**ISSN 3025-0757**
Indonesian Educational Research Journal, 1(2), 65-75

Indonesian Educational Research Journal

Journal homepage: https://journal.id-sre.org/index.php/ierj/index

# High School Students' Mathematical Connection Ability Profile in Solving Three-Variable Linear Equation System Problems Based on Cognitive Style

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| *Received* | *Revised* | *Accepted* | *Published* |
|---|---|---|---|
| October 15, 2023 | November 30, 2023 | December 19, 2023 | December 23, 2023 |

**Abstract**
This study aims to explore the profile of high school students' mathematical connection abilities in solving problems on systems of three-variable linear equations based on cognitive style. The method used in this research is qualitative method. This research was carried out in the even semester of the 2022/2023 academic year. The research subjects were 27 class X students at a high school in the North Central Timor district. Subjects were grouped based on FI and FD cognitive styles. Next, 6 subjects were selected, namely 3 FI and 3 FD to take the mathematical connection ability test. The instruments used in this research were GEFT, mathematical connection ability tests, and interviews. Data analysis techniques are data reduction, data presentation, and drawing conclusions. The results of this study show that the mathematical connection abilities of each student are different. Subjects with a field-independent cognitive style meet all indicators of mathematical connection ability, while subjects with a field-dependent cognitive style do not meet all indicators of mathematical connection ability. The implication of these findings is that FI students tend to have superior mathematical connection abilities compared to FD students' mathematical connection abilities. Therefore, it is recommended for FD students to study more diligently according to their characteristics, especially practicing solving mathematical connection problems regularly.

**Keywords:** Cognitive style, Mathematical connection ability, Three-variable linear equations.

## 1. INTRODUCTION

Education is one of the determining factors for the success of the development of a nation in increasing quality human resources. Education that is able to support development in the future is education that is able to develop the potential of students, so that students are able to apply and develop what they learn at school to face problems in everyday life. Therefore, one of the very

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**How to cite:** Nailake, M.D., Son, A.L. & Delvion, E.B.S. (2023). High School Students' Mathematical Connection Ability Profile in Solving Three-Variable Linear Equation System Problems Based on Cognitive Style. *Indonesian Educational Research Journal*, 1 (2), 65-75.

important subjects to improve the quality of learning is mathematics. Mathematics is one of the subjects that is needed and has relevance in everyday life. These connections are not only between mathematical topics, but also with other fields of science and problems in everyday life. In the opinion of Muhdiyanto, Hidayanto, & Chandra (2022) Mathematics is a field of study that consists of various topics that are interconnected with each other .

There are five basic mathematical abilities defined by the National Council of Teacher Mathematics (NCTM, 2000), namely problem solving, reasoning and proof, communication, connections, and representation. One's ability to connect between mathematical concepts is very important in solving problems, because the material used has a relationship between one concept and another. Mathematical connections can help students not only understand concepts and solve problems in mathematics, but also in other fields of study and problems in real life (Baiduri et al, 2020). Mathematical connection ability is one of the abilities that every student must have to develop during the process of learning mathematics.

Based on the results of observations during the researcher's practical experience in the even semester of the 2021/2022 academic year at one of the high schools in North Central Timor, it appears that in the learning process researchers often found students who were less able to relate to the material they were studying. Researchers often give questions about other mathematical concepts that are related to other fields of science and mathematics that are related to everyday life. However, students experienced difficulty in solving these questions. Therefore, the problem that students often experience is their lack of ability to solve mathematical problems, especially questions related to mathematical connections.

In making a mathematical connection, a person is certainly very influenced by how he thinks. Each student has his own way of organizing his thoughts, what he does, sees, and what he remembers. Someone will also have different ways of approaching learning situations, the way they receive, organize, and relate their experiences by responding to certain learning methods. The differences that are inherent in each individual by processing information and compiling from experiences are better known as cognitive styles (Son, 2022).

