

## Strategic Competencies of Prospective Teacher Students Based on Cognitive Style and Gender

Andi Syukriani

Mathematics Education Department, Universitas Patempo, Indonesia  
syukrianiandi@gmail.com

### ABSTRACT

This study aims to describe the strategic competencies of prospective teacher students based on cognitive style and gender in formulating, representing and solving problems. This type of research was descriptive qualitative. The supporting instruments were the GEFT (Group Embedded Figure Test) and the task of mathematical non routine problem contained several mathematical concepts, namely circles, trigonometry, and triangles. The research subjects consisted of 2 males Field Independent (FI) and 2 females Field Independent (FI), 6 females Field Dependent (FD) and 4 males Field Dependent (FD). Data was collected through documentation of solving mathematical problem and interview results. The data validity method used method triangulation and referential adequacy checks. Research datas were analyzed by reducing data, presenting data and drawing conclusions. The results showed that FI females and males were more analytical than FD females and males. FI males and FI females both understood problem situations by drawing, but FI males recognized the circle concept more quickly and confidently than FI females. FI females were more analytical in the process of transferring problem situations into pictures than FI males. FI males and FI females both represented problem situations in pictures and symbols but FI females tended to have more logical pictures and symbols than FI males. FD females tended to understand problem situations by drawing more than FD males, therefore FD females were said to be more analytical in transferring problem situations into pictures compared to FD males. The four types of subjects did not arrive at a correct final solution.

**Keywords:** Cognitive Style, Gender, Statigic Competencies

### ABSTRAK

Penelitian ini bertujuan mendeskripsikan kompetensi strategis mahasiswa calon guru berdasarkan gaya kognitif dan *gender* dalam memformulasi, merepresentasi dan menyelesaikan masalah matematika. Penelitian ini adalah penelitian deskriptif kualitatif. Instrumen utama adalah peneliti dan instrumen pendukung adalah Tes GEFT (*Group Embedded Figure Test*) serta tugas penyelesaian masalah matematika yang merupakan soal cerita tidak rutin dan terkandung di dalamnya beberapa konsep matematika, yaitu lingkaran, trigonometri, dan segitiga. Subjek penelitian terdiri dari 2 laki-laki *Field Independent* (FI) dan 2 perempuan *Field Independent* (FI), 6 perempuan *Field Dependent* (FD) dan 4 laki-laki *Field Dependent* (FD). Data dikumpulkan melalui dokumentasi penyelesaian masalah matematika dan hasil wawancara. Metode keabsahan data dengan menggunakan triangulasi metode dan pengecekan kecukupan referensi. Data hasil penelitian dianalisis dengan cara mereduksi data, menyajikan data dan menarik kesimpulan. Hasil penelitian menunjukkan perempuan dan laki-laki FI lebih analitis daripada perempuan dan laki-laki FD. Laki-laki FI dan perempuan FI sama-sama memahami situasi masalah dengan cara menggambar, tetapi laki-laki FI lebih cepat dan percaya diri mengenal konsep lingkaran daripada perempuan FI. Perempuan FI lebih analitis dalam proses mentransfer situasi masalah ke bentuk gambar daripada laki-laki FI. Laki-laki FI dan perempuan FI sama-sama merepresentasi situasi masalah ke dalam gambar dan simbol tetapi perempuan FI cenderung lebih logis daripada laki-laki FI. Perempuan FD cenderung memahami situasi masalah dengan menggambar daripada laki-laki FD, oleh karena itu perempuan FD dikatakan lebih analitis dalam mentransfer situasi masalah ke bentuk gambar dibandingkan dengan laki-laki FD. Keempat jenis subjek tidak sampai pada solusi akhir yang benar.

