Mathematical reasoning of student in senior high school based on gender differences

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Abstract. The reasoning is one of the goals of mathematics education. Reasoning related to mathematical concepts or information is called mathematical reasoning. The process of reasoning in the learning of mathematics is influenced by many factors, one of which is gender, especially in their way to solve mathematical problems and draw conclusion. This research aims to describe student mathematical reasoning in senior high school based on gender differences. This study used descriptive qualitative method. Mathematical reasoning consists of analyzing problem, initiating a strategy, seeking and using connections, and reflecting solution to a problem. This research has been conducted during the second semester of the academic year 2017/2018. The subject of the study consisted of two male students and two female students of National Senior High School Pekalongan which selected using purposive sampling. The results show that male students think flexibly while the female students tends to follow the strategy given by the teacher. Female students tend to be more accurate than male students for drawing conclusions.

1. Introduction
One of the most useful sciences for human life is mathematics. Mathematics can be used to develop the skills that involve the ability of logical reasoning, systematic, critical, careful and creative in communicating ideas or to solve problems [1]. One of the basic mathematical competencies that must be had by students in learning mathematics is the reasoning. The reasoning is inseparable from the truth of mathematical material will be more easily understood by the ability of good reasoning [2]. The reasoning may be communicated to others in a variety of ways through different representations, including visual, verbal, and dynamic [3]. The reasoning is one of the very complex mathematical abilities, this complexity makes reasoning as an ability that is not easy to achieve [4]. The studies showed that most of the studied parts of the learning environment, e.g. teaching, textbooks and teacher-made tests, focused heavily on algorithmic procedures and did not provide extensive opportunities for learning different kinds of reasoning [5]. One of the causes of the low quality of students reasoning in classroom learning, teachers are too oriented to procedural and mechanistic things such as teacher-centered learning, mathematical concepts often delivered informatively, and students are trained to complete
without a deep understanding. This is because most teachers are ready to transfer their knowledge directly to students. Active teachers while passive students during learning, consequently the process of classroom learning that have been done by students in problem solving without get teacher’s attention. Mathematical reasoning requires that students get involved in a variety of thinking and sense-making processes [6]. Mathematics is a science related to abstract objects hence most students have difficulties in understanding mathematical concepts.

The reasoning is a central concept in many theoretical frameworks. However, as a concept it is often used to represent some sort of high-quality reasoning, most often related to logical thinking, but at the same time it is rarely defined [7]. Previous research identified problems, exploration, and investigation tasks as means to develop students mathematical reasoning [8]. Mathematical reasoning with learning model Think Pair Share (TPS) very influential in student achievement [9]. Gender is seen as an analytic factor that humans use to think and organize their social activities [10]. The chosen gender perspective focusses on the result of having a spesifik gender in a specific context. Personal gender as an analytic category can focus on how the individual perceives the structure with its symbols, girls different views of themselves as students in mathematics [11]. In scholastic achievement, it has been a consistent finding that girls generally receive better school grades than boys [12,13]. Gender differences certainly lead to physiological differences and affect the psychological differences in learning. Gender differences affect students problem solving abilities, in which the problem solving abilities of male are better than female for middle and upper classes [14].

In Indonesia curriculum has been implemented which aims to encourage students to learn better, reason, and communicate what they gain or recycle after receiving the subject matter. Indicators of mathematical reasoning are (1) analyzing problem conclude looking for hidden structure, looking for patterns and relationships, making connections with previous work. (2) Initiating a strategy conclude Selecting mathematical concepts, representation, or procedures that may be applicable, making purposeful use of procedures. (3) Seeking and using connections conclude connecting seemingly different mathematical domains, connecting seemingly different contexts, connecting different representation. (4) Reflecting solution to a problem conclude Interpreting a solution and how it answers the problem, checking the reasonableness of a solutions [15].

