

# Mathematical Representation Ability and Self - Efficacy

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## Mathematics communication ability in statistica materials based on reflective cognitive style

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**Abstract.** This study aims to explore the mathematical communication of students based on Reflective cognitive style. This research is a qualitative research that is descriptive qualitative. The subjects in this study were students who took statistics methods, the selection of research subjects with a purposive sampling technique, the validity of the data was obtained by the method triangulation technique. Data analysis with the process: (1) reduction data, (2) presentation data; and (3) making conclusions and verification. The results of this study are: (1) SM subjects are able to propose hypotheses by making convince statements related to the problem given, but in guessing hypotheses tend to require a relatively long time, (2) SM subjects can understand and evaluate ideas in mathematics in problems solving in writing, (3) subjects are able to present and read tables, and graphs, as well as fill out the things that are known and asked completely and correctly, (4) the subject SM is able to conclude the answer from the results of solving the problem in accordance with the question, (5) able to complete and clear in communicating his ideas to others verbally, clearly and completely, but tends to take a long time. By studying or analyzing mathematical communication on statistical methods based on reflective cognitive style, it will certainly improve mathematics learning.

### 1. Introduction

Mathematics is the language of knowledge [1]. Mathematics is a language symbolized by a series of statements to be conveyed[2]. Mathematical language is mathematical terminology, notation, and symbol. So mathematics is very necessary for the progress of a nation. In mathematics learning process skills are needed. According to the National Council of Mathematics Teachers (NCTM) that there are five process skills that students must have in learning mathematics, namely: (1) problem-solving skills; (2) reasoning and proof making skills; (3) communication skills; (4) connection skills; and (5) representation skills [3]. While [4] formulates learning Indonesia broken down into four important types of abilities that students must master, namely: (1) problem solving; (2) reasoning; (3) communication; and (4) knowing the usefulness of mathematics as an objective of learning mathematics. In mathematics, communication plays a very important role. To share ideas and clarify understanding, one of them is by communication.

Student's mathematical communication skills are needed to improve the success of the mathematics learning process. If individual communication skills are disrupted, then the development of learning will be hampered [5]. Communication skills help students guide themselves and find the best for the individual [6]. [7] said that mathematical communication skills need to be applied in the process of



learning mathematics, because the difficulties concepts in mathematics if convey to the students appropriately then students can understand them and solve mathematical problems. One important aspect for students to have good mathematical problem-solving skills, then these students must have communication skills [8] [9]. So that without good mathematical communication, a student will have little information, data, and facts about the process and application of mathematics [10]. [11] argues that mathematical communication makes it easy for students to understand, interpret, and express mathematics that is being or has been learned.

The same thing was also stated by [12], who stated that in learning mathematics a student must be able to communicate mathematical language. Whereas [13] defines mathematical communication skills in the form of the sense to convey mathematical ideas in writing and orally, and be able to understand and accept mathematical ideas carefully, critically, analytically, and evaluatively. Mathematical communication can help the process of perfecting understanding of mathematical ideas and can help build students in generating permanent meanings and ideas. When students are challenged to think and reason about mathematics and communicate their ideas verbally and in writing, then with the help of a picture can get a clearer understanding.

There are two important reasons why communication needs to be developed in mathematics learning, first is mathematics as a language where it is not only a tool for thinking, a tool for finding patterns, problem-solving or making conclusions, but mathematics is also an invaluable tool for communicating ideas, precisely, and consciously and the second is learning mathematics as a social activity or vehicle for interaction between students and communication tools between students and teachers [14].

Teachers need to master a variety of competencies or abilities in order to be able to become facilitators, motivators, boosters, and inspirational learners for students. In learning mathematics, educators need to have mathematical communication skills, both oral and written in addition to various other abilities, such as the reason, proof, mathematical representation, and mathematical problem-solving ability. In this case, because the mathematic teacher plays a role in giving students a description of mathematics.

Statistics is an important lesson for students, so it is necessary for students to understand statistics. Student's understanding of statistics is influenced by their experience in learning statistics. Mathematic teacher in communicating the mathematical concepts, structures, or formulas to students, will affect the student's description of statistics.

