www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Students' Mathematic Communication Ability in Solving Mathematics Problems from Cognitive Style and Gender

Sigid Edy Purwanto[1], Wulandari Liga Kusumawati[2]
[1,2]*Universitas Muhammadiyah Prof. Dr. Hamka, Indonesia*
sigid@uhamka.ac.id, wulandarikusumawati99@gmail.com

Abstract

This study aims to analyze the level of students' mathematical communication skills in solving mathematical problems in terms of cognitive style and gender in the aspects of mathematical writing, drawing, and expression. This is qualitative research with the research subjects are 37 students of VIII class. Sampling was done by purposive sampling technique. Collecting data in this study using written tests and interviews. Data analysis in this study used data collection, reduction, presentation and verification. The results showed that: 1) Students in FD and FI were both able to understand questions and gave good responses, the difference was that FI understood the problem separately while FD understood the problem as a whole; 2) FD can draw based on information on the problem without analyzing the problem but not according to problem solving steps so that there are few errors, while FI are able to draws based on analysis of the information presented correctly and in accordance with problem solving steps but there are unclear for readers; 3) FD and FI can both express results using mathematical equations and present problem solving results based on the results of visualizing the problem, but FI present results are structured while FD are not structured.

Keywords
cognitive; communications; gender

I. Introduction

Mathematical Communication Ability is the ability of students to convey mathematical ideas both orally *(talking)* as well as writing in printed form(Hodiyanto, 2017). Students' Mathematical Communication Ability can be made through the learning system in schools. One of them is the mathematics learning system. According to(Pratiwi, 2015) through communication, students can explore their mathematical thinking and knowledge then develop in solving problems using mathematical language. Communication is the process of delivering messages by someone to other people to tell (Hasbullah, et al: 2018)**.**

According to (Faradillah, 2021) Mathematics is one of the subjects that is considered difficult because of its abstract nature making mathematics seen as a boring and uninteresting subject. Therefore, it takes the ability to communicate mathematical thinking either orally, drawing, written, arranged, drawing, graphing, using objects, introducing symbols, or using mathematical graphs.(NCTM, 2000).

One important characteristic that has a close relationship with the mathematics learning process is the students' cognitive and reasoning style in solving math problems(Faradillah, 2014). Related to this, the way students can be different in processing message symbols, storing, and using information to respond to an assignment. This is in accordance with the opinion of Wolfe & Johnson in (Lim, 2016) which states that people have different ways of seeking and processing information, as well as seeing and

interpreting it. The difference in the way a person processes information is better known as cognitive style (Keefe in Oh & Lim, 2005:54); (Kamid et al., 2020).

According to (Lianasari, 2017) cognitive style is the individual's personality in the process of thinking, feeling, remembering which is connected with the perspective of information. This attitude is shown by handling information, storing information, getting information, dealing with problems and solving problems. The cognitive style that will be used in this study is the cognitive style according to (Witkinet Al, 1997) especially the Field Dependent (FD) and Field Independent (FI) cognitive styles which mark the proportion of affirmation, remembering, and thinking about each individual perceiving seeing, replacing, and handle information (Saracho, 1997).

Independent Field is a characteristic of individuals who tend to view objects that consist of discrete and separate parts from their environment and are able to analyze in separating elements of a more analytical context. Meanwhile, Field Dependents have individual characteristics that tend to organize and process information globally so that perceptions are easily influenced by environmental changes (Komarudin et al., 2014).

Each student has differences in their initial abilities before and after the lesson so that each student will have different obstacles. According to research(Saputra & Zulmaulida, 2020)Students who have high initial abilities will usually understand and observe the answers to the questions presented more quickly, but the opposite can happen to students who have moderate abilities, they will take longer to understand than students who have high abilities, as well as students who have high abilities. who have low abilities. capacity. Likewise, different cognitive styles in each student will really be decisive for students who have the choice to understand and observe the answers to the problems introduced. Therefore, it takes a superior role of educators in carrying out learning exercises as a restoration of learning models that are often used.

Furthermore, students' cognitive style affects mathematical communication skills. How an individual processes and responds to information will affect the ability to communicate in mathematics orally and in writing(Kamid et al., 2020). In addition to cognitive style, there are other factors that affect students' mathematical communication skills, namely gender. Gender is an inherent trait of men and women that is socially and culturally constructed(Fakih, 2014). According to (Amir, 2020)that there are differences in students' mathematical communication skills from the aspect of gender. The difference can be seen from the ability to solve problems. Female students are shown to have less experience outside of school than male students, many female students never explore their potential for thinking except the thinking taught in the school curriculum. On the other hand, female students excel in mathematical communication skills (verbal), are more motivated, organized in studies.

