ability test by FI 2 at the stage of carrying out the plan that has been devised is shown in Figure 15.

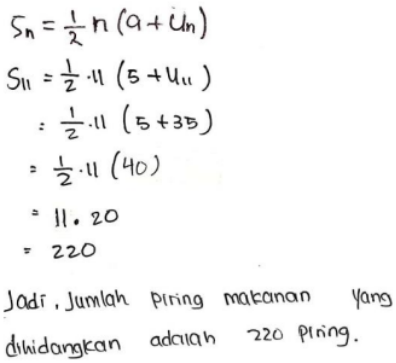
$S_n = \frac{1}{2} n (a + U_n)$
$S_{11} = \frac{1}{2} \cdot 11 (5 + U_{11})$
$= \frac{1}{2} \cdot 11 (5 + 35)$
$= \frac{1}{2} \cdot 11 (40)$
$= 11 \cdot 20$
$= 220$
Jadi, Jumlah piring makanan yang dihidangkan adalah 220 piring.

Figure 15. Stage of Carrying Out the Plan by FI 2

Based on Figure 15, FI 2 can carry out the plan that has been prepared correctly. FI 2 can solve problems in problems by using concepts and formulas of Number Patterns compiled. The results of the Number Pattern problem-solving ability test by FI 2 at the stage of the completion are shown in Figure 16.

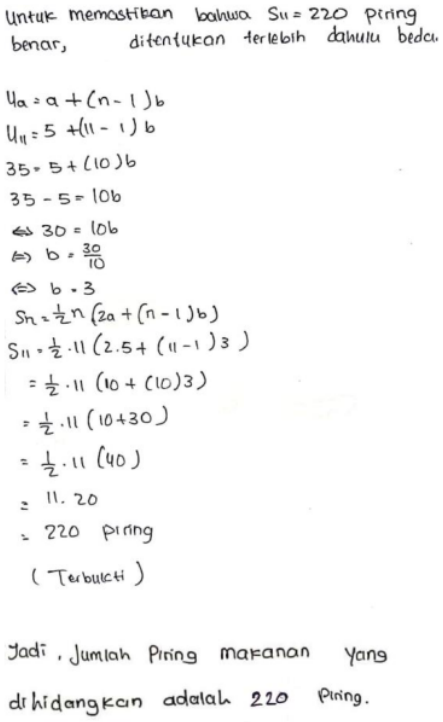

Figure 16. Stage of Looking Back by FI 2

Based on Figure 16, FI 2 can look back at the complete settlement. FI 2 can look back at the settlement by proving the correctness of the settlement and the results obtained. This is by the interview results, which state that the FI 2 can verify the correctness of the settlement by checking the S_n formula, and the student can make conclusions from solving the problem.

Discussion

The results showed the ability of students with Field Dependent (FD) and Field Independent (FI) cognitive styles to solve math problems. In solving mathematical problems, students carry out the stages of understanding the problem, devising a solution plan, carrying out the plan that has been devised, and looking back at the solution. At the stage of understanding the problem, students with Field Dependent (FD) cognitive style can capture the information on the problem, know what concepts are contained in the problem, be able to write things that are known and ask questions with mathematical symbols. This is to research conducted by Nur Afifah and Ningrum (2018), which revealed that students with strong FD cognitive styles could understand problems where students can write down things that are known and ask questions.

At the stage of devising a settlement plan, students with a Field Dependent (FD) cognitive style can determine ways to facilitate the problem-solving process following their knowledge. Students can choose the form, concepts, and formulas for solving problems by looking at the

information on the problem, and students can devise a problem resolution plan. This is to research conducted by Nuraida et al. (2022), which shows that students with FD cognitive style can use their knowledge and skills to devise a completion plan that is then used to solve the problem.

When carrying out the plan devised, students with Field Dependent (FD) cognitive style can determine the steps taken to apply appropriate concepts and formulas to solve problems in problems able to provide problem-solving using the most effective and proper concepts and procedures. This is following research conducted by Nuraida et al. (2022) which revealed that students with FD cognitive style have the ability in the stages of solving problems on problems.

At the stage of looking back on the completion, students with Field Dependent (FD) cognitive style cannot prove the correctness of the answer with a complete and precise formula application strategy, so students cannot conclude the completion that has been done. This is following research conducted by Suhatini et al. (2019) which revealed that students with FD cognitive style could not prove the correctness of the completion of known data, making it difficult to make conclusions.

At the stage of understanding the problem, students with the Field Independent (FI) cognitive style can capture the information on the problem, know what concepts are contained in the problem, and explain and mention things that are known and asked on the problem with mathematical symbols. This is following research conducted by Sutama et al. (2021), which revealed that students with fi cognitive styles could understand problems well, where students can explain the process. Students can understand issues, write down known things, and ask questions.

When devising a solution plan, students with Field Independent (FI) cognitive style can determine ways to facilitate the problem-solving process by their knowledge. Students can select the form, concept, and formula for solving problems by looking at the information on the problem so that students can devise a problem-solving plan. This follows research conducted by Nur and Palobo (2018) which revealed that students with FI cognitive style could plan completion with appropriate procedures.

At the stage of carrying out the plan that has been devised, students with the Field Independent (FI) cognitive style can determine the steps taken to determine the appropriate concepts and formulas to solve problems in the problem, able to provide problem-solving using the most effective and proper concepts and procedures. This is following research conducted by Zakiah (2020) which revealed that students with FI cognitive style have accuracy in solving problems with appropriate strategies.

At the stage of looking back at the completion, students with the Field Independent (FI) cognitive style can prove the correctness of the answer with a strategy of applying the formula in a concise, complete, and precise manner so that students can conclude the completion that has been done. This is by research conducted by Mahfiroh et al. (2021), which revealed that students with fi cognitive style could look back at the plans and completions and make conclusions.

Based on the above exposure, there is a novelty in the research results compared to previous studies. This study showed that the math problem-solving abilities of students with FD cognitive style were not good. This is demonstrated in FD students who can understand the problem, devise a settlement plan, and carry out the plan well but have not been able to look back at the settlement and make conclusions. Meanwhile, in the previous research conducted by Nuraida et al. (2022), it was obtained that FD students understood the problem, devised a settlement plan, carried out the plan, looking back at the settlement to make conclusions.

Conclusion

At the stage of understanding the problem, students with Field Dependent (FD) cognitive styles and students with Field Independent (FI) cognitive styles can understand the situation well. This is evidenced by the ability of FD and FI students to decipher known information and asked on questions with mathematical symbols. When preparing a plan, FD and FI students can determine the form, concept, and formula for solving problems by looking at the information on the problem, and students can devise a problem-solving plan.

At the stage of carrying out the plan devised, FD and FI students can carry out the plan well. This is evidenced by the ability of FD and FI students to provide problem-solving using appropriate concepts and formulas. FD and FI students can provide problem-solving using the most effective and proper concepts and procedures. At the stage of looking back, FI students can look back at the completion steps well. This is evidenced by the ability of FI students to prove the truth of the answer thoroughly and precisely so that FI students can conclude the settlement that has been done. However, FD students are not able to prove the truth of the answer thoroughly and precisely, so FD students are not able to conclude the settlement that has been done.

There are limitations in this study, namely time constraints. Researchers who will raise this problem are expected to maximize the time to find out more about students' mathematical ability in solving math problems judging from cognitive styles.

Conflicts of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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