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Lower Secondary School Student's Written Mathematical Communication based on Gender

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Abstract

Mathematical communication is a skill that lower secondary school students need to master in order to support their learning achievement. One of the focus areas in developing students' mathematical communication is by using written communication through problem solving. The subjects of this study are six lower secondary school students consisting 3 female students and 3 male students. It is found that there is a difference written mathematical communication ability between the two genders on solving geometrical problems.

Keywords: Written Mathematical Communication, Gender

Introduction

Mathematical communication is an important part on learning mathematics in lower secondary high school regarding the goals of learning mathematics and five standards by National Council of Teacher Mathematics. Furthermore, Baroody (1993) emphasized that learning should focus on developing students' mathematical communication since learning mathematics is not only as tools for thinking, finding pattern, problem solving or inferring conclusion but also as a powerful language and tool for communicating various ideas clearly, correctly and concisely.

Language and thinking is inseparable, a good development of a language follows a good development of thinking (Suryabrata, 2002). Moreover, Cockburn (2007) stated that children's mathematical misconceptions frequently arise as a result of poor communication. Hence, mathematical communication is an important skill that students need to master in order to improve their mathematical ability. According to Ndlovu and Mii (2012), Ozerem (2012), the lack of knowledge and geometrical vocabularies of students might be the cause that the students encounter difficulties in learning geometry.

However, in practice, it is often found that several students face difficulties to communicate their mathematical ideas in learning mathematics (Brown & McNamara, 2011). The students' mathematical communication is limited to only give short answers when trying to determine measure of angle from certain geometrical object (Maulida, 2016). Maulida concluded that the students are in a poor qualification in several indicators of conceptual understanding on the topic of line and angle.

Studies comparing gender of lower secondary school students conducted by Ponter (2009), Santrock (2007), Usiskin (1982) showed that male students' visual, proofing and reasoning skills are more superior than female students. Meanwhile, the female students are better in reading and writing. Santrock (2007) further explained that geometrical topic especially visuospatial ability might also differ between the two genders.

The aforementioned studies suggest that there is a need for further study focusing on written mathematical communication of lower secondary school based on gender. The outcomes of the study might potentially reveal students' difficulties on the topic of geometry that the students encounter.

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Mathematical Communication

Mathematical communication is defined as a ability to write, read, listen, reason, interpret and evaluate mathematical ideas, symbols, terms and information (Dahlan, 2011). Meanwhile, Susanto (2015) stated that mathematical communication could also be defined as a conversation or interconnection which takes place in a classroom environment consisting of delivering mathematical messages such as concepts, formulas, or problem solving strategies that students learn. Parties that involve in the communication phenomenon are the teacher and the pupils. The messages are delivered orally or in written form.

Asiskin (Susanto, 2015) stated the roles of communication in learning mathematics as follow: (1) It may explore mathematical ideas from various perpectives, promote students' thinking and improve students' abilities to see connection from various mathematical strands. (2) It could be used to measure and reflect students' mathematical understanding. (3) It may promote students to organize and consolidate their mathematical ideas. (4) It may enhance mathematical knowledge construction, reasoning, self-confidence and social skills. (5) It may promote inclusive mathematical communication.

Ui Hock (Dahlan, 2011) explained that developing mathematical communication should involve three elements as follow: (1) values and aims of communication such as identifying relevant context, students' motivation and learning sources, they may support students' activity and skill for stimulating meta cognition, positive attitude and creatively creating a conducive learning environment. (2) oral communication: several desired communication techniques are story-telling, questioning, answering, structured and unstructured interview, discussion, and presenting mathematical tasks. (3) written communication: a curriculum promotes an active communication activity such as practicing, keeping scrap books, keeping folios, doing mathematical projects and solving tests.

Soemarmo and Hendriana (2014) wrote several indicators to measure students' mathematical communication ability as follow: (1) drawing or representing real objects, figures and diagrams into ideas or mathematical symbols. (2) Explaining ideas, situations and mathematical relations orally or in written form by using real objects, figures and algebraic expressions. (3) Representing daily life phenomenon into language or mathematical symbols then constructing the mathematical models of the phenomenon. (4) Listening, discussing and writing about mathematics. (5) Critical reading toward mathematical presentations. (6) Constructing conjectures and arguments, formulating definitions and generalizations. (7) Revealing mathematical passages or paragraphs into own language and style.

Elliot and Kenney (1996) stated that the ability to express mathematical ideas orally or in written form could be translated into four aspects of mathematical communication ability: (1) Grammatical ability defined as student's ability to understands vocabularies and grammar used in mathematics such as formulating a definition of mathematical terms, using symbols or notations and mathematical operations correctly. (2) Discourse understanding ability defined as student's ability to understand and to describe important information from a mathematical discourse such as mathematical problems or mathematical statements. (3) Socio-linguistic ability defined as student's ability to comprehend cultural or social information that are found in problem solving such as ability to interpret figures, graphs or mathematical sentences into appropriate contextual explanation also representing the contextual problems into figures, graphs or algebra. (4) Strategic ability, it is defined as student's ability to elaborate key messages from a mathematical problem and solve it coherently such as constructing conjecture toward relation among mathematical concepts, communicate mathematical ideas or relations using figures, graphs or algebra and solving the problems coherently.