Research result (Wijaya et al., 2016) stated that the completeness of mathematical communication of female students is better than the completeness of mathematical communication of male students, but the accuracy of mathematical communication of male students is better than that of female students. In addition, the oral communication of female students is better than that of male students. relevant come from (Saputra & Zulmaulida, 2020) which states that there is a difference between students' cognitive styleson students' mathematical communication skills, while (Pratiwi, 2015); (Thursday, 2020) stated that in addition to students' cognitive styles, gender factors alsoaffect students' mathematical communication skills.

This study aims to analyze the level of students' mathematical communication skills in solving mathematical problems in terms of cognitive style and gender. Similar research that specifically examines aspects of mathematical writing, mathematical drawing, and

mathematical expressions has not been done before so that through this research new innovations will be obtained in the world of mathematics education which can then be used by all groups to make it easier to solve mathematical problems so that mathematics does not become a frightening subject for students.

II. Research Method

This research is a qualitative research type of situation analysis case study, namely analyzing students' mathematical communication skills in terms of cognitive style and gender. There are indicators of students' ability in mathematical communication skills in learning mathematics according to(NCTM, 2000)there are from the ability to communicate mathematical thinking through oral, written and illustrated; the capacity to understand, decipher and assess mathematical thinking both orally and in other writings; the capacity to use terms, mathematical notation, and design to introduce connections and state models of mathematical situations.

In this study, researchers took 2 classes, namely class VIII-1 and class VIII-4 with a total of 37 students as subjects. The research subject is the subject of FD1 (male) and FD2 (female) who have field dependence cognitive style and FI1 (male) and FI2 (female) which have field independence cognitive style. Subjects were selected using the GEFT cognitive style test which adopted the study (O'brien, 2001);(Ulya, 2015);(Thursday, 2020). According to(Ulya, 2015)GEFT is a perceptual test modified from the Embedded Figure Test (EFT) developed by Herman. A Witkin et al. GEFT is the standard test in America, so changes to GEFT are not made as much as possible. This GEFT test has been measured for its level of reliability by previous researchers. The value obtained from the Cornbach Alpha reliability is 0.84, meaning that the reliability of the GEFT is very high(Khodadady & Tafaghodi, 2013)

According to (Ulya, 2015) The GEFT test consists of three parts. The first part is considered an introduction which consists of seven questions. The other two sections (second and third) each consist of nine questions. During the test, the instructions on the first page were read aloud at first. Students can work on each section within the 10 minute time limit. Some students who complete a section in shorter time are not allowed to continue to the next section. All students start working simultaneously on each section. The score for each student is the sum of the points in the last two sections of the test. Each correct answer is given a score of 1. The maximum score is 18 points and the minimum is 0 points. Determination of FI, FDI, and FD cognitive styles is based on the scores obtained by students. Determination of cognitive style FI, FDI, and FD based on the scores obtained by students.

Determined by the Maine Holistic Rubric for Mathematics, Maryland Mathematical Communication and the QUASAR General Rubricas shown in Table 1(Kamid et al., 2020).

Table 1. GEFT Score Category

Correct Score Score	Cognitive Style
0 to 9	Dependent Field
10 to 13	Intermediate Field
14 to 18	Independent Field

Validity test was conducted to determine the validity of the data. The validity test in this study was carried out by giving 25 questions which were divided into 3 sessions. The researcher used the Biserial Point Correlation formula to find out whether the questions that were being worked on were valid or not. Based on the results of the validity test, it was found that rcount > rtable, namely the value of $r_{hitung} > r_{tabel}$(0.46), it can be seen that of the 25 questions tested, all of them are valid and can be used as instruments during the research.

The data in this study are mathematical communication skills in solving mathematical problems obtained from the results of written tests and interview transcripts. The result of the transcript is a conversation between the researcher and the subject which is then reduced to obtain data on mathematical communication skills. Furthermore, the data from the reduction results are categorized based on aspects of mathematical communication which consist of three aspects, namely drawing, writing and mathematical expression indicators (Damayanti, et al., 2020). The categorized data is adjusted to the level of mathematical communication indicators, namely levels 0 to 4.