Mathematical communication skills of students are influenced by many factors, one of them is cognitive style. Cognitive style is used in cognitive psychology to describe the way individuals think, understand, and remember information [15]. [16] states that cognitive style is a typical way for students to learn, both related to how information is received and processed, attitudes toward information, and habits related to the learning environment. There are several types of cognitive styles that have been classified by psychologists, including reflective cognitive styles. Students with a reflective style consider many alternatives before responding, so there is a high likelihood that the response given is correct [17]. Reflective students in answering have a slow character but tend to be careful so they tend to be right [18]. While [19] states that by applying it to students with reflective cognitive styles, guided inquiry learning can improve student achievement, compared to impulsive cognitive styles. While [20] suggested that communication must be one of the aspects developed in mathematics learning.

In this case, the lecturers and managers of the Mathematics Education Study Program must equip prospective mathematic teachers with good mathematical communication skills. Responding to the fact that there are weak mathematics teacher candidates in mathematical communication, the research wants to get a description of mathematical communication skills for prospective mathematics teachers. The problem-based lecture strategy is offered as an alternative to overcoming problems involving the weaknesses of prospective mathematics teachers in terms of mathematical communication skills. Based on the rationale stated above, the problem in this study was formulated: "How to analyze mathematical communication on statistical material for mathematics teacher candidates based on a

reflective cognitive style?". In line with the formulation of the problem, <sup>25</sup> the purpose of this study is to study or analyze mathematical communication for prospective mathematics teachers based on reflective cognitive style.

## <sup>10</sup> 2. Research Method

This study uses qualitative research methods because of the data collected in the form of oral and written data. Verbal data were obtained from student interviews while <sup>11</sup> written data were obtained from students' work in answering given questions. [21], [22] states that qualitative research is research aimed at describing and observing events, social <sup>8</sup> activities, attitudes, perceptual beliefs, thoughts of people individually or in groups. [23] states that qualitative research methods are defined as social science research methods that collect and analyze data in the form of words (oral and written) and human actions.

There are several indicators related to communication skills, including according to Baroody, NCTM and the PPPG Mathematics Team in Zanthy [8],[3], [24]. While the mathematical communication indicators follow LACOE <sup>20</sup>, as follows: (1) Reflect and classify thoughts about mathematical ideas, (2) linking everyday language with mathematical language with symbols, (3) using reading, listening, evaluating, interpreting mathematical ideas, and (4) using mathematical ideas to make guesses and make convincing arguments. Of the several opinions of existing mathematical communication indicators chosen indicators are: (1) able to submit allegations by making convincing arguments, (2) able to understand and evaluate mathematical ideas <sup>2</sup>, solving problems in writing, (3) able to present mathematical statements in tables, and graphs, (4) able to conclude the answer to the <sup>6</sup> problem in accordance with the question.

This research was conducted at the University of PGRI Semarang with the following considerations: (1) locations that are easily accessible by researchers; (2) has problems that are in accordance with existing problems; (3) heterogeneous subjects. The sample <sup>27</sup> this study uses purposive samples because in qualitative research there are no random samples. The selection of this subject is based on the results of cognitive style tests based on the Matching Familiar Figures Test (MFFT) instruments as well as the opinions of lecturers supporting statistical methods. So that one <sup>10</sup> subject chosen with a reflective cognitive style [26].

Data collection <sup>3</sup> techniques are the most strategic step used because the main goal of researchers is to get data [27]. Data collection techniques used in this study are test techniques, interviews and documentation with, the validity of the data obtained by the method of triangulation techniques.

In this descriptive qualitative study, the researcher himself who became the research instrument-assisted with the first aid instrument is a written test, second aid in the interview instrument and third assistive instrument is the reflective cognitive style test. For data analysis carried out before researchers go into the field, analysis in the field, up to <sup>17</sup> reporting research results. In this study, the data analysis technique used by researchers uses the Miles and Huberman models. that is, data reduction, data display, and conclusion drawing/verification [27].

## 3. Results and Discussion

### <sup>3</sup> 3.1. Results

Based on research that has been carried out from August to October 2019. Data on SM subjects with reflective cognitive style has the following characteristics.