**Kata kunci:** Gaya Kognitif, *Gender*, Kompetensi Strategis

Received : April 11, 2023  
/Accepted : May 17, 2023

/Revised : April 25, 2023  
/Published : May 30, 2023

### Introduction

The demands of the 21st Century pose a challenge to every teacher to develop students' competencies so that they are ready to adapt and face global progress (Rahayu & Indra Putri,

2021). Niss concluded that competence includes knowledge and skills of students can be measured (Albano & Pierri, 2014). Strategic competence as the ability to solve mathematical problems through a strategy that comes from the thinking process (Syukriani et al., 2017). Strategic competence is inseparable from the involvement of students' mathematical understanding and reasoning (Syukriani et al., 2017). Prior descriptions show that strategic competence is needed to adapt in the 21st century because it requires the ability to use strategy in the problem solving process.

Strategic competence is described as an ability to formulate, represent and solve problems through the use of strategies as solutions (Syukriani et al., 2017). Strategic competence as the ability to know and implement strategies as solutions so that it is easy to analyze, complete tasks and solve problems (Özdemir & Pape, 2012). PISA presents student competencies in a complex manner, namely thinking and reasoning, arguments, communication, mathematical models, problem posing and problem solving, representation, use of mathematical symbols and use of technological aids (OECD, 2006). Based on some explanations of the strategic competencies mentioned above, this study examines strategic competencies which include the ability of prospective teacher students to use their strategies to formulate, represent and solve mathematical problems. This is strongly supported by an understanding of mathematical concepts and the involvement of individual characteristics in processing information. Formulating a problem is the process of understanding the problem as an activity finding out the known conditions and asked conditions, representing the problem is an activity of presenting an image or symbol that is equivalent to the problem situation and solving problem as use of the solution to the final result (Syukriani et al., 2017).

Each individual has diversities in information processing activities. These diversities can be caused by the characteristics (tendencies) of each individual, called cognitive style (Astutik & Purwasih, 2023; Kuo et al., 2012; Onyekuru, 2015) and gender (Santrock, 2019). Each individual based on their characteristics will provide diversity in presenting the direction of the solution when solving math problems (Syukriani et al., 2017). Therefore, these characteristics need to be studied so as to provide opportunities to carry out various efforts to increase individual competence so that they are more strategic in providing solutions to each mathematical problem. Students' mathematical competence can be increased through a clear assignment approach (Albaladejo et al., 2015).

Cognitive style is a tendency based on individual characteristics in processing and transforming information (Holmes et al., 2013; Kuo et al., 2012; Mousavi et al., 2012). Field-dependent (FD) and field-independent (FI) cognitive styles are one of the cognitive style dimensions that have received the most attention in terms of educational implications (Mousavi et al., 2012). FD individuals in solving problems tend to be influenced by external factors, think globally and do not focus on seeing important components in problems, while FI individuals tend to be influenced by internal factors and are analytical in dealing with problems and always focus on seeing important components in problem (Holmes et al., 2013; Kuo et al., 2012). There are differences in numerical abilities between FI and FD individuals (Ahiri & Banerje, 2021).

In addition to cognitive style, gender is also a characteristic in individuals as male and female where male have masculine characteristics and female have feminine characteristics (Santrock, 2019). There are gender differences in solving math problems in the form of multiple choice questions and essays (Ajai & Imoko, 2015; Salihu Mari, 2012). There are various research results related to gender differences which are very complex in the process of solving problems

(Zhu, 2007). The description above shows that gender is an individual characteristic that distinguishes male and female as personal and social identities (Tunu et al., 2022) and raises their respective tendencies in thought processes so as to provide diversity in implementing strategies as solutions to problem solving.

FI and FD cognitive styles have a relationship with gender, namely male tend to be FI and female tend to be FD (Onyekuru, 2015). Both are characteristics in individuals who show a tendency in the process of cognition to solve mathematical problems. The process of solving math problems requires logical procedures to produce a strategy that leads to the final solution. Thus, differences in cognitive style and gender provide a variety of solutions to a math problem.

Mathematical problems require clear boundaries in their use. Mathematical problem divided into two parts, namely routine problem and non-routine problem (Polya, 1973). Polya further added that routine problem can be directly recognized by the steps for solving them based on experience when solving that problem, whereas non-routine problem requires thinking to understand and solve that problem. Non-routine problem involves mastery of mathematical concepts and principles (Abdullah et al., 2017). The mathematics problem in this study is word question that require non-routine procedures to solve.

