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Profile of Mathematics Communication Ability of Seventh-Grade Students in Solving Set Problems Based on Cognitive Style

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ABSTRACT

This study aims to describe the profile of students' mathematical communication ability in solving set problems in terms of field-dependent and field-independent cognitive styles. This research method includes qualitative descriptive research. In this study, the collected data was in the form of words so that it did not emphasize numbers. Participants in this study consisted of three students with a field-dependent cognitive style and three students with a field-independent cognitive style from class VII at one of the junior high schools in North Central Timor Regency. The instruments used are mathematical communication ability test, Group Embedded Figure Test, and interviews. The results showed that students with a field-independent cognitive style have high mathematical communication abilities. This can be seen from the test results of the three field-independent students who are able to express mathematical ideas through oral, written, demonstration and describe in visual form, are able to analyze, interpret, and evaluate mathematical ideas through oral, written, and other visual forms, and are able to use terms, mathematical notations, and their structures to present ideas, describe relationships, and situation models when solving problems mathematical sets. Meanwhile, students with a field-dependent cognitive style have low mathematical communication abilities. This can be seen from the results of the mathematics communication ability test of the three field-dependent students who have not been able to meet all the indicators of mathematical communication.

Keywords: Cognitive Styles, Field-Dependent, Field-Independent, Mathematics Communication Ability.

ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan profil kemampuan komunikasi matematika siswa dalam menyelesaikan soal himpunan ditinjau dari gaya kognitif *field-dependent* dan *field-independent*. Metode penelitian ini termasuk penelitian deskriptif kualitatif. Pada penelitian ini data yang terkumpul berbentuk kata-kata sehingga tidak menekankan pada angka. Partisipan dalam penelitian ini terdiri dari tiga siswa dengan gaya kognitif field dependent dan tiga siswa dengan gaya gaya kognitif *field-independent* dari kelas VII pada salah satu SMPN di Kabupaten Timor Tengah Utara. Instrumen yang digunakan adalah soal tes kemampuan komunikasi matematika, *Group Embedded Figure Test*, dan wawancara. Hasil penelitian menunjukan bahwa siswa dengan gaya kognitif *field-independent* memiliki kemampuan komunikasi matematika yang tinggi. Hal ini dapat dilihat dari hasil tes ketiga siswa *field-independent* yang mampu menyatakan ide-ide matematis melalui lisan, tulisan, demonstrasi serta menggambarkan dalam bentuk visual, mampu menganalisis, menginterpretasikan, dan mengevaluasi ide-ide matematis melalui lisan, tulisan, maupun bentuk visual lainnya, dan mampu menggunakan istilah, notasi matematika, dan struktur-strukturnya untuk menyajikan ide-ide, mengambarkan hubungan-hubungan, serta model-model situasi saat menyelesaikan soal himpunan matematika. Sedangkan siswa dengan gaya kognitif *field-dependent* memiliki kemampuan komunikasi matematika yang rendah. Hal ini dapat dilihat dari hasil tes kemampuan komunikasi matematika ketiga siswa *field-dependent* yang belum mampu memenuhi semua indikator kemampuan komunikasi matematika.

Kata kunci: *Field-Dependent, Field-Independent*, Gaya Kognitif, Kemampuan Komunikasi Matematika.

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Introduction

Mathematics is one of the compulsory subjects studied by students from the basic education level to the higher education level. It is designated as a compulsory subject because mathematics plays an important role in the formation of students' critical thinking processes for solving problems in mathematics itself, and problems in everyday life. In addition, mathematics can play a role in the development and for solving problems of other sciences. In this sense, Suherman (2003) said that mathematics is the queen and ministry of science. The point is that mathematics is a source of other sciences. This means that mathematics is here to help and master problems in the economic, social, medical, natural, physical, and also engineering fields.

On the other hand, Duval (2016) considered the conversion and treatment between the representation register is an indicator of the comprehension for learners at each stage of the curriculum. So, one of the ability that is expected to be achieved in mathematics learning is that students have the ability to communicate ideas with symbols, tables, graphs, or diagrams to study circumstances or problems (Son & Ahzan, 2017). This proficiency is hereinafter referred to as mathematical communication abilities (NCTM, 2000). There are two important reasons why communication is one of the focuses in mathematics learning. First, mathematics is basically a language, so it can be used as a tool to communicate various ideas clearly, precisely, and concisely. Second, learning and teaching mathematics is a social activity that involves at least two parties, namely teachers and students (Rohmah, 2014). Mathematical communication is a special form of communication itself, namely any form of communication that is carried out in order to express ideas, and solutions of mathematical problems.