Testing the credibility of the data with time triangulation is done by checking the data through interviews in different times or situations. In this study, the triangulation process was carried out by analyzing the data obtained from the first data and then compared with the second data. In the first data, the subject was given a written test and then an interview was conducted to verify the answers to the written test questions so that data certainty was obtained. After that, the second data was taken with a different time based on the same procedure. The data is said to be valid if the first data gives the same trend of results when compared to the second data. However, if the data is invalid then the data is discarded. After collecting data from the first source, data is collected from the second source and so on until the researchers get really valid results regarding the ability and level of mathematical communication of students in each gender and different cognitive style. The results of data analysis from each subject in the problem solving tests I and II were time triangulated and showed valid results for all aspects studied, namely reading, writing, and mathematical expressions.

III. Results and Discussion

Mathematical communication skills of subjects FD1 and FD2 can be seen in Table 2 below.

Table 2. Comparison of FD1 and FD2 Mathematical Communication

Indicator	Valid Data Subject Fied Dependent Male	Valid Data Subject Field Dependent Female
Writing ability	Subjects can understand the problem as a whole and determine the problem to be answered, then students can write mathematically important information from the problem. Students' answers are obtained by experimenting with certain patterns so that the correct and clear answers are obtained, but the presentation is incomplete	Subjects can understand the problems presented and then respond to questions with good responses but are still general and incomplete, so that communication and presentation are less clear

Mathematical drawing skills	Subjects can express mathematical problems in pictures but they are incomplete and there are few errors	Subjects can draw based on the information on the problem without analyzing the actual problem that occurred and not according to the expected problem solving steps, so there are still a few errors.
mathematical expression ability	Subjects can respond to questions correctly and then make mathematical equations based on the information obtained, but the problem solving steps that are carried out are less structured and incomplete so that the solutions obtained from these calculations still contain errors.	The subject responds to the question correctly and can then make a mathematical equation but it is less structured, incomplete and the solution of the calculation carried out is less precise.

In Table 2, there are several similarities and differences in students' mathematical communication based on three indicators, namely:

1. Ability to interpret mathematical ideas
   Students of FD1 and FD2 have similarities, can understand the whole problem presented in the problem and are able to write mathematically important information from the problem. The difference is that in FD1 there is an attempt to try out questions with a certain pattern until a solution is found in the form of an answer, even though the answer is not quite right, while in FD2 the response given is still very general and incomplete so that the answer given is not clear.
2. Mathematical Drawing Ability
   FD1 and FD 2 students are able to respond well to the problems presented in the problem, the difference is in FD1 the subject can state mathematical problems into the picture after analyzing the existing problems but there are still a few errors, while in FD2the subject can draw based on the information on the problem without analyzing the actual problem so that the problem-solving steps are not appropriate.
3. Ability to express mathematical problem solving results
   FD1 and FD2 students have similarities in good responses in the form of stating the results of problem solving by using mathematical equations. but slightly different in presentation, FD1 students present the results of problem solving based on the results of visualization of the problem and structuredbut the problem-solving steps that are carried out are less structured and incomplete so that the solutions obtained from these calculations still contain errors, while FD2 can present the results of problem solving based on the results of the visualization of the problem and is less structured andincomplete and the solution of the calculations carried out is less precise.

Table 3. Comparison of FI1 and FI2 Mathematical Communication

Indicator	Valid Data Subject Fied Dependent Male	Valid Data Subject Field Dependent Female
Writing ability	Subjects can understand the problem separately and make the correct response in the form of problem-solving steps well, but there are still some errors in communication and presentation	Subjects can understand the problem separately and make the correct response in the form of problem-solving steps well but the presentation is still incomplete
Mathematical drawing skills	Subjects can make drawings based on analysis and in accordance with problem solving steps and accompanied by other image applications to ensure answers, but the presentation still has a few imperfections.	Subjects can create images based on analysis and in accordance with problem solving steps by trial and error so that the presentation is less clear.
mathematical expression ability	Subjects can state the results using mathematical equations and present the results of problem solving based on the results of visualizing the problem and being structured but still not perfect.	Subjects can state the results using mathematical equations and present the results of problem solving based on the results of visualizing the problem and being structured but still not perfect.

Furthermore, based on table 3 it is found that:

1. Ability to interpret mathematical ideas
   FI1 and FI2 students have similarities in understanding problems, namely in a separate way and can provide good and correct responses in the form of problem-solving steps, but in their presentation there are still a few incompleteness.
2. Mathematical drawing skills
   FI1 and FI2 students have similarities in terms of making pictures based on analysis correctly and in accordance with problem solving steps, but the difference is for F1 students being able to include other image applications to ensure answers, although the presentation still has some imperfections. Meanwhile, FI2 students tend to try and experiment so that the presentation is less clear.
3. Ability to express mathematical problem solving results
   FI1 and FI2 students alike can express results using mathematical equations and present problem solving results based on the results of visualization of the problem and structured.

