Investigation of student’s obstruction on mathematical communication and the solution through self-correction

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Abstract. There are numerous students who experienced difficulties in communicating spatial geometry concept in solving the problems. The ideas in explaining spatial geometry problems solving is not communicatively expressed. This study aims to investigate the obstruction of the students in communicating spatial geometry concept and find the solutions. According to the epistemological barrier, the obstruction of the mathematical communication in the student may be caused by errors experience in applying concepts, inaccuracies in completing settlement strategies, and errors in interpreting results to draw conclusions. To overcome the problems in mathematical communication, some solutions can be generated by buildup self-correction in planning, processing and concluding of the solving problems activities. Subjects with high mathematical communication obstruction can be overcome by training the ability to (1) express ideas completely, (2) draw conclusions based on similar patterns by comparing, and (3) increase accuracy in carrying out calculations through understanding the application of concepts to solve the problem. Whereas subjects with low Mathematical Communication barriers can be overcome by getting used to focusing more on the relationship between concepts in implementing the solution strategy.

Keywords: mathematical communication, self-correction, student obstruction.

1. Introduction

In active learning, discussion activities are carried out by communicating ideas orally or in writing. Students with good mathematical communication skills also have good abilities in understanding, solving, and interpreting mathematic problems [1]. However, some cases in geometry, numerous students are having problems in generate their ideas to communicate the solution concept. Moreover, the students who able to solve the problems are lacking information in their solution, which performing by incomplete or inaccurate answer to determine the distance from the point to the plane in three-dimensional objects [2]. Based on the research conducted by Tiffany et. al., [3], expresses the mathematic students may common have low mathematical communication especially in delivering or explaining the mathematical ideas in writing and or declaring everyday events using math symbol or language. But it also supported by other research that student more common developing their mathematical communication and communicate their ideas through picture or diagram [4–6]. It shows that several students are experiencing an obstacle in communicating the ideas in mathematical problem solving.
The mathematical communication skill can be defined into three concepts, there were 1) the student-teacher understanding in subject explanations or questions and to the given answers or feedback, vise-versa; (2) students' ability to use mathematical knowledge to solve problems, and (3) students' ability to interpret the problems that are expressed verbally through the language of mathematics [7].

Perbowo & Anjarwati [8] suggest that obstacles in learning mathematics are influenced by external factors, included curriculum; and internal factors which include student's motivation and understanding of the material. Meanwhile, Zamora [9] reveals that students who are able to find their own mistakes have better academic achievement. The ability to identify their own mistakes in expressing the ideas makes students become good independent learners. If the students are able to identify their experienced obstacles, the student is expected to be able to acknowledge the actions that needed to overcome the obstacles [10,11]. Thus, the action called self-correction can be used as a means to find solutions to the obstacles of mathematical communication experienced by students. It is also an effective way to overcome misunderstandings and contribute to increase the success of the learning process [12,13].

According to Ramdass & Zimmerman [14], self-correction is a process that a person uses to achieve learning goals by activating and managing ideas, behaviors, and emotions. In this process a person implements strategies to solve problems, evaluate one's own performance, seek help when needed, and find out the success of the effort that has been made.

2. Methods
This research was conducted with a descriptive qualitative approach. The respondents were students of the Mathematics Education Study Program of UIN Walisongo in class 2A who had attended the Spatial Geometry lecture. The data of mathematical communication was obtained from the Spatial Geometry test on the topic of angles and distances. The data was then analyzed through triangulation and comparison of, (1) the delivered information and answers from the respondent during the test and the information during the interview at different times, (2) data from the Spatial Geometry test document and the results of structured interviews, and (3) the subject's perceptions of the concept of angles and distances used in problem solving. Based on the test results, there were three students chosen to be involved for in-depth interviews.

3. Result and Discussion
In this research, mathematical communication barriers that experienced by the respondent is focused on epistemological barrier. Epistemological barriers mean for the obstacles where students' knowledge has limited conditions in applying knowledge or concept they have [15]. The epistemological obstacles can be overcome by understanding the main reason why these obstacles pops up [16–18].

After test, the obstructions of the mathematical communication were experienced by most of the students can be grouped based on the basic knowledge of concept understanding. The obstruction of students' mathematical communication was investigated and classified by the obstacles on conceptual, procedural, and operational technique. The conceptual obstacle is identified from two difficulties, (1) difficulties in understanding mathematical concepts, operations and principles, and (2) difficulties in applying and linking concepts in solving mathematical problems. Meanwhile, the procedural obstacle is an obstacle related to the steps or algorithms that used in solving mathematical problems in a flexible, efficient, and accurate manner. The operational engineering barrier is an obstacle related to the errors in applying technical calculations to solve mathematical problems.