Cognitive style is an individual's characteristics in using cognitive functions (thinking, remembering, solving problems, making decisions, organizing and obtaining information). A person's way of handling, organizing and utilizing information to answer or resolve a problem (Makbul, 2019). Cognitive style can describe the characteristics of each individual such as attitudes, motivation, interests and thinking abilities. According to Amalisa, et al (2020) say that cognitive style has an influence on mathematical connection abilities. In the psychological aspect, cognitive styles are divided into two, namely field dependent (FD) cognitive styles and field independent (FI) cognitive styles. Students with the FD cognitive style tend to be influenced by other people, and receive information in solving problems. Meanwhile, students with cognitive FI tend to respond well and are autonomous in solving problems, and choose to study individually (Muhdiyanto et al., 2022; Son & Fatima, 2021) .

field independent and field dependent cognitive styles have different abilities. These differences in cognitive styles can influence each student's mathematical connection abilities (Son & Fatima, 2021). Therefore, this study was carried out with the aim of explore the profile of high school students' mathematical connection abilities in solving three-variable linear equation system problems based on cognitive style.

## 2. METHODS

This study is descriptive research with a qualitative approach. Thus, this study is a type of qualitative descriptive. Therefore, in this study, the data will be presented as it is without any specific manipulation or treatments. This study will expose students' mathematical connection abilities and clarify them based on the cognitive styles of field-dependent and field-independent.

The subjects in this study were class X students at a high school in North Central Timor district with a total of 27 students. The selection of subjects in this research was based on the results of the *group embedded figure test* (GEFT) which were grouped based on *field independent* and *field dependent cognitive styles*. The subjects were then taken as many as 3 students from each representative of the FI and FD cognitive style groups.

The instruments used in this study were GEFT, connection ability tests and interviews. The GEFT consists of 18 questions, for each correct answer a score of 1 is given and an incorrect answer is given a score of 0. Kepner and Neimark's opinion (Basir, Kristiawati, & Usman, 2022) is that students who answer correctly 0-9 can be classified as *field dependent* (FD) and 10-18 are classified as *field independent* (FI). The mathematical connection ability test instrument aims to measure mathematical connection ability based on indicators determined by NCTM (2000), namely 1) recognizing and using the relationship between ideas in mathematics, 2) understanding how ideas in mathematics are related to each other, and 3) recognize and apply mathematics both internally and externally. This test of mathematical connection ability consists of 3 questions related to students' mathematical connection ability which are worked on for 60 minutes. The interviews conducted in this study had the aim of strengthening the results obtained from the test of the mathematical connection abilities of each subject.

The procedure in this research includes three stages, namely the preparation stage, implementation stage and final stage. The preparation stage includes preparing research instruments consisting of the GEFT test, connection ability test, and interview guide. The implementation stage consists of giving the GEFT test to select research subjects and then giving a mathematical connection ability test, as well as interviews. The data analysis technique used refers to the Miles and Huberman model (Sugiyono, 2019), namely (1) data reduction, data is summarized and the important ones are selected; (2) data display, before presenting the data, the validity of the data is first tested using triangulation; and (3) conclusion drawing/verification.

## 3. RESULTS AND DISCUSSION

The process of determining research subjects based on cognitive style is the GEFT test developed by Witkin et al (1977), namely the GEFT instrument. The following results of students' cognitive styles can be presented in table 1.

Table 1. Student Cognitive Style Data

| Cognitive Style | The number of students |
|---|---|
| FI | 11 |
| FD | 15 |

Based on Table 1, there were 26 students who took the test and were divided into two groups: 11 students were in the FI category and 15 students were in the FD category. FI students are students who get a score of 10-18, while FD students are students who get a score of 0-9. From the two groups, test

questions for mathematical connection abilities will be given which are differentiated based on the cognitive style obtained by the students, namely 3 students who have FI abilities and 3 students who have FD abilities.

Analysis of the description of the study was carried out to find out the results of the mathematical connection test which can be differentiated based on indicators of mathematical connection ability according to NCTM (2000) namely 1) recognizing and using the relationship between ideas in mathematics ka, 2) understanding how ideas in mathematics are interrelated, and 3) recognize and apply mathematics both internally and externally. The following are the results of students' mathematical connection ability tests.

