Teacher’s Mathematical Communication Profile in Facilitating and Guiding Discussion

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Abstract. Teacher’s communication skill plays an important role, one of which is to guide a class discussion for teaching purposes. This study aimed to investigate a teacher’s mathematical communication profile in facilitating and guiding a class discussion. This study is qualitative. A junior teacher of high school (i.e., a teacher with 1 to 5 year teaching experience) teaching mathematics at X-Social Class was selected as the subject of this study. The data was collected by observing the teacher’s mathematical communication in facilitating and guiding a discussion with the rules of sinus as the teaching material, and it was followed by a deep interview. The result showed that the junior teacher facilitated and guided a class discussion include providing responses addressing students’ difficulties and providing chances for students to propose and explain their ideas and be active in discussion. The junior teacher provides responses at sharp, optimal, and specific manner. In addition, she provides chances for her students to explain their thinking and have a discussion in anticipative, observative, selective, and connective manner. However, the study found that some of high-school teachers develop mathematical communication skills and use them to develop students’ mathematical communication skills.

1. Introduction
A teacher-student communication has tight relation with a teaching-learning process. [1] argued that there were five aspects, which involved representing, listening, reading, discussing, and writing. Representing mathematical ideas or thoughts with another concept may help students describe those ideas and help them discover strategies to solve problems, since it needs a deep analysis and actively involves their thinking. In curriculum standard of mathematics, [2], however, representation is no longer applied in mathematical communication. Thus, it is considered excluded. The second aspect is carefully listening to people questions and opinions. This skill should be improved since it may influence students’ mastery in comprehending the given material, capturing information needed, and proposing their comments or opinions. Listening to people opinion and other information may help students either see a new connection or clarify their thinking.
Following [1], the third aspect is reading mathematics textbooks as the sources of thinking and information. When students read, they may memorize, understand, compare, analyze, and organize the content of what they read. They must focus on the contents that provide important information, containing references relevant to the concept they are learning on or problems encountered. Another aspect that should exist in communication is discussing, which includes discussing with teacher and classmates in order to reflect their ideas and thoughts. Students who got engaged with a discussion may express and reflect their thoughts related to the material discussed. In a discussion, verbal
communication skill is necessary and it may evolve through regular exercises by teachers like giving chances for students to present their ideas, having students work in small groups, and any other activities that encourage students’ verbal communication skill. After having a discussion, students may express their mathematical ideas in a writing activity, consciously conducted in order to express and reflect their thoughts. Through writing, students may see the objectives of writing, reflect what they have done and thought, find out the point of problems, and develop their capability to combine mathematical language with their daily language in order to see a connection between mathematics and other concepts in daily life.

Related to the mathematical communication, [2] makes standard of ability that students should achieve. That is, organize and consolidate mathematical thinking through communication; communicate mathematical thinking coherently and clearly to peers, teachers and others; analyze and evaluate the mathematical thinking and strategies of others; and use the language of mathematics to express mathematical ideas precisely. In this research, the mathematical communication profile is a complete picture of teacher communication in building the learning community of mathematics.

To build the learning community of mathematics, teachers’ skills are needed in facilitating and guiding class discussions. [3] proposed a teaching strategy to build Mathematical Discourse Community by providing tasks for students to discuss, creating a comfort learning environment for students, and giving chances to propose and explain their ideas and thoughts, and encouraging students to participate actively in a discussion during the class.

Providing tasks to discuss. In this case, the teacher may develop students’ mathematical communication skills by selecting mathematical problems and tasks which encourage students’ interest to discuss, provide responses (e.g., in the form of questions or ideas/thought making the students actively engaged in a class discussion). [4] argued that “effective teachers understand that the tasks and examples they select influence how students come to view, develop, use, and make sense of mathematics”. This implied that in designing task to be discussed, a teacher should have assured that it was aimed to improve students’ mathematical comprehension in case of the subject matter concerned on. Hence, in order to complete the tasks, students needed to think independently on how to apply particular formulation, algorithm, and procedures related to particular concepts and comprehensions. Besides, in designing tasks, a teacher had to consider on how big chances the students might have to reveal significant ideas of mathematics. Giving mathematical tasks with appropriate level of difficulty might encourage students’ development, improve the use of a series of reasoning activities, and enhance students’ mathematical thinking.

Increasing a comfort learning environment. It refers to a conducive learning environment for students to propose and share their ideas and it may improve the quality and the quantity of discussion [5]. In a discussion, students would try to explain and provide some reasons that correlate to their ideas and ask their classmates to give responses or clarification on ideas they shared [6]. [7] found that through a small group discussion, a student’s intensity to express his/her thought might increase. This might bring big opportunity for students to develop their mathematical communication skills.

Providing chances for students to deliver and explain their ideas and thoughts. [4] asserted that effective teachers would encourage their students to explain and justify and stand their solutions on. With teacher’s guidance, students would learn how to use mathematical ideas, language, and methods.