The ability to communicate mathematical ideas is very important to emphasize in learning because 1) mathematics is an essential language that is not only a tool for thinking, finding formulas to solve a problem, or concluding, but mathematics also has unlimited value to state various ideas clearly, carefully and precisely, 2) mathematics and learning mathematics are at the heart of human social activities, for example in mathematics learning the interaction between teachers and students, between students themselves, between mathematics learning materials and students are important factors in advancing students' potential (Baroody, 1993).

Mathematical communication ability are very important for students, but the reality in the classroom shows that students' proficiency in this competency has not been as expected. Based on the observations of researchers during the Field Experience Practice, mathematical communication ability in students in the form of written communication are still very lacking. Many students are not able to express mathematical ideas through oral or written demonstrations or describe them visually, they also

show difficulties in analyzing, interpreting, and evaluating mathematical ideas, as well as difficulties in the use of terms, mathematical notations, and their structures to present ideas, describe relationships, as well as model situations when solving mathematical set problems. At the time of solving the set questions, most students have not been able to complete according to the indicators of mathematical communication abilities, and when presenting the results of their work, when there are responses from other students or teachers, the student is less able to explain what has been written. The same problem was revealed by Hendriana and Kadarisma (2019) that students' communication abilities are still relatively low.

The set is one of the mathematics subjects taught to seventh grade students. In the student material, they are not only required to understand the material in accordance with the predetermined curriculum and solve the questions given, but students are also expected to be able to communicate their understanding. Developing mathematical communication comprehension abilities is different for each student. That's because there are cognitive styles that influence it. Cognitive styles are very influential on the process of information in the student brain so that there will be differences in the delivery of students' mathematical ideas in each cognitive style. Nugraha and Awaliyah (2016) defined cognitive style as a response that a person raises related to differences in the approach to a person's perceptual and intellectual characteristics that lead him to respond to something faced.

Witkin (1973) revealed that cognitive styles are categorized into field independent (FI) and field dependent (FD) cognitive styles. There are many dimensions of cognitive styles developed by experts, in this study the focus of discussion is the cognitive styles FD and FI. The cognitive styles of FI and FD emphasize more how a person's psychic state is when interacting with his environment (Son & Fatimah, 2021). Cognitive FD is a person who accepts a pattern as a whole. This means that they tend to be difficult to focus on one aspect of a situation or analyze a pattern into different parts. Whereas a person with cognitive FI shows more of a separate part of the overall pattern and is able to analyze patterns into its components (Usodo, 2011; Son & Fatimah, 2020).

This difference in cognitive styles characteristics results in differences in students' mathematical communication abilities. The difference is in the form of speed of understanding the problem, accuracy, and clarity in conveying ideas. Pratiwi et al. (2013) said that a person has a different way of processing information, as well as seeing and interpreting it. This difference is determined also by the differences in the characteristics of FI students and FD students. A person with an FD cognitive style generally has a high social attitude, is able to blend in with the people around them, and usually empathizes and understands the thoughts of others more. Meanwhile, a person with an FI cognitive style generally tends to have an independent or individual attitude, competitive and more confident (Nurwijaya, 2014). In

relation to student responses in the learning process, students with a cognitive style of FI work independently, and tend to give responses related to the explanation of the material by the teacher, while FD students give answers based on praise, more likely to give responses related to those outside the subject matter (Suryanti, 2014).

The above description illustrates the differences in the characteristics of FI students and FD students. These differences certainly result in their mathematical communication abilities. Therefore, this study was conducted to explore the profile of students' mathematical communication ability in solving problems in the set material in terms of field dependent and field independent cognitive styles.

Research Methods

This research uses qualitative descriptive research methods. This research was conducted on Class VIII students of one of the junior high schools in North Central Timor Regency, odd semester of the 2022/2023 School Year. Six students were the participants, with a breakdown of 3 students having a field independent cognitive style, and 3 students having a field dependent cognitive style.