Table 2. Mathematical Connection Ability Test Results

| FI Cognitive Style | | | FD Cognitive Style | | |
|---|---|---|---|---|---|
| Subject | Value | Code | Subject | Value | Code |
| DM | 28 | $FI_1$ | MFT | 18 | $FD_1$ |
| ST | 30 | $FI_2$ | NGSAL | 20 | $FD_2$ |
| HKL | 21 | $FI_3$ | EB | 11 | $FD_3$ |

**FI Students' Mathematical Connection Ability**

In this section, the results of students' work and interviews in solving the questions will be described. However, for each student 1 question and interview number will be included. Meanwhile, the other question numbers will provide a general description of how to solve the questions given.

1. Field Independent Students ( $FI_1$)

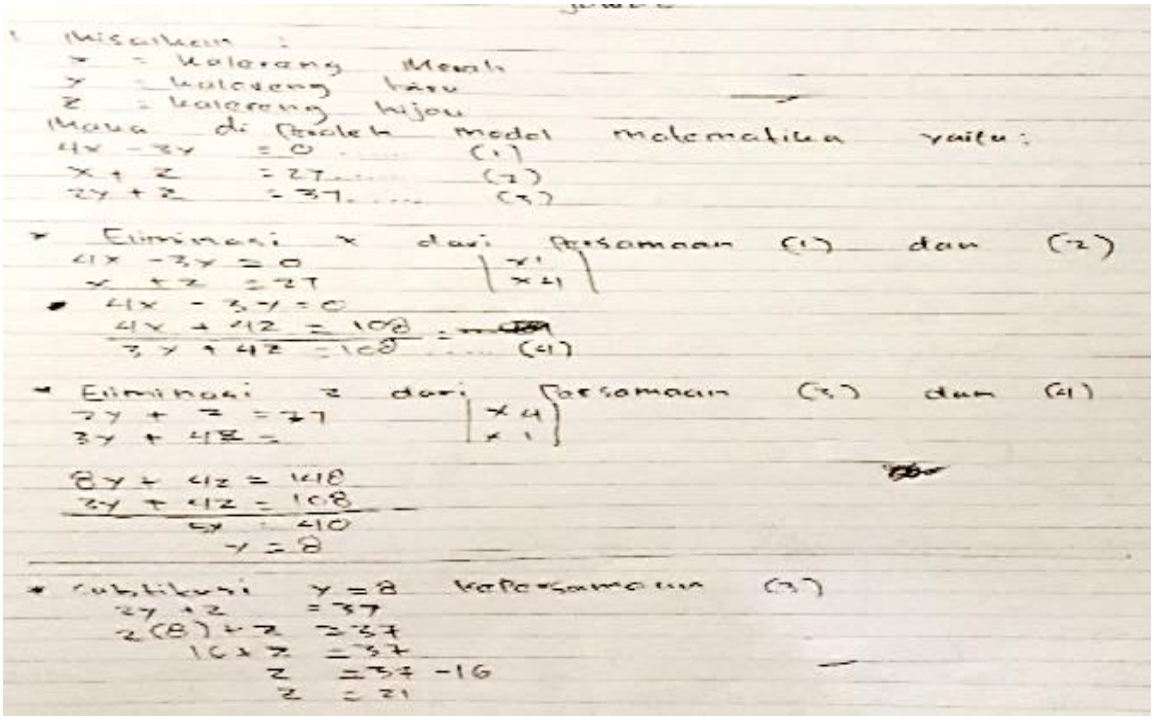


Figure 1. Students' mathematical connections $FI_1$ in indicator 1

Students $FI_1$ are able to solve and connect these problems with mathematical concepts using their understanding. This is in accordance with the student's statement $FI_1$ as follows (R: Researcher):

*R* : *what do you know about this matter?*
*S-FI₁* : *red, blue and green cans*
*R* : *Now that you know this question, according to your understanding, does this question have a connection between mathematics and System of Linear Equations in Three Variables (SLETV) material?*
*S-FI₁* : *this question is related to the ratio, namely 3:4*