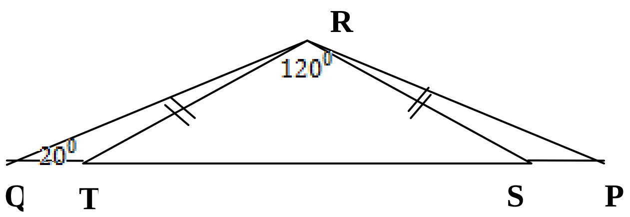
Furthermore, NCTM (2000) stated that communication can support student' learning of new mathematical concepts as they act out a situation, draw, use objects, give verbal accounts and explanations, use diagrams, write and use mathematical symbols. Hence, communication also support the students to have good understanding toward concepts being learned so that they may solve related problems. In other words, students' mathematical communication should be promoted in order to support students' learning achievement.

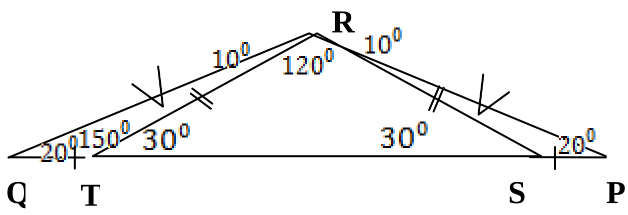
The subject of this study is six lower secondary school students consisting three males students (coded as SL1, SL2, SL3) and three female students (coded as SP1, SP2, SP3).

Aspect of mathematical communication being used is grammatical ability, discourse understanding ability and strategic ability. The problem being used to investifae students' written mathematical communication is "A triangle RST is an isosceles triangle which RS is equal to RT and the angle of SRT is 120^0. If P and Q lie on the extension of ST such that S between P and T, while T between S and Q. Determine the measure of angle SRP if SP and TQ is equal and the angle of TQR is 20^0.

Indicators of mathematical communication being employed in this study is adopted from Elliot and Kenney (1996).

Table 1
Mathematical Communication Indicators or Lower Secondary School Students

No.	Observed Aspects	Indicators
1	Grammatical ability	Using symbols/notations, mathematical operation correctly, Symbol/notation: triangle (Δ), name of a triangle (*SRT*), angle ($\angle$), measure of an angle (m$\angle$ or $\measuredangle$), name of an angle (*SRP)*, degree ($...^{0}$), name of a side ($\overline{SP}$), equal length (=), congruent ($\approx$), meanwhile the expected operation could be addition (=), subtraction (-) and division (: or /) or using words.
2	Discourse understanding ability	Giving ideas about what is being asked from a task. Given: ΔRST is an isosceles triangle. $\overline{RS} = \overline{RT}$ and $\measuredangle TRS = 120^{0}$ $\overline{SP} = \overline{TQ}$ and $\measuredangle TQR = 20^{0}$  Asked: $\measuredangle SRP$
3	Strategic ability	Explaining mathematical ideas into figures correctly. *Properties of isosceles triangles* If $\Delta\ RST$ is an isosceles triangle, then $\measuredangle RST = \measuredangle STR$ *Sum of angles in a triangle* $\measuredangle TRS + \measuredangle RST + \measuredangle STR = 180^{0}$ $120^{0} + 2\measuredangle RST = 180^{0}$ ($\measuredangle RST = \measuredangle STR$) $\measuredangle RST = \frac{180^{0} - 120}{2} = 30^{0}$ $\measuredangle RST = \measuredangle RTS$=$30^{0}$ *Sum of supplementary angle* Hence, $\measuredangle RTQ = 180^{0} - 30^{0} = 150^{0}$ *Sum of angles in a triangle* $\measuredangle RTQ + \measuredangle TQR + \measuredangle TRQ = 180^{0}$ $150^{0} + 20^{0} + \measuredangle TRQ = 180^{0}$ $170^{0} + \measuredangle STR = 180^{0}$ $\measuredangle TRQ = 180^{0} - 170^{0}$ $\measuredangle TRQ = 10^{0}$ *The congruent properties of a triangle* $\Delta\ RPS \cong \Delta\ RQT$ since (i) $\overline{RS} = \overline{RT}$ (side) (ii) $\measuredangle RSP = \measuredangle RTQ$ (angle) (iii) $\overline{SP} = \overline{TQ}$ (side) hence $\measuredangle SRP = \measuredangle TRQ$ $\measuredangle SRP = 10^{0}$ Therefore, $\measuredangle SRP = 10^{0}$ Or using the geometrical figure to solve it directly.