Solving math problem requires a thorough understanding of concepts. Prospective teacher students are assumed to have had a lot of learning experience in constructing an understanding of mathematical concepts so that it is possible to develop the flexibility of them in solving mathematical problems. In addition, prospective teacher students also have a variety of characteristics in processing information through their internal factors called cognitive style and gender. Therefore, this study analyzes the strategic competencies of prospective teacher students based on cognitive style and gender in formulating, representing and solving math problem. Thus, the results of this analysis can be used as a reference to design learning, the form of assignments and assessments for the scope of prospective teacher students at University of Patempo Makassar with instruction that are relevant to cognitive style and gender to provide opportunities to increase the flexibility potential so that they are able to adapt in the 21<sup>st</sup> century.

### **Research Methods**

This research was exploratory research with a qualitative approach, which explored the strategic competency of solving math problems for prospective teacher students at Patempo University in Makassar based on cognitive style and gender. The GEFT (Group Embedded Figure Test) test was used to determine cognitive style, namely Field Independent (FI) (for scores 14-18) or Field Dependent (FD) (for scores 1-9 out of a total score of 18) (Kepner & Neimark, 1984). The mathematical ability of all prospective teacher students was at a low level. In detail, the subjects of this study was a class consisting of 14 prospective teacher students. Subjects were divided into 4 students with the FI cognitive style and 10 students with the FD cognitive style. FI consisted of 2 males (MFIL) and 2 females (MFIP), while FD consisted of 6 females (MFDP) and 4 males (MFDL). The research results were obtained from the results of strategic competence interviews on the results of solving mathematical problem. Mathematical problem contained several concepts, namely circles, trigonometry and triangles. The data validity method used method triangulation and referential adequacy checks. Research data were analyzed by reducing data, presenting data and drawing conclusions.

## Result and Discussions

This study described the strategic competency analysis of prospective teacher students based on cognitive style and gender for the results of solving math problems. Strategic competence included the ability to formulate, represent and solve mathematical problems. The following describes the strategic competencies of field independent female prospective teacher students (MFIP), field dependent female prospective teacher students (MFD), field independent male prospective teacher students (MFIL), and field dependent male prospective teacher students (MFDL).

### *Field Independent Female Prospective Teacher Students (MFIP)*

MFIP directly formulated mathematical problem situations by made picture analytically even though they are less logical. MFIP directly tried to understand the problem situation by drew all informations were received from the problem to find out the concrete conditions (figure 1). These conditions show the existence of an analysis process in every simple sentence or in complex sentences to produce ideas (picture). Ideas were related by the information asked were also designed in the pictures form (figure 1). If a problem that looks complex is made in another form (multiple mathematical representations), then the problem will look simple so that it allows to be solved quickly (Wilujeng & Andriyani, 2022). MFIP found important elements in known information and tried to function them to find a form of solution from the asked information (figure 1). MFIP tried to connect known informations and asked informations by analyzed and then observed picture that have been made based on all the information in the problem. MFIP did some scribbling on the picture to come up with the next idea. This process shows that MFIP is thinking about the direction of the solution to the problem situation being faced, in accordance with the opinion of (Hermiati et al., 2021) that someone will find out how to solve a problem every time they are faced the problem. In accordance with the results of study from (Syukriani et al., 2017) that FI individuals tend process informations analitically. Therefore, MFIP had the opportunity to come up with the idea of a circle concept based on the processed of functioning important element but because according to him there were many concepts that had to be passed in order to reach this solution and the steps were difficult for him, he decided to take only a triangular solution (figure 1). MFIP recognized the concept of circle while were explaining the reasons for using a triangle shape as a solution. This condition indicated that MFIP found an idea when she was providing an explanation for their conjecture. In addition, there was also other MFIP who did not recognize the concept of a circle at all, even though she awared existency of important elements but did not try to function the important elements to find a solution form of the asked information. Both types have an incomplete understanding of concepts relevant to the problem situation, so they did not have a sense of confidence and were not challenged to think more about a complete and correct solution. The picture were a concept image that were reached by the thought process.