Students $FI_1$ said that the problem was related to comparative material, by determining mathematical equations and connecting SLETV questions with comparative material. Students are able to say what is known in the problem and are able to solve by eliminating and substituting each equation to get the value of each variable, namely x, y and z. These activities can show that students $FI_1$ able to solve problems by determining interrelated mathematical ideas according to their understanding. Novianti (2021) say that students with the FI cognitive style are able to understand and connect the questions given and are able to underlie a concept between topics in mathematics. Meanwhile, the indicator connects mathematics with other disciplines, students $FI_1$ are able to solve and relate these questions to other fields of science, namely economics. In solving problems students $FI_1$ are able to say what is known in the problem and eliminate the mathematical equations contained in the problem. From the results obtained by students, $FI_1$ it is known that students are able to relate these questions to other fields of science. Students are able to solve questions related to everyday life, namely agriculture. The results of student work $FI_1$can be seen that students are able to solve problems by determining mathematical equations, and are able to eliminate and substitute each variable. Based on the results of students' work $FI_1$ in solving problems, it can be seen that students are able to connect and interpret questions with mathematical concepts, mathematical concepts in other fields of science and mathematics in everyday life. This is in accordance with the opinion of Setyaningsih (2016) who said that FI students are able to find a solution concept, understand mathematical topics, are able to apply mathematics to other fields of science and are able to apply mathematics in everyday life.

2. Field Independent Students ($FI_2$)

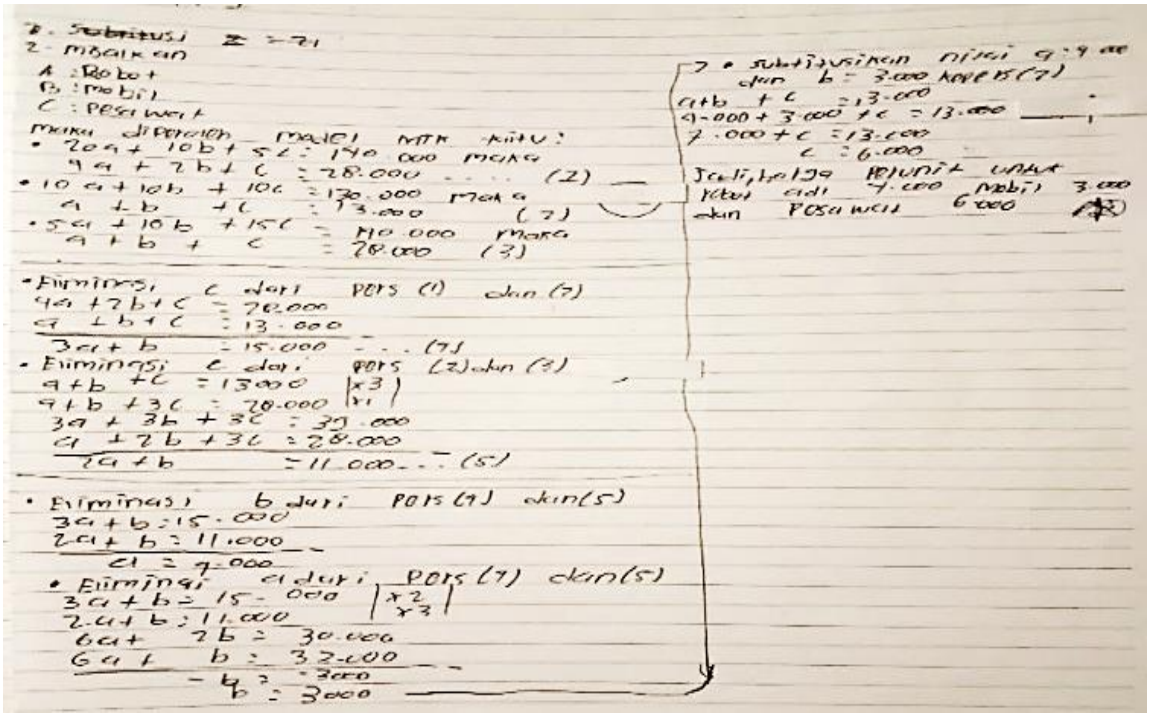

Figure 2. Student Mathematical Connection $FI_2$ 2nd indicator

Students $FI_2$ are able to connect other material related to the SLETV concept using their abilities. This

is in accordance with student statements $FI_2$ as follows:

*R : In your opinion regarding question number 2, is it related to other material?*

*S- $FI_2$ : this question is related to economics*

Student $FI_2$ able to understand and mention problems related to economics. This activity shows that students are able to interpret mathematical concepts in other fields of study by making a mathematical model of each equation to find the value of each variable. From the completion steps taken by students, $FI_2$ it can be seen that students are able to solve questions according to the SLETV procedure or concept so as to obtain the correct final results. Sari's opinion (2017) states that students with the FI cognitive style are able to connect the problems given and are able to solve problems according to procedures, and students are able to connect them with other fields of science. Meanwhile, the indicator that connects mathematics with mathematical concepts is that students $FI_2$ are able to connect the problem, namely the comparison between red, blue and green marbles. The first step taken by students $FI_2$ is to determine each equation of the number of cans, namely x, y and z. The results obtained show that students are able to solve questions according to their abilities and understanding so that they get the right results. Then the indicator connects the questions with everyday life. Students $FI_2$ are able to connect questions related to plantations, namely determining each variable x, y and z in each equation. Based on the results of student work, $FI_2$ it can be seen that students are able to solve problems by connecting the SLETV concept with other fields of science, as well as mathematics in everyday life. This is in accordance with the opinion of Alifah & Aripin (2018) who say that FI students are able to carry out the solution process well, as well as obtain answers according to the solution plan and are able to use mathematical principles correctly.

3. *Field independent* student ($FI_3$)