The instruments used to collect data were mathematical communication ability tests, Group Embedded Figure Tests (GEFT), and interviews. GEFT is used to determine the cognitive styles of students in the field dependent and field independent categories, developed by Witkin (1973). Meanwhile, the mathematical communication ability test adds 3 numbers of set questions, which were confirmed through interviews. The indicators of mathematical communication ability proposed by NCTM (2000) were used in this study, namely: 1) stating mathematical ideas through oral, written, demostration and describing in visual form, 2) analyzing, interpreting, and evaluating mathematical ideas through oral, written, and other visual forms, 3) the ability to use terms, mathematical notation, and their structures to present ideas, describe relationships, as well as models of the situation.

The data analysis methods used are data reduction, data display, and conclusion. At the data reduction stage, researchers reduce the data by correcting and assigning scores to the GEFT test results, as well as correcting the results of the students' mathematical communication ability test. Next is calculated the average percentage of students' mathematical communication abilities, with the equation:

$$Value = \frac{Scores\ earned\ by\ student}{Maximal\ score}\ x\ 100\%$$ (Ramdani, 2019).

Students' math communication ability scores are categorized based on the following conversion table.

Table 1. *Score Conversion*

Number	Interval	Category
1	90,00 < P ≤ 100	Very High
2	80,00 < P ≤ 90,00	High
3	65,00 < P ≤ 80,00	Medium

4	55,00 < P ≤ 65,00	Low
5	P ≤ 55,00	Very Low

(Source: Sriwahyuni, Amelia & May, 2019)

P is the level of mathematical communication ability of each student. At the stage of data display, the researcher formulates quantitative data into qualitative data with good and correct language, and the last stage is to draw final conclusions regarding the profile of students' mathematical communication ability.

Results and Discussion

The Group Embedded Figure Test (GEFT) was carried out on August 19, 2022 and was attended by 31 class VIIB students of SMP Negeri 1 Insana. Based on the GEFT results, there are 26 students who have a field dependent cognitive style and 5 students who have a field independent cognitive style. Then 6 students were selected who had the strongest tendencies of each cognitive style. Students' GEFT results are presented in Table 2.

***Table 2**. Subject of Research.*

Number	Student Name	Number of Score	Gaya Kognitif
1	NES	17	FI
2	DN	16	FI
3	AD	14	FI
4	AN	3	FD
5	YA	2	FD
6	CO	1	FD

From the GEFT results (Table 2), the scores were obtained, namely NES obtaneid a score of 17, DN a score of 16 and AD a score of 14. The three students have the strongest tendency to field independent (FI) cognitive styles because they have a score close to 18. In addition, AN obtained a score of 3, YA a score of 2 and CO a score of 1 (See Table 2). The three studens have the strongest tendency to field dependent cognitive style (FD) because they have a score close to 0.

The results of the student's mathematical communication ability test were analyzed based on the mathematical communication indicators previously described. Data analysis of mathematical communication ability test results aimed to determine the communication abilities of students (Table 3) with high, medium, and low abilities based on the scores obtained by students.

***Table 3.** Student's Mathematics Communication Ability Level*

Number	Code Subject	Scores Obtained	Interval	Category	Cognitive Styles
1	NES	95	90,00 < P ≤ 100	Very High	FI
2	DN	85	80,00 < P ≤ 90,00	High	FI
3	AD	70	65,00< P ≤ 80,00	Medium	FI
4	AN	60	55, 00 < P ≤ 65,00	Low	FD
5	YA	40	P ≤ 55,00	Very Low	FD
6	CO	30	P ≤ 55,00	Very Low	FD

From the work of the six participants, there were two subjects that had the same category, namely YA and CO subjects with very low scores, so the researchers chose one student to represent this category. Here are the results of mathematical communication ability tests and interviews of all five participants:

a) NES obtained very highly capable ($P = 94$) in terms of field independent cognitive style for the indicator 1 (Figure 1).