MFIP represented a mathematical problem situation using pictures and formula symbols as a solution to represent the problem situation. The pictures created did not reflect an overview of concepts that are relevant to the problem situation so that they did not arrive at the correct final solution. MFIP used the formula for two triangular areas as a representation of the asked information which was based on the initial process of understanding the asked information (Figure 1). These conditions showed that MFIP did not analytical in processed images to produce the right final solution so that they only continued on pictures and formulas that were mastered. A representation can be produced correctly if the representation is formed based on the process of extracting the meaning of one form of representation from another so that each form of representation that has been produced (multiple representations) has the same meaning

(same interpretation) and then these meanings are easily recognized properly (Arefaine et al., 2022). These activities required a clear and relevant concept image based on problem situation to produce a representational form of problem solving.

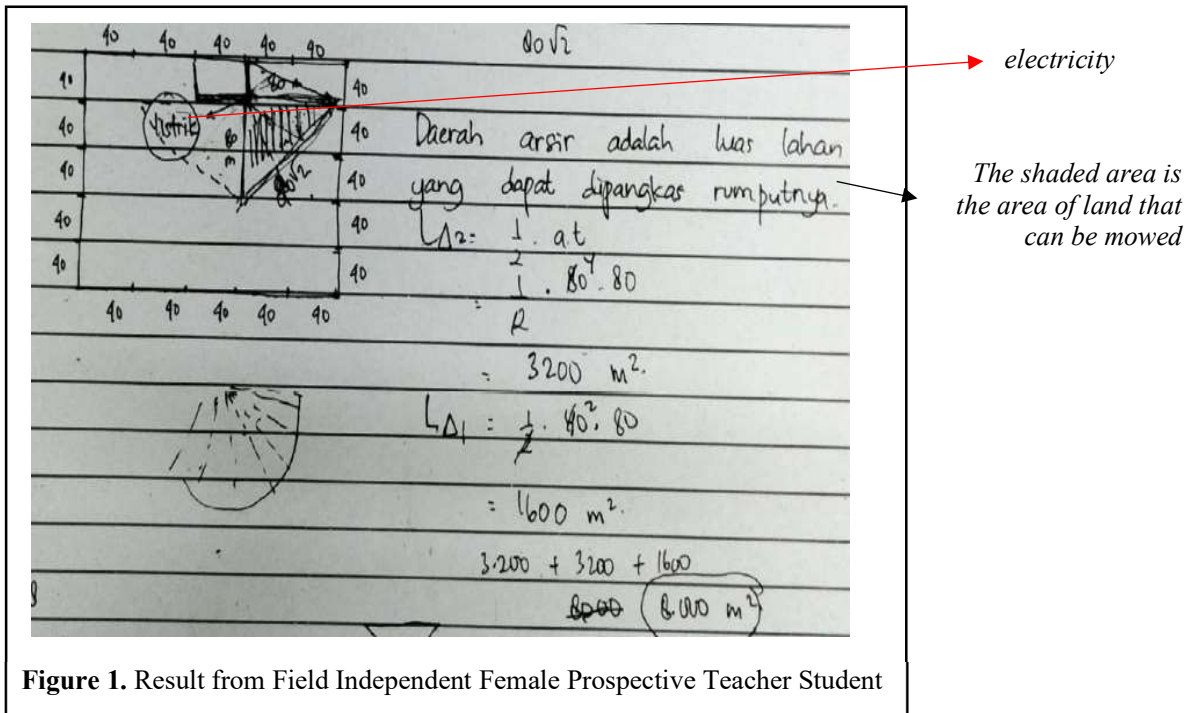


Figure 1. Result from Field Independent Female Prospective Teacher Student

Based on the explanation of form representation above, the process of solving problems from MFIP were using a simple solution procedure. MFIP directed the problem situation to a form that were simple and close to their learning experiences so that the formula used follows the resulting form representation. These activities were routine procedural activities.