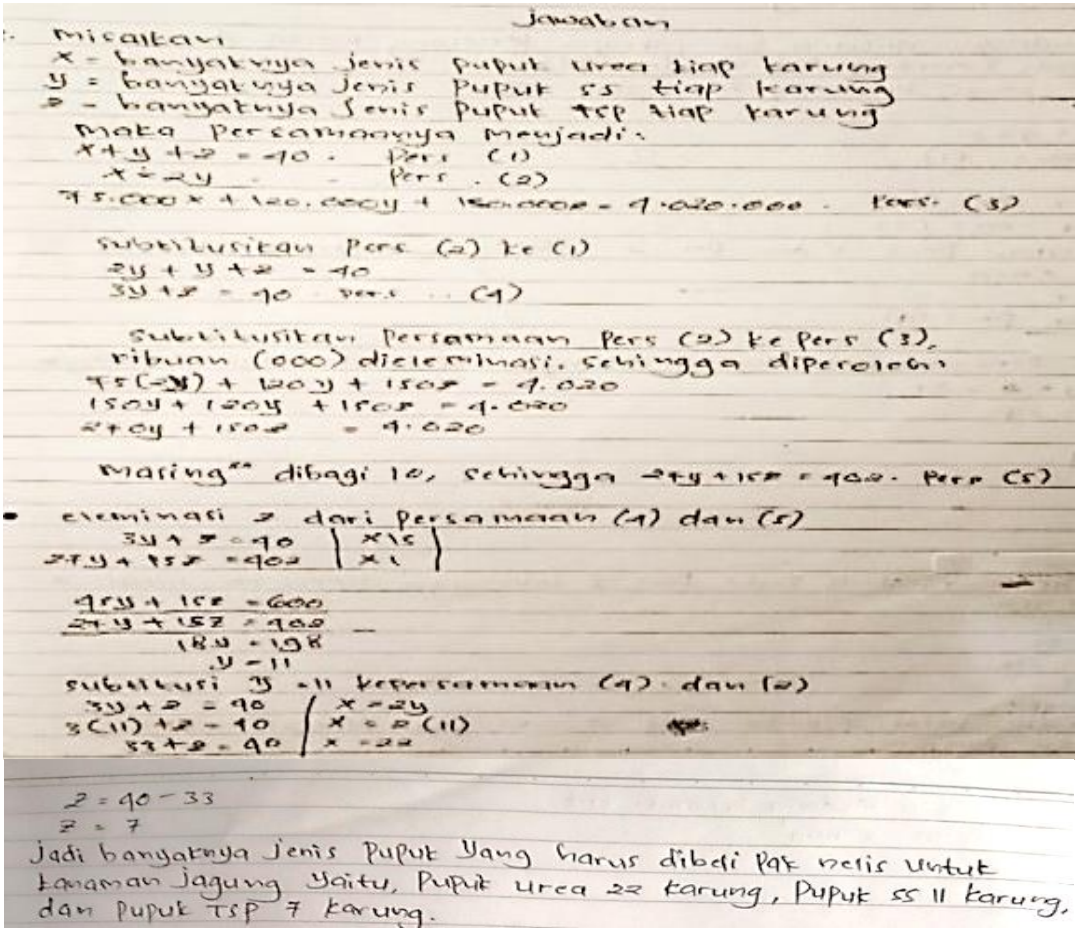


Figure 3. Mathematical Connection $FI_3$ on the 3rd indicator

Students $FI_3$ are able to solve problems by connecting these problems in everyday life. This is in accordance with the student's statement $FI_3$ as follows:

*R : From the results of your work, do you think this question has something to do with everyday life?*

*S-FI₃ : Yes. This question is related to agriculture, namely Mr. Nelis who has 2 ha of garden that will be planted with corn*

Students $FI_3$ are able to mention and relate the SLETV concept to everyday life. From the results of student work, it can be seen that students are able to solve by eliminating and substituting each equation to get the value of each variable. This shows that students are able to connect these questions with everyday life. Students can complete the steps correctly to get the right results. The opinion of Firdaus, et al (2018) states that FI students are able to interpret and understand questions according to procedures for solving questions related to real life. Meanwhile, the indicator of connecting the students' own mathematical concepts is able to mention the SLETV concept related to comparison. From the results of the students' work, $FI_3$ it is known that students are able to interpret the questions by eliminating and substituting each variable so that in the next step it can be done to get the value of each equation. Meanwhile, the indicator linking mathematics with other fields of science, students $FI_3$ are also able to interpret questions related to economics. Students are able to determine the mathematical equation for each variable and are able to substitute each equation to obtain the correct results. In the completion process it is known that students $FI_3$ are able to complete according to their abilities. This is in accordance with the opinion of Taufik & Zainab (2021) and Minarti et al (2017), FI students tend to solve problems using their understanding and are able to understand and state mathematical concepts correctly.

**FD students' mathematical connection ability**

In this section, the results of student work and interviews in solving the questions will be described. However, for each student 1 question and interview number will be included. Meanwhile, the other question numbers will provide a general description of how to solve the questions given.

1. Field dependent students ($FD_1$)

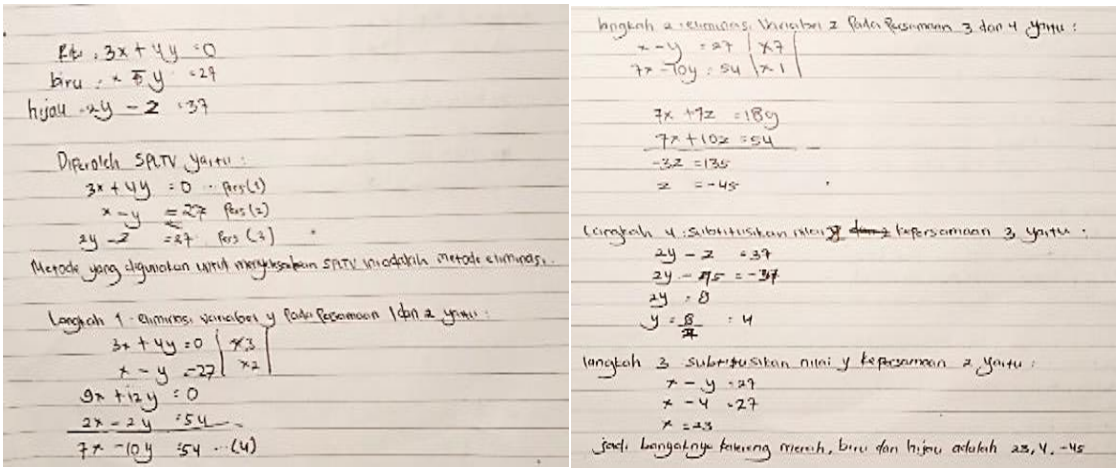


Figure 4. Students' mathematical connections $FD_1$ on indicator 1

Student $FD_1$ less able to solve problems by connecting the problems with their own mathematical concepts. This is in accordance with student statements $FD_1$as follows:

*R : What do you know about this question?*

*S-FD₁ : Red, blue and green cans*
*R : Now that you know this question, does this question have anything to do with other material?*
*S-FD₁ : I don't know*

From the results of student work, $FD_1$ it is known that students are unable to interpret questions using the SLETV concept. In solving questions, students $FD_1$are able to write down the steps of the SLETV concept according to their abilities. However, the results of the work carried out by students are still wrong in eliminating each equation so that they get wrong results. Mean while, indicators link mathematical concepts with other fields of study. Students are able to interpret the questions in the economic field. The solution steps taken by students are still not precise so that the answers they get are not correct. Indicators connecting mathematics with everyday life students are unable to interpret the questions. From the solution steps taken by students, it is known that there is a connection between the problem and everyday life by making mathematical models. However, the results obtained are less precise. Based on the results of student work, $FD_1$ it can be seen that students are less able to interpret questions using the SLETV concept. Students are not able to eliminate questions correctly so they get the wrong answer. It can be seen that the ability of FD students is still lacking in interpreting these questions because they experience difficulties. This explanation is in line with the opinion of (Sri Ayu Azriati, 2017) who says that field dependent students are able to solve things globally and experience difficulties in solving problems and are more influenced by the environment.

2. Field dependent students ($FD_2$)

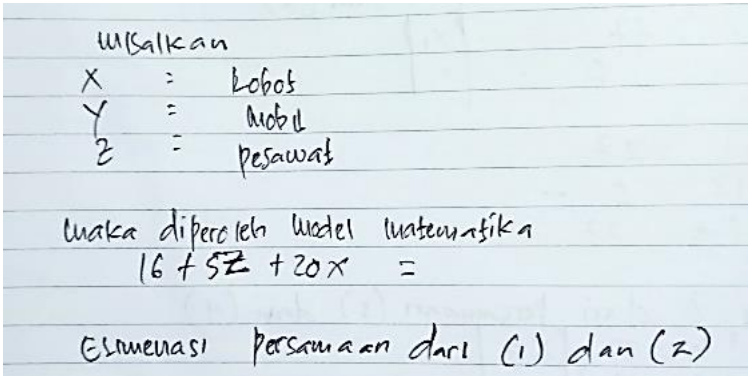


Figure 5. Students' mathematical connections $FD_2$ on indicator 2

Students $FD_2$ are not able to interpret the question in other fields of study. This is in accordance with the student's statement $FD_2$ as follows:

*R : What do you know from this question?*
*S-FD₂ : Robots, cars and planes*
*R : Now that you know this question, does this question have any connection between mathematics and other fields of science?*
*S-FD₂ : Mathematics*

Students $FD_2$ are unable to solve and relate these problems to other fields of science. From the results of the students' work, $FD_2$ it can be seen that in the completion process the students were able to write down what they knew. However, the following steps, namely determining the mathematical equation, students are not able to solve because they experience difficulties. This explanation is in accordance with the opinion of Warih et al (2016), namely that FD students are unable to apply previously learned concepts to concepts in other material so that students experience difficulty in

solving these problems. Meanwhile, the indicator of connecting ideas in mathematics that students use in the process of solving problems shows that students are able to write down what they know in the problem and are able to apply the SLETV concept with comparisons. However, from the steps in solving the questions, students were less able to solve the questions so that the answers they obtained were less precise. Meanwhile, indicators link mathematics to students' daily lives $FD_2$ also less able to relate the matter. Student $FD_2$ able to write down what is known in the problem, namely x = urea, y = SS and z = TSP can be done correctly. However, the next step could not be done because the student was unable to eliminate the next equation. Based on the results of students' work $FD_2$ It can be seen that students $FD_2$ are less able to solve and connect these questions using connection ability indicators. This agrees with (Hasan, 2020) who said that FD students are able to accept things globally and have difficulty separating themselves from circumstances or being influenced by the environment.