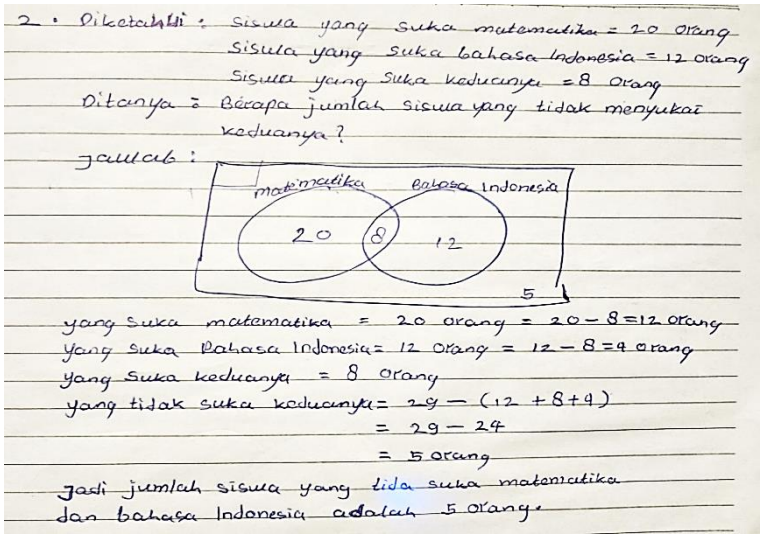

Figure 1. *Answers of NES subjects to indicator 1.*

Based on the solution of the questions shown in Figure 1, NES was able to understand the questions and he was able to write down the answers completely. But the subject is wrong when writing down the number of students who like mathematics and Indonesian on the venn diagram. To convince us as researcher (R) about the correctness of the student's (S) answer, we conducted the following interview:

R: Do you understand the meaning of question number 2?

S: Yes mom, it's about the Venn diagram.

R: Once you understand the intent of the question, what is the next step you will take?

S: In the question is asked to count the number of students who like the subject of mathematics and Indonesian.

R: After that, what next steps are you going to take?

S: On the problem that likes mathematics 20 people, I reduce it with those who like both is 8 people to $20 - 8 = 12$ people, students who like Indonesian 12 people I reduce again with students who like both, then $12 - 8 = 4$ people. Furthermore, to count the number of students who do not like both I

subtract the number of students in class $29 - (12 + 8 + 4) = 29 - 24 = 5$ people, so it can be concluded that the number of students who do not like the subjects of mathematics and Indonesian is 5 people.

R: Good. The answer is correct, but mom sees your answer on your work, you wrong to wrote the number of students who like the subject of mathematics and Indonesian.

S: Yes mom, it's actually the students who likes math is 12 people and the who likes Indonesian 4 people, I wrong the wrote mom.

R: Yes, well noticed later.

Based on the results of the interview the NES subject was able to explain in detail what he had written. This is in line with Nayan (2020) that in this indicator field independent students are able to express mathematical ideas orally, in writing way, make demonstrations and can describe them in other visual forms.

b) The results of the mathematical communication ability test in highly capable subjects (DN) were reviewed from the field independent cognitive style in indicator 2.

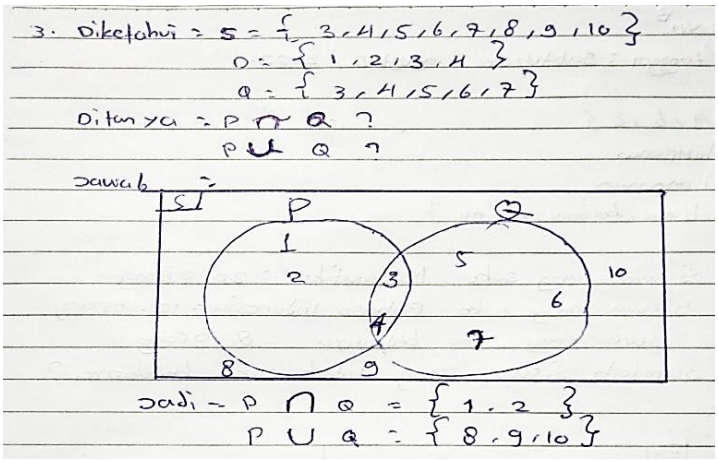

Figure 2. *DN subject answer to indicator 2.*

Based on Figure 2, it can be seen that the DN subject was able to solve the problem as seen from the way the subject describes the shape of the Venn diagram. To convince us about the correctness of the student's answer, we carried out the following interview:

R: From this question number 3, what is known?

S: The known question number 3 is that there are sets $S = \{3, 4, 5, 6, 7, 8, 9, 10\}$, $P = \{1, 2, 3, 4\}$ and $Q = \{3, 4, 5, 6, 7\}$.

R: What's next to look for?

S: What is sought in question number 3 is $P \cap Q$ and $P \cup Q$.

R: What's the next step you take to solve this problem?

S: For how to solve it, namely by using the Venn diagram drawing, after that just determine $P \cap Q$ and $P \cup Q$.