Encouraging students to actively participate in a discussion. An effective and meaningful discussion would require students to carefully listen to, proceed, and understand other students’ ideas and thoughts [5]. Students need to be familiar with giving responses over the answer that another participant had shared in order to make the subject matter meaningful to learn [8]. Discussion is an interaction among students or between teacher and students in order to solve a problem or examine a particular concept. Therefore, teachers need to keep the discussion on track based on the learning objectives. [9] presented 5 practices –which may effectively help teachers to use students’ responses to improve students’ comprehension- in facilitating and leading a class discussion. These five practices stressed on the importance of planning. It noted that through planning, a teacher may anticipate the likelihood of students’ participation, prepare any possible responses from students, and make particular decisions
related to how to organize students’ presentation and make an agenda of mathematics, respectively. The practices involved anticipation, monitoring, selection, arranging, and connecting students’ various responses.

Therefore, the researcher was interested in investigating a teacher’s mathematical communication in providing chances for students to propose and explain their ideas and be active in a discussion dealt with anticipative, observative, selective, and connective actions. The subject matter selected for this study was trigonometry (the rule of sine). Trigonometry is a very important subject, not only in mathematics but in other fields. That is, to understand the concept of trigonometry requires students' understanding of algebra and geometry. This study aimed to thoroughly describe a teacher’s mathematical communication profile in providing chances for students to propose and explain their ideas and be active in discussion. The result would be useful as means to develop other teachers’ mathematical communication skills. It was expected to be a reference for teachers to improve their mathematical communication with students and develop students’ mathematical communication skills as well.

2. Method
This study is qualitative-descriptive. It aimed to describe a teacher’s mathematical communication profile in providing chances for students to propose and explain their ideas and be active in discussion. A high-school junior teacher with 1-5 year teaching experiences. It observed the subject’s mathematical communication in a teaching process the subject organized, and then a deep interview was conducted respectively in order to see and further investigate on how the subject’s mathematical communication was in providing chances for students to propose and explain their ideas and be active in discussion. The results of both observation and interview were then analyzed and described thoroughly in the form of teacher’s mathematical communication profile in providing chances for students to propose and explain their ideas and be active in discussion.

3. Result
In this chapter, the researcher would describe data informing the subject’s mathematical communication. It was collected through observation and in-depth interview. It was presented in 2 sections, including the subject’ mathematical communication in providing responses (answer) on students’ difficulties dealt with accuracy, be optimal, and be specific and providing chances for students to propose and explain their ideas and be active in a discussion dealt with anticipative, observative, selective, and connective actions.

The result of observation and interview showed that the teacher teachers started the discussion by giving tasks to the students. She gave the tasks after explaining on how to derive the rule of sine along with its application. The tasks was in the form of problem containing 5 essay problems which related to the rule of sine (Figure 1). Problem 1 required the students to determine the length of one of the sides of a triangle, Problem 2 and 4 asked them to determine the magnitude of one of the angles of a triangle, Problem 3 asked them to determine the comparison of length for the sides of a triangle, and Problem 5 asked them to determine the cosine of one of angles of a triangle. Each group must do the task based on their group number, thus, it made them complete a different problem for each other. It was aimed to make the students have better understanding on the stages of the rule of sine. The teacher claimed that the task should be completed in group and those who had completed their tasks might come forward and present their works. The teacher provided the tasks for group discussion and the representative of each group had to present their group works respectively. This was aimed to make them familiar with presentation and class sharing, and to improve their comprehension on the given material (i.e., the rule of sine). The group consisted of 5 pupils who were heterogeneous on their mathematical skills. They had been classified into groups since the class started.

After each group got the task sheet and began to discuss the problem, the subject led the discussion with several phases, including (1) walking around each group, (2) asking some groups that seemed ready to complete and present their works, (3) discussing the group works, (4) repeating the 2nd and 3rd phases until all groups had successfully completed and presented their works.
The subject walked around each group while monitoring their works. It was aimed to give the students chances for asking anything they did not get yet dealing with the given task. It was possible for groups to ask while the subject walked around the students. Encountering such situation, the subject gave a direct approach. It did happen in this study. A member of a group raised her hand indicating that she had something to ask. Knowing this situation, the subject provided an accurate responses by immediately approaching the student. Dealing with this, the subject immediately approached the student with a belief that, in each group, there must be one smart student who well-understood the given material, some students with moderate level of intelligence and some others who were completely blind with the rule of sine. In addition, the subject also gave a responses toward a student who proposed a question by approaching her in front of the class.

Noted that the subject’s responses dealt with the students’ questions, which related to the procedures of problem-solving. In this case, the students were encouraged to discover the answer of their question by themselves. Besides, she gave it (explanation) in specific manner –both orally and written- with a consideration that if the students were still confused with spoken explanation, a written explanation would be applied for better understanding.

After several minutes of group discussion, the subject would be selective by giving chances for groups that had completed their tasks to present their works. It was aimed to motivate other groups to present their works as well, in addition to a consideration of time.