3. Field dependent students ($FD_3$)

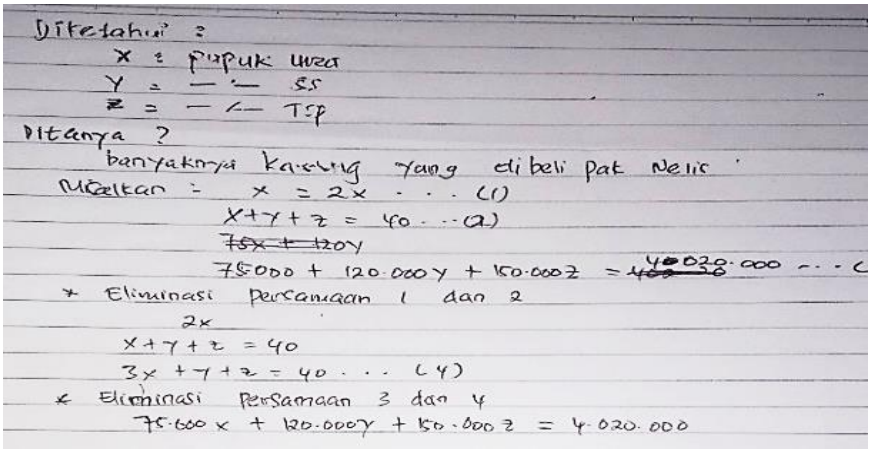


Figure 6. Students' mathematical connection $FD_3$ to indicator 3

Student $FD_3$ unable to apply SLETV questions to everyday life. The following are student statements $FD_3$ as follows:

*R* : *What do you know about question number 3?*
*S-FD₃* : *Mr. Nelis has 2 ha of garden*
*R* : *Then does this problem have anything to do with everyday life?*
*S-FD₃* : *I don't know*

Students $FD_3$ are unable to understand, solve and interpret these questions in everyday life. From the results of the work carried out, students are able to write down what they know and ask in the questions. However, the following steps taken by students show that students are less able to solve the problem. Ariawan & Nufus (2017) also said that students with a field dependent cognitive style were not able to connect these questions with everyday life. The indicator connects ideas in mathematics that students $FD_3$ do not be able to relate mathematical concepts to the SLETV concept. In the process of solving problems, students experience difficulty in eliminating each mathematical equation so that the results obtained are incorrect. Meanwhile, indicators of mathematics in other disciplines show that students are unable to connect questions with other concepts. This is known from the solution steps taken, students experience errors so they are unable to solve the problem correctly. Based on the results of students' work $FD_3$, it appears that students are unable to connect these questions with everyday life or mathematical concepts in other disciplines. It can be seen that students do not understand in solving problems so that they get wrong results. The opinion of Novianti (2021) states

that students have not been able to solve problems according to plan and do not understand the ideas in mathematics that underlie each other and in the context of everyday life.

## 4. CONCLUSION

Based on the results of previous research and discussion, it is concluded that the mathematical connection abilities of field independent (FI) students tend to be different from those of field dependent (FD) students. FI students are able to solve problems with indicators connecting mathematical concepts, mathematical concepts with other fields of science, and are able to solve mathematics problems with everyday life. From these three indicators, FI students are able to solve questions correctly and in accordance with the steps for solving the SLETV concept. As for students who do not meet the three indicators of mathematical connection ability, namely students who have the FD cognitive style, namely not being able to connect mathematical concepts, connect mathematics with other sciences, and mathematics related to everyday life. In solving the problem, the student experienced difficulties, in this case the steps taken by the student were not correct, resulting in wrong results.

The implication of these findings is that FI students tend to have superior mathematical connection abilities compared to FD students' mathematical connection abilities. Therefore, it is recommended for FD students to study more diligently according to their characteristics, especially practicing solving mathematical connection problems regularly.

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