Offered solutions to overcome the obstruction of the mathematical communication that traced through self-correction, were focused on the self-assessment of the student efforts in solving geometry problems, especially in distance concept. Based on the self-assessment test, the students actually know where is the mistakes or difficulties that popping up the obstacles on mathematical communication. Hence, the students independently able to do improvements or follow-up the cases to create a solution to overcome the obstacles they have experienced. In fact, the students’ problem solving through self-
correction was developed based on the problem solving through planning, processing, and drawing conclusions stages. At the planning stage, self-assessment was seen from the activities of identifying the problems and compiling a resolution plan. Whereas during problem solving processes, the self-assessment was seen from the activities of implementing problem-solving strategies, expressing ideas, finding mathematical patterns, properties or symptoms, and presenting the steps. While, the self-assessment was performed from the activity of generalizing and drawing up conclusions on the results, and interpreting the solutions, during the drawing-conclusion stage.

By assessing the student answers, identification of the obstruction of the mathematical communication can be described in detail based, and can be used to understand the proposed strategies.

Figure 1. The three different type of the obstruction of the mathematic communication from three different students, A and B show the constraints on conceptual, procedural, and operational techniques, then C shows procedural obstacles only

On the Figure 1, it can be shown that the mathematical communication obstacles experienced by first student or S1 respondent (Fig 1.A) in solving problems, includes:

1) An error in applying Pythagoras' theorem. This error was exposed in determining the length of the EO spot. The S1 respondent did not pay close attention to the BOE triangle, so the applied operation was error. In this case, it can be concluded that the S1’s obstacle is in the operational techniques.
2) An error in applying the concept of point-to-plane distance in three-dimensional shapes. The first respondent thought, the EO line to be perpendicular to BD line because BD located above the plane of BDG. The inability of the first respondent to notice the position of point E against BD line on the BDG plane resulting the first respondent being inaccurate in identifying the EOG as an isosceles triangle with the EG side as the base, not EO. In this case, the S1 experiences conceptual mistake which result in procedural obstacles.

To overcomes the S1’s problems, proposed solution based on the self-correction, can be define into (1) at the process stage, because S1 respondent is incomplete in implementing the problem solving strategy and only involves two concepts and (2) at the conclusion stage, because S1 respondent is not correct in interpreting the results of the solution. It was identified from interview between researcher (R) and respondent (S1) as described in Table 1:

| Question | Answer |
|----------|--------|
| R : in your opinion, how do you use the solution strategy? | S1 : in my opinion, it is still incomplete, ma'am |
| R : try to explain which part of the strategy you think was still incomplete! | S1 : In the answer I wrote, I only used four steps, ma'am. So, I still have trouble finding the lines and fields used to find the distance. |

In the other hand, the obstacle which experienced by the second student (S2) was described by two reason, there were:

1) An error in determining the length of the GM line. It was caused by incorrectly applying of the concept of the sine’s value. This has an impact also in determining the value of the distance from point E to the BDG plane, i.e. the length of EM = \( \sqrt{168} \) as the student result, which should be obtained with the result of \( \sqrt{48} \).

2) An error was found in finding the size of \( \angle MEG \) and \( \angle EGM \). The S2 did not provide steps for obtaining this measure along with an explanation or definition of the used theorem. So the results of the obtained calculations appear because of trial and error using the size of the 60° and 30° angle. The S2 also made the mistake of determining which angle should be considered as 60° or which angle is 30°.

Meanwhile, based on self-correction, the identification of S2 obstacles includes (1) at the process stage, The S2 respondent was not precise in completing the used strategies, and has difficulty in expressing the ideas that linking several concepts and (2) at the conclusion stage, the S1 was not correct in interpreting the results of the completion. It was identified based on the interview between researcher (R), bellow:

| Question | Answer |
|----------|--------|
| R : in your opinion, how accurate is the calculation you offer? | S2 : the calculations I made to solve the problem was not quite right, ma'am |
| R : which part was not quite right? | S2 : the calculation looks for the value of the distance from E to BDG. because EM is the base of the triangle GEM, so when using Pythagoras, it should be reduced, not added. |
The obstruction of the mathematical communication experienced by third student or S3 respondent as shown in Figure 1.C is due to an error finding of the OG line length as the base of the EOG triangle. This problem makes the obtained result from the calculation, i.e. $3\sqrt{4}$ cm, was incorrect, which should be $3\sqrt{6}$. The S3 also did not include the calculation process in determining the OG line length. The error in obtaining the length of OG line, resulting in incorrect length of the height line in the EOG triangle. It makes the distance from point E to the BDG plane that student measured as length as $6\sqrt{2}$ cm, was incorrect, because the correct answer was $4\sqrt{3}$ cm.