Based on the results of the tabulation of students' mathematical communication skills in Table 2 and Table 3, there are similarities, namely students in FD and FI both can understand questions and give good responses, the difference is that FI students understand the problem separately while FD students understand the problem as a whole. In this case, FI students are better able to separate objects from the surrounding environment so that when a context changes, FI students will not be confused and can analyze new information received, while FD students are only strong at manipulation but have difficulty when presented in other contexts. This is in accordance with the opinion(Pratiwi, 2015)and(Witkin, 2017)which states that field dependent cognitive is able to think globally and accept existing structures or information, while the characteristics of the FI cognitive

style view objects as consisting of discrete and separate parts from the environment (Awlliyah et al., 2015).

Furthermore, in terms of drawing mathematically, it is known that the subject of FD can draw based on information on the problem without analyzing the actual problem and not according to the expected problem solving steps, so there are still a few errors. This is in accordance with the characteristics of the FD cognitive style which has difficulty processing information and tends to only accept the information presented without reorganizing it so that it is difficult to describe the problem situation through pictures. (Pratiwi, 2009). In contrast to FD students, FI students are able to make drawings based on an analysis of the information presented appropriately and in accordance with problem solving steps through trial and error or accompanied by image applications, but the drawback is that the presentation is still not clear to the reader. This is in accordance with the opinion (Awalliyah et al, 2015) which states that FI students are stronger in terms of analytics and are able to deal with problems that require elaboration.

FD and FI students can both express results using mathematical equations and present problem solving results based on the results of visualizing the problem, but FI students present results in a structured manner while FD students are not structured. This corresponds to (Pratiwi, 2009) which states that the characteristics of the FD cognitive style are difficult to focus on one aspect and analyze patterns into different parts, while the characteristics of the FI cognitive style tend to be able to seek more information, not only referring to existing information, but also being able to distinguish an object from another object. more easily then analyze the problem by analyzing it (Awalliyah, 2015).

Based on the results of this study, it shows that FD students are classified as more difficult to solve a problem when the context of the question is changed because they tend to be stronger in terms of manipulation, namely only receiving information without being able to reorganize, while FI students are classified as being able to solve problems when the context changes because they able to receive information then analyze and reorganize the information obtained better. This is in accordance with the theory of (Witkin, 2017)

In addition, almost all students, both FD and FI, did not succeed in answering questions with perfect scores because male and female students tend to have low motivation to work on the questions until the final process due to a feeling of fear of being wrong. This is in line with the results of research (Dilla et al., 2018) which states that students with mathematical resilience who are less likely to work as they are, do not even finish until the final process of solving the problems.

Regarding gender, it was found that male students scored higher than female students in both FD and FI. This is because the right hemisphere of the male student's brain has a stronger ability in the field of numerical and logic than the right hemisphere of the female student. While the left hemisphere of the female students has advantages in the aesthetic and religious fields than the left hemisphere of the male students (Word, 2013).

IV. Conclusion

Based on the results of data analysis and discussion for research subjects in class VIII SMPN 63 Jakarta, it was concluded that students in FD and FI both could understand questions and gave good responses, the difference was that FI students understood the problem separately while FD students understood the problem separately. whole. Furthermore, the subject of FD can draw based on the information on the problem without analyzing the problem that actually occurs and does not match the expected problem solving steps, so there are still a few errors, while the FI students are able to make

drawings based on an analysis of the information presented appropriately and in accordance with the solving steps. problems through trial and error or accompanied by image applications, but the lack of presentation is still not clear to the reader. In addition, FD and FI students can both express results using mathematical equations and present problem solving results based on the results of visualizing problems, but FI students present results in a structured manner while FD students are not structured. Almost all students, both FD and FI, did not succeed in answering questions with perfect scores because male and female students tend to have low motivation to work on questions until the final process due to a feeling of fear of being wrong.

Based on the research in the field, the researcher gives some suggestions so that teachers should pay attention to the assignment and delivery of line and angle material about relationships, lines, angles, and determine their size. This is so that students understand correctly the position of the angles that occur when two lines are cut by another line. In compiling school or home assignments, teachers should emphasize students' mathematical communication skills, such as questions that require students' ability to express mathematical problems in pictures. Teachers should also provide more non-routine problem solving questions. It aims to make students more accustomed to dealing with mathematical problems, besides that problem solving steps can make students more coherent in solving mathematical problems.

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