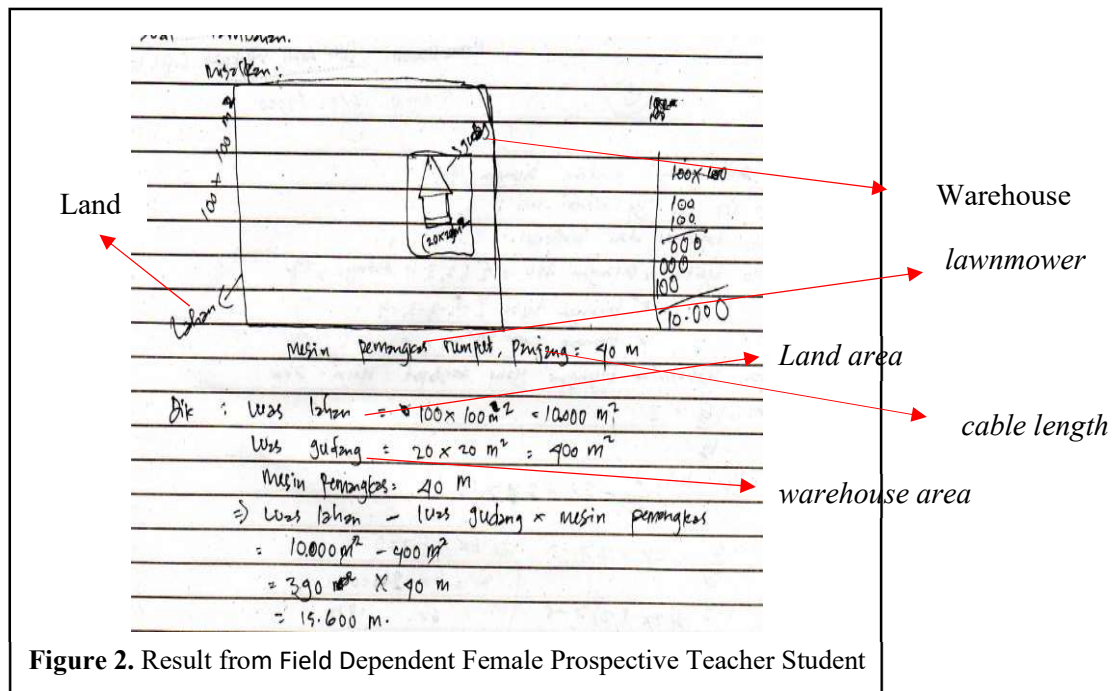


Figure 2. Result from Field Dependent Female Prospective Teacher Student

*Field Dependent Female Prospective Teacher Students (MFDP)*

MFDP formulated the problem by directly wrote back the known informations. Some MFDP also tried to understand the problem situation by made pictures of all known information (figure 2), although most of the MFDP did not make pictures to understand the problem. The resulting picture did not match to known information (figure 2). These conditions indicated that MFDP did not carry out an analysis process of all known and questioned information. Information with simple sentences could be made into simple pictures as well, while information with complex sentences could not be drawn correctly. MFDP were not aware of important elements of the known informations. Thus, they were unable to understand the problem to get an idea (form of solution) from the asked information. These illustrated that MFDP were unable to obtain a concepts image that were relevant to the problem situation because were illogical in processed informations.

Some of MFDP represented problem situations through symbols that were illogical and did not through an analytical process even some of the other MFDPs did not produce form representations. Their inability, namely bringing the solution to the final solution, were caused the concepts image were not successfully built. These showed that MFDP were not analytical in connected known information with asked information and their relationship with relevant concepts. The forms of the settlement were not formed at all because MFDP didn't involve a logical mind. The ability to think logically is very important in supporting mathematical skills (Sari et al., 2022). On the other hand, these are in accordance with previous research that individuals with the characteristics of the FD cognitive style tend to make more mistakes in solving math problem (Astutik & Purwasih, 2023).