Meanwhile, based on the results of self-correction, the identification of obstacles for S3 includes (1) at the planning stage, the S3 has not yet understood the relationship between the problem and the known components of the case, and made mistakes in preparing the solution strategy plan. (2) at the process stage, the S3 respondent made a mistake in applying the used concepts, The respondent was unable to find alternative solutions, and inaccurate in implementing the solution strategy. (3) at the conclusion stage, the S3 was drawn the conclusions by ignoring the relationship between geometry concepts and existed properties. It can be revealed by the following interview between the researcher (R) and the respondent (S3).

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**Table 3.** the interview record from interviewee and third student

| Question | Answer |
|----------|--------|
| R: why did you do like that? | S2: I still find it difficult to express the idea, ma'am |
| R: which steps did you have a problem? | S2: connecting point E to the BDG plane, Mom. Sometimes the position of the point is not quite right, so I am confused about what concept to use. Then when determining what plane contains the projection of point E to the BDG plane. if the plane is a triangle, which triangle concept should be used, I'm not good at it either. |

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**Table 3.** the interview record from interviewee and third student

| Question | Answer |
|----------|--------|
| R: how do you identify the information on the given problem? | S3: I understand it by finding out what should be known first. But I experienced difficulties at the beginning, Mom. I was sometimes afraid to start and afraid of wrong decision in choosing at the first step I made. But if I have mastered the initial concept, the next step will be easy ma'am. |
| R: then how did you plan for the solution strategy you used? | S3: based on the provided information, I have not been able to immediately implement a strategy to find a solution. So, I was looked for the same characters from known information. I took the edge of BE line equal to DE because they are the diagonals of the plane. |
| R: why do you use BE and DE? | S3: through BE, I then looked for the same side as BE, namely EG which is located in the ACGE plane. Whereas on the AC side I gave point O so that there is a triangle EOG, and from here the BDG plane is the distance E to OG. |
The results of problem identification from the S1 and S2 respondent, indicates strong obstruction, described by most of the mathematical communication obstacles caused by the conceptual, procedural, and operational techniques incorrect use. Meanwhile, it is known that the solutions to overcome these obstacles are (1) enhancing the ability by training the student to express ideas completely alongside with increasing logical reasons and theorems application, (2) increasing the ability of drawing the conclusions based on similar patterns by comparing, and (3) increasing accuracy in calculating through understanding the application of concepts to solve the problems. The identification results on the S3 respondent show week obstruction on the mathematical communication barriers due to procedural obstacles. Based on the results of self-correction, the solution of the obstacles is the student have to be used to more focus on the relationship between concepts to implement settlement strategies and draw conclusions.

The self-correction process that was implanted in students, can helps them to learn the solution independently and strengthen the efforts to achieve a success goal [14]. The activity of conducting self-assessments also helps students who have low mathematical communication skills, to do not rely their self to others. When students emerge the ability to find out their weaknesses and be able to overcome it, it will gain their self-confidence in solving other problems that positively affects in reducing mathematical communication barriers. This is in accordance to the previous research, that one of the stages can be used to categorize the growth of the mathematical communication skills is by checking the student answers [19]. In addition, to develop mathematical communication skills, teachers need to develop self-assessment skills in addition to self-monitoring [20].

The obstruction in mathematical communication that are not realized by students, triggers the student not to make improvements solution about their difficulties. Therefore, tracing errors in mathematical communication through self-correction can help overcome misunderstanding of concepts and difficulty solving problems. In addition, students who are able to do self-assessment well are also able to develop mathematical communication skills so that they will have better academic achievement.

4. Conclusion
The origin of the obstruction in mathematical communication experienced by the mathematics education students of UIN Walisongo on the concept of distance can be identified by the mistakes that student made. Then, through self-correction, the obstacles which was experienced by the student can be identified and developed to generate the solution. The mathematical communication obstacles such as those experienced by the S1 and S2 respondents can be overcome at the planning, process, and conclusion stages. Meanwhile, the obstacles such as those experienced by S3 can be overcome by emphasizing more on the process stage. The things that need to be considered in overcoming mathematical communication obstacles include (1) lecturers can familiarize students with assessing their weaknesses and abilities, so the students will grow self-confidence which has an impact on increasing mathematical communication skills; (2) students can practice their ability to make improvements and solution to overcome misunderstandings on the concepts, independently; (3) the learning carried out should support activities to foster confidence in students in carrying out self-correction activities; and (4) the need to develop learning that fosters the ability of students to link concepts, make generalizations based on mathematical patterns, and solve problems with various alternative solutions.

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