R: Are you sure your answer to question number 3 is correct?

S: Not sure, because for question number 3, I don't know to determine the wedge and the combine.

R: Oia good sister. For $P \cap Q$ the younger brother must look at the members of the set that are in the set P and there are also in the set Q so $P \cup Q = \{3, 4\}$ because 3 and 4 are in both sets, and for $P \cup Q$ the sister must register all the members that are in the set P and also exist in the set Q so for $P \cup Q = \{1, 2, 3, 4, 5, 6\}$.

S: Oh, so that's how it's solved, thank you mom.

R: It's welcome.

Based on the interview above, the student DN was able to present the answer correctly, but he could not determine the slice and combination on the question. This is in line with Anintya et al. (2016) who said that in this indicator field independent students are able to analyze, interpret, and evaluate mathematical ideas orally, in writing way, and in other visual forms.

c) The student AD obtained medium capable in terms of field independent cognitive style for the indicator 3 (Figure 3).

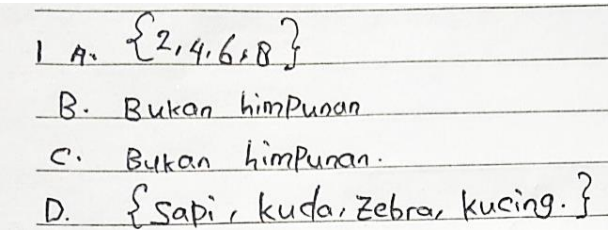

Figure 3. *Ad Subject's Answer to Indicator 3*

From Figure 3, it can be seen that the student AD was able to write the notation of the set correctly, registered its members, and distinguished a set and not a set. To be sure that the student's answer is correct, we conducted the following interview:

R: Do you understand the question of question number 1?

S: Question number 1 is about the set and being told to distinguish which is a set and which is not a set, and is then told to register its members?

R: Then, are you sure your answer to number 1 is correct?

S: I'm sure it's right mom.

R: Ok.

Based on the previous interview, we identified that student AD understood the problem, he was able to use the notation to record its members, and his answer was correct in distinguishing a set and not a set. This is in line with Anintya et al. (2016) that field independent students are already able to use mathematical terms, notations, and structures to present mathematical ideas with situation models.

d) The results of the mathematical communication ability test indicated that student AN had low ability in terms of field dependent cognitive style by indicator 1.

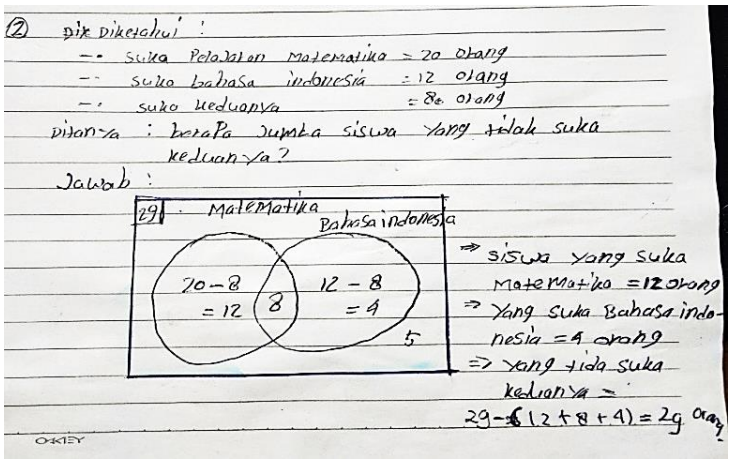

Figure 4. *AN Subject Answers to Indicator 1.*

Based on Figure 4, we indentified that the student AN was able to draw the Venn diagram correctly, but when writing down the steps to solve the problem he still gets it wrong, and he does not make conclusions from the answer. The veracity of the student's answer it can be ensured through the following interview:

R: Do you understand the of No. 2?

S: Yes, I'm understand mom.

R: What is known in the matter?

S: In the problem, it is known that there are 20 students who like mathematics, there are 12 people who like Indonesian, and there are 8 students who like both.

R: Then, what is asked in the question?

S: What is asked is the number of students who do not like math and Indonesian.

R: Then try to explain what you have done, can you?

S: You can do it, mom, on the question, there are 20 students who like mathematics, there are 20 students who like Indonesian 12 people and students who like both there are 8 people. Next subtract $20 - 8 = 12$ and $12 - 8 = 4$.