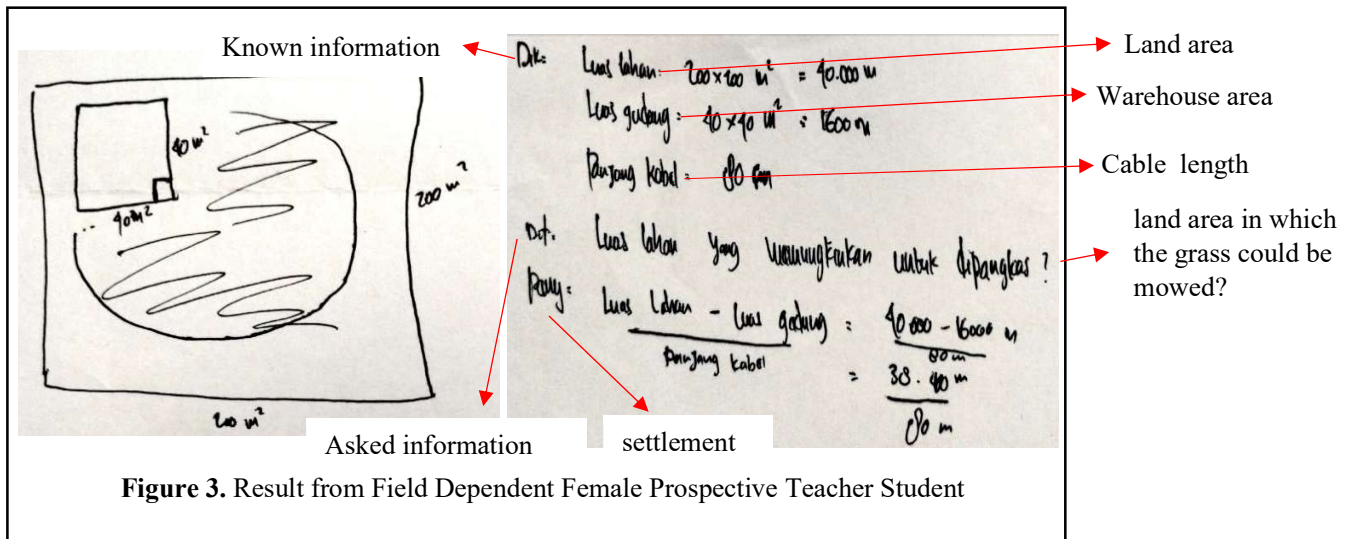


Figure 3. Result from Field Dependent Female Prospective Teacher Student

*Field Independent Male Prospective Teacher Students (MFIL)*

MFIL formulated a problem situation by directly sketching pictures of all the known and asked information and then wrote back the known and asked information (figure 3). All known informations were made in a suitable form but in an incorrect position. This showed that MFIL were able to analyzed all simple verbal information so that it were presented in the right form but could not formed the right picture based on complex verbal information.