Next, the subject asked all the students to pay attention on her and correct the works of their group mates. She showed the answer keys through power point and tried to match the group works with the answer keys. This was aimed to see whether or not the group works were correct before an appreciation and support were given toward groups and students. She continued the process by correcting the procedures of presented works. When it was found that the students’ works were less, the subject would give chances for them to correct their works. It was aimed to make them see in which part they got fault on their works. For instance (in another context), the subject provided a correction for a student’s work by changing \( \frac{\sqrt{2}}{2} = 12 \cdot \frac{\sqrt{3}}{2} \) into \( BC \cdot \frac{1}{2} \sqrt{2} = 12 \cdot \frac{1}{2} \sqrt{3} \). In addition, to introduce the student with the related symbols, she noted \( \sin \alpha \) as \( \sin A \), \( \sin \beta \) as \( \sin B \), and \( \sin \gamma \) as \( \sin C \). After having a discussion, she reminded the students to be careful and accurate in completing the tasks. After each of the groups came forward presenting their works and be corrected, the subject asked the students to make a conclusion on the rule of sine along with its usage in order to make sure that the expected learning objectives had been successfully reached.
Figure 1. The tasks was in the form of problem containing 5 essay problems which related to the rule of sine

4. Discussion
This section, the subject’s mathematical communication skill in providing responses (answer) on students’ difficulties dealt with accuracy, be optimal, and be specific. Accuracy dealt with the teacher’s soundness in providing responses. Be optimal dealt with the informed information as a kind of responses on several difficulties the students might encountered. It involved information on students’ errors along with the justifications and by considering the scale of priority which referred to particular points on the learning objectives. Be responses dealt with the kinds of ways applied to provide the responses. It could be in the form of oral or written. The subject’ mathematical communication in providing chances for students to propose and explain their ideas and be active in a discussion dealt with anticipative, observative, selective, and connective actions. Be anticipative required the teacher to be responsive with various strategies the students might propose for problem-solving. Be observative required the teacher to observe to what extent the students completed the given tasks and to what extent their involvement in a group discussion. Be selective made the teacher enable to select one of the students to present his/her work, and it was based on the assessment and contribution he/she gave to reach the learning objectives. Be connective required the teacher to help students link their works with their classmates.
The subject providing chances for students to propose and explain their ideas and be active in discussion, was consistent with [9] that teachers should be observative on students’ works along with their involvement during discussion. Teachers might do an observation by walking around while the students did their tasks (whether in group or individual). Such action might encourage students to reveal their ideas, clarify them, and make sure that each of their group members were active in group discussion. It also implicitly made the students consider any points of problems they needed to see closely. Therefore, before being observative, teachers should be anticipative. [9] defined this anticipative action as an action to anticipate any responses from the students toward the given tasks. In this case, the subject did anticipation by predicting any possible solutions the students might make by preparing the answer key for each of the tasks.

The subject providing responses (answer) addressing students’ difficulties, was consistent with [10] that argued one strategy teachers might apply to provide a responses was by immediately giving the responses for questions or difficulties the students proposed. The subject immediately approached the student with a belief that, in each group, there must be one smart student who well-understood the given material, some students with moderate level of intelligence and some others who were completely blind with the rule of sine. The subject provide an optimal response which related to the procedures of problem-solving and students are led to find the answer to the question. It was consistent with the strategies that [10] had proposed. The subject giving explanation in specific manner both orally and written.

After being anticipative on responses or students’ responses and being observative on students’ works, teachers might become selective by choosing some students to present their mathematical works and the selection was based on the group works. This was consistent with a theory that [9].

The last, the subject ended discussion by inviting the students to make a conclusion. She asked the students to make a conclusion on the rule of sine along with its usage in order to make sure that the expected learning objectives had been successfully reached. This was consistent with the procedures that [9] had proposed which involved connecting various responses or responses from the students as an attempt to help them capture out the correlation between the solutions their solutions and other students’ ideas, as well as the idea of mathematics.

5. Conclusion
Based on the analysis of this study, it concluded that the subject’s mathematical communication in facilitating and guiding a class discussion was as follows. The Subject’s Communication in Providing Responses (Answer) Addressing Students’ Difficulties. She gave responses in accurate manner by immediately providing answers for the students’ questions. She gave responses in optimal manner by providing explanations that corresponded to the students’ questions. She also led the students to find the answers of their questions by themselves. She gave responses in specific manner –both orally and written- with a consideration that if the students were still confused with spoken explanation, a written explanation would be applied for better understanding. The Subject’s Communication in Providing Chances for Students to Present and Explain Their Ideas and to be Active in a Discussion. She anticipatively gave chances for students to express their ideas and thoughts. She had estimated the possible solutions they would propose in the form of answer keys for each task. She observatively gave chances for students to express their ideas in order to make them feel comfort to ask about any notion they did not understand yet. She selectively gave chances for students to express their ideas by pleasing some groups who seemed ready to present their works in front of the class. It was aimed to motivate other groups to present their works as well, besides considering the time provided. She connectively gave chances for students to express their thoughts by leading them to make a conclusion on the given material. It was aimed to convince them that the expected learning objectives had successfully been reached out.
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