R: Are you sure the answer is correct?

S: No mom because I can't count the number of students who don't like the subject of mathematics and Indonesian.

R: He is right, there is indeed another final completion step so that you can get the number of students who don't like math and Indonesian, so after that you should reduce the number of all students in class 29 people with the results you have obtained then $29 - (12 + 8 + 4) = 29 - 24 = 5$ people. So, in conclusion the number of students who do not like mathematics and Indonesian is 5 people.

S: Ok mom, thank you.

R: You have to learn a lot and practice questions like this at home so that later you can answer questions like this.

S: Yes, mom.

From the above interview, student AN correctly describes the shape of the Venn diagram, but his answer is incorrect in the calculations to determine the final result of the number of students who do not like mathematics and Indonesian, so that it can be said that the student has a field dependent cognitive style in the first indicator. For this reason, AN has not been able to explain mathematical ideas well in problem solving. This is in line with Nayan (2020), who said that in the indicator field dependent style students are still unable to analyze, interpret, and evaluate mathematical ideas both orally, in writing, and in other visual forms.

e) According to the results of the mathematical communication ability test, we identified that YA is a student who has a are very low in ability in terms of field dependent cognitive style in indicator 2.

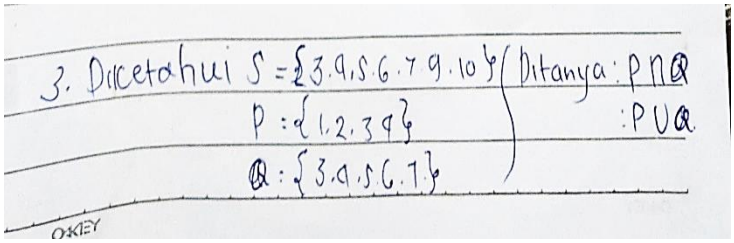

Figure 5. *Subject's Answer YA to Indicator 2*

Based on Figure 5, it can be seen that the subject of YA writing is known and asked in the question but does not work out the steps for solving it at all. To understand the student's answer, the following interview was conducted:

R: What to look for in the matter?

S: The number three question to look for is $P \cap Q$ and $\cup Q$.

R: Are you sure your answer is correct?

S: No mom because I can't do this problem.

R: Okay, mom will explain for this matter. First you have to solve it in the form of a ven diagram, after that specify $P \cap Q$ and $P \cup Q$. There are the sets $P = \{1, 2, 3, 4\}$ and $Q = \{3, 4, 5, 6, 7\}$ so for $\cap Q = \{3,4\}$ $P \cup Q = \{1,2,3,4,5,6\}$.

S: Mom why is the set of S not included?

R: Since what is asked in the question is only told to specify $P \cap Q$ and $P \cup Q$ then the set of S does not need to be written.

S: Yes mom.

Based on the interview above, the student YA did not do this problem at all, so it can be said that the subject has not been able to analyze, interpret, and evaluate mathematical ideas through oral, written, or other visual forms. This is in line with Anintya et al. (2016), who said that in this indicator field dependent students have not been able to analyze, interpret, and evaluate mathematical ideas both orally, in writing, and in other visual forms.

Conclusion

The results of the test and discussion showed that students with a field independent cognitive style had high mathematical communication abilities. This can be seen from the test results of the three field independent students who are able to express mathematical ideas through oral, written, demonstration and describe in visual form, are able to analyze, interpret, and evaluate mathematical ideas through oral, written, and other visual forms, and are able to use terms, mathematical notations, and their structures to present ideas, describe relationships, and situation models when solving problems mathematical sets.

On the other hand, according to the results the students with a field dependent cognitive style have low mathematical communication Abilities. This can be seen from the results of the mathematics communication ability test of the three field dependent students who have not been able to express mathematical ideas through oral, written, demonstration and describing in visual form, have not been able to analyze, interpret, and evaluate mathematical ideas through oral, written, or other visual forms, and have not been able to use terms, mathematical notation, and their structures to present ideas, describes relationships, as well as models of situations when solving mathematical set problems.

Therefore, based on the identified learning styles, as well as their characteristics, it is recommended to mathematics teachers in schools to use learning strategies by multiplying practice questions about sets in order to facilitate the mathematical communication ability of field dependent students so that there is no significant difference in mathematical communication ability between field independent and field dependent students.

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