#### 3.1.1. Able to guess by making convincing statements

The subject of SM was able to make a hypothetical parameter assumption in the form of a statement, accompanied by reasons, it was appropriate, but in conveying ideas tends to require a relatively long time.

Dengan  $\alpha = 5\%$  Ujilah apakah terdapat perbedaan kedua metode mengajar A dan B? Mana yang lebih baik.  
d) solusi:  
1.  $H_0: \mu_1 \leq \mu_2$  (Metode mengajar A tidak lebih baik)  
 $H_1: \mu_1 > \mu_2$  (Metode mengajar A lebih baik)

Figure 1. Suspected subject to the hypothesis

Based on the analysis of the test results in Figure 1 and a brief interview, the SM subjects suspected the hypothesis in this analysis initially occurred in the choice of confusion, because they had to choose what test, the hypothesis using the right, or left or two parties' test. SM subjects guessing for a long time can finally guess correctly. This can be seen from the results of the SM subject's written test in Figure 1.

3.1.2. *Being able to understand and evaluate mathematical ideas in solving problems in writing.*

SM subjects can understand and evaluate mathematical ideas in solving problems. At this stage, SM subjects can work on given problem with sequential steps related to the problem given. SM subjects can also complete these steps in full step by step until the final results are obtained.

3. Uji Statistik yang digunakan  
$$t = \frac{(\bar{x}_1 - \bar{x}_2) - d_0}{SP \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t(n_1 + n_2 - 2)$$
  
4. Komputasi  
$$SP = \frac{(n_a - 1)s_a^2 + (n_b - 1)s_b^2}{n_a + n_b - 2}$$
  
$$SP = \frac{(19)(2,58) + (17)(3,32)}{20 + 18 - 2}$$
  
$$= 1,71$$
  
$$t_{obs} = \frac{(6,95 - 6,44) - 0}{1,71 \sqrt{\frac{1}{20} + \frac{1}{18}}} = 0,9179806 \dots \approx 0,92$$

Figure 2. Answer SM subjects understand and evaluate mathematically

Can be seen in Figure 2, SM subjects can make writing in the form of an average test formula with the distribution, by being able to choose the formula used as in figure 2. SM subjects can choose the answer idea, if the population standard deviation data groups are the same and unknown, then the statistical test uses the formula as shown in Figure 2. Furthermore, the subject of SM in delivering complete and coherent mathematical problem solving accompanied by clear stages, but based on observations and interviews in conveying ideas tends to require a relatively long time. As shown in the results of the SM subject's written test in figure 2 above.

3.1.3. *Present and read a table or graphic*

SM subjects can present and read tables or graphs in the given problem-solving process. At this stage, SM subjects can fill out the things that are known and asked completely and correctly.

5. Daerah Kritis  
 $t_{0,05;36} = 1,645$   
 $DK = \{t \mid t > 1,645\}$   
 $t_{obs} = 0,92 \notin DK$

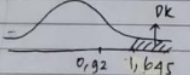
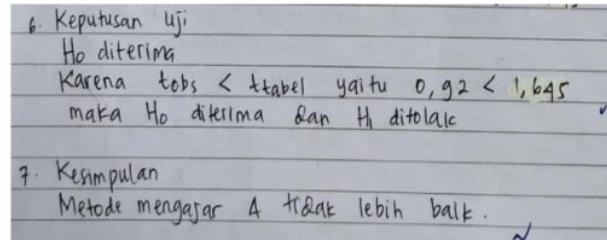


Figure 3. Answer SM Subjects present and read the distribution table or graph

As shown in Figure 3 written test results, SM subjects can present the t distribution table at  $\alpha = 0.05$ , with d.f. = 36, obtained 1.645, and SM subjects can show in the t distribution curve, it can be seen in Figure 3, that  $t_{obs} = 0.92$  less than  $t_{tabel} = 1.645$ .

3.1.4. **Able to deduce the answer to the problem in the question.**

SM subjects can work with sequential steps until they can conclude completely and clearly. SM subjects can communicate their ideas to others verbally and completely but tend to take a long time, then SM subjects also do a review of what that has been done.



**Figure 4.** SM subjects make conclusions

Based on Figure 4, SM subjects can deduce correctly, taking into account the results of the calculations obtained, although with caution.