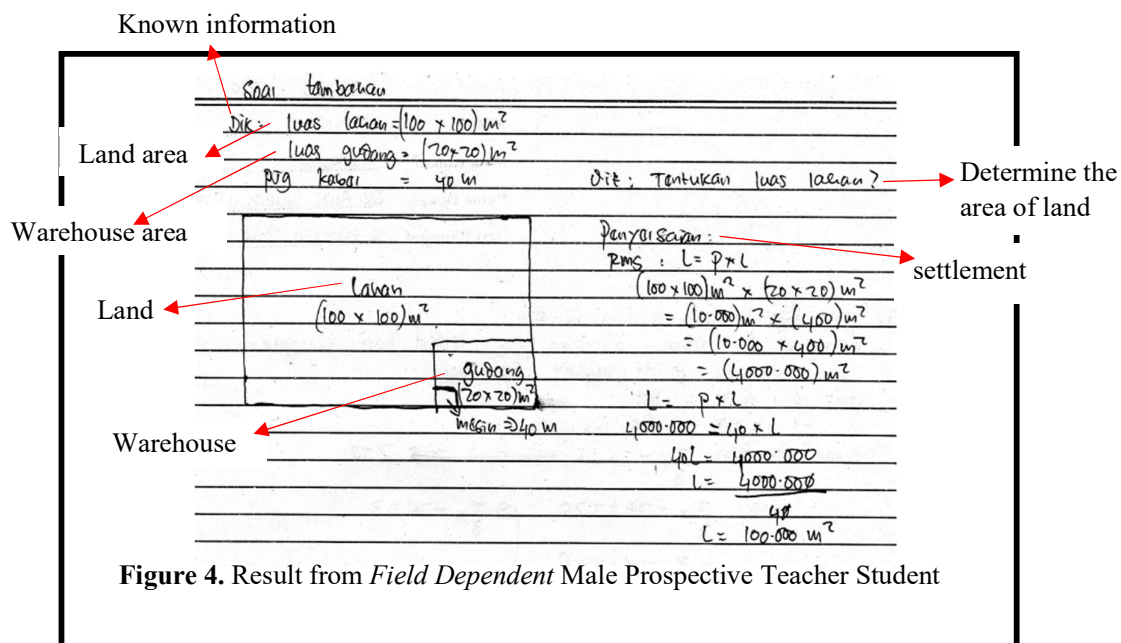
MFIL represents the problem situation in pictures and symbols (figure 3). The resulting picture representations were a full circle shape that appeared based on the process of functioning

important elements to form the asked information. The important elements were functioned but didn't completely because it didn't involve other elements around them which influenced the formation of the area asked in the problem. MFIL recognized the initial concept that emerges when these important elements were put into action, but MFIL didn't continue to explore the proper shape thoroughly. MFIL Recognized the concept after stimulated their learning experience (reflection) related to the problem situation being faced. these conditions indicated that MFIL processed information that was closed to their learning experience, namely concepts that are easy to recognize. MFIL ignored complex forms and complicated settlement procedures. The formula used was a formula that didn't match to the image that had been produced because they avoided forms and procedures that are complex and difficult to recognize.

MFIL solved problems using simple forms and formulas. The complexity of forms and formulas were avoided by MFIL and then led to the easy forms and procedures even though the direction of the solution illogical. In accordance with the result of (Fatimah, 2021) research that students often use procedures that are not in accordance with the mathematical nature of the problem situation at hand. Therefore, MFIL were not successful in directed the solution to a correct form and formula.

#### *Field Dependent Male Prospective Teacher Students (MFDL)*

MFDL formulated a problem situation by directly rewrote the known information and asked information. Most MFDL didn't transfer known information into picture. This showed that MFDL didn't have a concepts image at all related to the information found in the problem, so there was no analysis process in linked between known information with relevant concepts. Furthermore, regarding the asked information, MFDL did not carry out the process of established a solution area.



Most of MFDL represented problem situations through formula symbols that were not illogical with problem situations and a small number of MFDL used picture and formula (figure 4). The

resulting formula was illogical and irrelevant to the situation from asked information because they used a formula that closed to their experience, which was easy to solve. MFDL didn't carry out an in-depth analysis process to produce the right representation of symbols and pictures. These are in line with the prior results of research that FD individuals think globally and they are not aware the existency of key features to find a solution direction (Holmes et al., 2013; Kuo et al., 2012). Thus, MFDL couldn't determine the direction of the final solution.

### Conclusion

This study concludes that there are many variations in the use of strategies in formulating, representing and solving problem situations based on field independent (FI) and field dependent (FD) cognitive styles and gender. FI females and males were more analytical than FD females and males. FI males and FI females both understood problem situations by drawing, but FI males recognized the circle concept more quickly and confidently than FI females. FI females were more analytical in the process of transferring problem situations into pictures than FI males. FI males and FI females both represented problem situations in pictures and symbols but FI females tended to have more logical pictures and symbols than FI males. FD females tended to understand problem situations by drawing more than FD males, therefore FD females were said to be more analytical in transferring problem situations into pictures compared to FD males. The four types of subjects did not arrive at a correct final solution.

### Acknowledgement

The researcher would like to thank the Mathematics Education Department at Patompo University.

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