Written Mathematical Communication

Subject SL1 wrote only several symbols/notations such as the measure of an angle (using words), degree, the name of an angle, angle (using words) and addition operation. The student had no complete communication by figures and symbols, but wrote what is being asked using words appropriately. Furthermore, the student's explanation about his mathematical ideas in form of a figure of isosceles triangle was not clearly expressed because there was no equal length notation. The student's written work may be seen as follow.

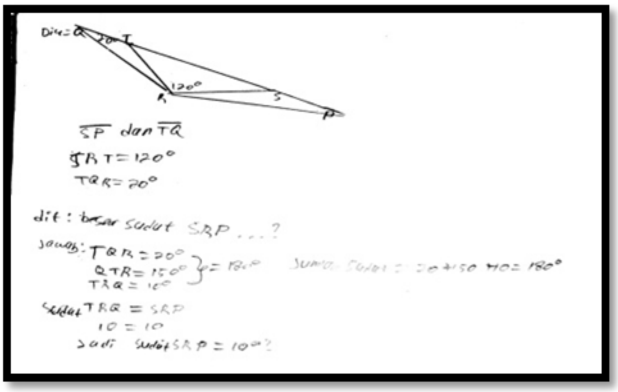


Figure 1: SL1's written work

Subject SL2 wrote triangle symbols/notations (by words), the name of the triangle, the name of the angle, degree, congruent (by words), and addition, subtraction and division operations. The student wrote what is given using figure completely and what is being asked using a question mark. Furthermore, he also explained his mathematical ideas in form of figure clearly. Meanwhile, SL3 student only wrote degree symbols/notations. Moreover, he only wrote what is given from the problem using figure and its description but fairly not appropriate. He also wrote his mathematical ideas using figure but not clearly obvious since based on his written work, the triangle seems like an equilateral triangle.

Subject SP1 wrote triangle symbols/notations, isosceles triangle, the name of the triangle, equal length (by words), angle, the name of angle, degree, congruent (by words), and addition operation. She wrote what is given from the problem using words, symbols and figure completely. In addition, she wrote what is being asked from the problem using a question mark on the figure using *x*. She also explained her mathematical ideas using figures and statements clearly. Her written work could be seen as follow.

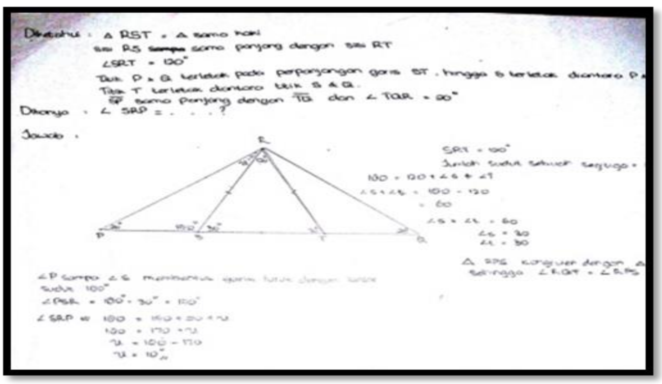


Figure 2: SP1's written work

Subject SP2 only wrote symbols/notation of angle, the name of the angle, and degree. She further wrote what is given and what is asked from the problem completely. In addition, she wrote her mathematical ideas into a clear figure. Meanwhile, subject SP3 only wrote symbols/notations of angle. She also wrote what is given using figures but not in precise way. Moreover, she also wrote her mathematical ideas using figures but it was not really clear since there is no equal-length sign given.

Based on the explanation above, we may infer that female students tend to wrote more symbols/notation rather than the male students. It means that the females' grammatical ability (Elliot and Kenney, 1996) is better than the males. Moreover, the female students wrote what is given and asked from the problem, more complete than the male students. In other words, the female students' discourse understanding ability (Elliot and Kenney, 1996) is better than the male students'. In addition, the female students' written mathematical ideas are clearer than the male students' hence their strategic ability (Elliot and Kenney, 1996) is better than the male students'.

The elaborated discussion above is in line with theories from Santrock (2007) and Usiskin (1982) that female students' writing and reading ability are better than male students'. Furthermore, we also confirm that geometrical subject may have performance differences between male and female students.

We also found important finding such as: (1) All of the subjects could not differentiate the measure of angle symbol/notation with the angle. For example $\angle SRP = 20^0$ should be written in "the measure of *SRP* = 20^0 or $m\angle SRP = 20^0$ or $\measuredangle SRP = 20^0$; (2) Among the two students who wrote "congruent", none wrote symbol $\approx$; (3) There was a female subject who already use algebraic notation such *x*.

Conclusion

Based on the problem that the students solved and the student's written work, it may conclude that there is a difference in written mathematical communication of lower secondary school students with regard to the gender.

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