Furthermore, the ability to explain verbally to others can be seen below.

P-51 : Can you explain the conclusions from your answers to questions about part c?  
 R-51 : Yes, sir  
 P-52 : Try to explain?  
 R-52 : Method of teaching A and method of teaching B the same.  
 P-42 : Why the results can be the same  
 R-42 : (think for a long time) because Ho was accepted and H1 was rejected  
 P-43 : Are you sure about the answer you have given?  
 R-43 : Wait a second, I'll check first  
*a few moments later*  
 R-44 : I have checked, sir, and correct, I am sure

Conclusion of mathematical communication on the subject of SM

Based on the results of the analysis that has been done, the subject "BC" can be stated as follows.

**Table 1.** Results of mathematical communication analysis on the subject

No	Form of mathematical communication	Communication indicator
1	able to guess by making convincing statements	SM subjects can make hypothesis assumptions following the problem at face, by making hypothetical statements clearly and convincingly, but in guessing hypotheses tend to require a relatively long time.
2	understand and evaluate mathematical	SM subjects can understand problems, problems are worked out coherently and completely, SM writes

	ideas in solving problems in writing	and evaluates mathematical ideas in problems solving. In determining the statistical test SM subjects are still confused in determining the formula, but can determine the statistical test correctly. so in conveying ideas tends to require a relatively long time.
3	Present and read tables, or graphs	SM subjects can read the distribution table but it takes a long time. At this stage, SM subjects can fill out the things that are known and asked completely and correctly. In making the curve of rejection or acceptance of the subject "BC" takes a little longer in presenting the graph of acceptance and rejection of $H_0$ .
4	Being able to deduce the answer to the problem in accordance with the question.	SM subjects can work with sequential and coherent steps, SM subjects can conclude completely and clearly. In communicating his ideas to others, verbally clearly and completely, but it tends to take a long time, and the subject of SM also conducts a review of what has been done.

## 2 Discussion

Based on the results of the analysis that has been done, obtained mathematical communication results of students in statistical completion as follows. SM subjects with reflective cognitive style can make hypotheses following the problem at hand, by making hypothetical statements clearly and convincingly, but in guessing hypotheses tend to require a relatively long time. SM subject can understand the question and work coherently and completely, SM subject can write and evaluates mathematical ideas in solving problems. In determining the statistical test SM subjects are still confused in determining the formula, but can determine the statistical test correctly. SM subjects can read the distribution table but it takes a long time. At this stage, SM subjects can fill out the things that are known and asked completely and correctly. In making the curve of rejection or acceptance area of the subject of BC, it takes some time to present the graph of acceptance and rejection of  $H_0$ . SM subjects can work with sequential and coherent steps, SM subjects can conclude completely and clearly. SM subjects in communicating their ideas to others, in the form of verbal clearly and completely, but tend to take a long time, and SM subjects also do a review of what has been done.

The tendency of students with reflective cognitive style in answering the questions correctly and completely but requires a relatively need a long time. This is because students with a reflective cognitive style, according to [17] state students with a reflective style consider many alternatives before responding, so the possibility of a given response is correct. Reflective individuals, who implement an analytic process and are cognitively mature [26]. Reflective students are students who have the characteristics of being slow in answering questions, but being careful so that answers tend to be correct [18].

## 5. Conclusion

From the results of the discussion, it was concluded that subjects with reflective cognitive styles in the completion of statistical material had the following mathematical communication: (1) SM subjects can



propose hypotheses by making convincing statements related to the problem given, but in guessing hypotheses it tends to require time relatively need a long time, (2) SM subject understands and evaluates mathematical ideas in solving-problems in writing, (3) subject can present and read tables, or graphs, SM subjects can fill in the things that are known and asked completely and correctly, (4) SM subject can conclude the answer from the results of problem solving following the question, (5) able to complete and clear in communicating his ideas to others verbally and comprehensively, but tends to take a long time, then the subject SM can do a review of what has been done. By studying or analyzing mathematical communication on statistical methods based on reflective cognitive style, it will certainly improve mathematics learning. Furthermore, mathematical communication analysis can be developed in cognitive styles and other materials.

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