Based on the description above, this study aims to describe student mathematical reasoning based on gender differences. The researchers choose an indicator of mathematical reasoning based on NCTM consisting of analyzing the problem, initiating strategy, seeking and using connections, and reflecting solution. The strategy of thinking male and female are different in classroom learning. It is defined how the performance of male or female students on solving the problem of mathematical reasoning. Reasoning can help students to understand and solving the problem. Mathematical reasoning as a part of the mathematical thinking that involves forming generalizations and drawing conclusions.

2. Method
This research was a qualitative descriptive. Qualitative research is a study which intends to understand the phenomenon of what is experienced by research subjects, such as behavior, perception, motivation, action, etc. Holistically and by way of description in the form of words and language, in a special, natural context and by utilizing various scientific methods [16]. The descriptive approach itself means this research to describe the problem, situation happen at that time.

The research was carried out the even semester on 2017/2018. The subject of this research consisted of four students class X one of National Senior High School Pekalongan which selected using purposive sampling. The subjects consist of two male students and two female students who have the excellent mathematics ability and excellent communication was selected. The research instruments are used to describe of student mathematical reasoning in the form of written test. The data analysis includes data reduction and conclusion.
3. Results and discussion

The results of the research on the mathematical reasoning of student’s based on gender differences. The researcher gives the problem to students to know how students can solve the problem with the reasoning that they have. The researcher looks at and describes how students’ reasoning in solving the problems. The question includes indicators of students’ mathematical reasoning based on NCTM. The indicator of mathematical reasoning to review presented in table 1 is following:

| Table 1. The indicator of mathematical reasoning. |
|-----------------------------------------------|
| Analyzing a problem                            |
| Looking for hidden structure                   |
| Looking for patterns and relationships         |
| Making connections with previous work          |
| Initiating a strategy                          |
| Selecting mathematical concepts, representation, or procedures that may be applicable |
| Making purposeful use of procedures            |
| Seeking and using connections                  |
| Connecting seemingly different mathematical domains |
| Connecting seemingly different contexts        |
| Connecting different representation            |
| Reflecting solution to a problem               |
| Interpreting a solution and how it answers the problem |
| Checking the reasonableness of a solutions      |

The following description of mathematical reasoning male and female students.

3.1. Male students

Based on the test result S1 on figure 1 above, the researcher can describe how the student resolved the given problem. In analyzing the problem, he was already good, he could analyze the existing problems. He knew how to start working on the problem. S1 could analyze the problem with using and seeking connections from previous lesson that had been. S1 can change the form $\sin 3000^\circ$ to $\sin(8 \times 360^\circ + 120^\circ)$. S1 applied the same strategy in $\cos(2400^\circ)$ to solve the problems, but used different steps. S1 could choose mathematical concepts that might be applicable. S1 could solve the problem using knowledge that they had shortly.

\[
\begin{align*}
\sin 3000^\circ &= \sin(2 \times 360^\circ + 120^\circ) \\
&= \sin 120^\circ \\
&= \frac{\sqrt{3}}{2}
\end{align*}
\]

\[
\begin{align*}
\cos 2400^\circ &= \cos(6 \times 360^\circ + 240^\circ) \\
&= \cos 240^\circ \\
&= -\frac{1}{2}
\end{align*}
\]

Figure 1. Male student’s answers (S1).

Based on the test result S1 on figure 1 above, the researcher can describe how the student resolved the given problem. In analyzing the problem, he was already good, he could analyze the existing problems. He knew how to start working on the problem. S1 could analyze the problem with using and seeking connections from previous lesson that had been. S1 can change the form $\sin 3000^\circ$ to $\sin(8 \times 360^\circ + 120^\circ)$. S1 applied the same strategy in $\cos(2400^\circ)$ to solve the problems, but used different steps. S1 could choose mathematical concepts that might be applicable. S1 could solve the problem using knowledge that they had shortly.

\[
\begin{align*}
\sin 3000^\circ &= \sin(8 \times 360^\circ + 120^\circ) \\
&= \sin 120^\circ \\
&= \frac{\sqrt{3}}{2} \\
&= \frac{1}{2}
\end{align*}
\]

\[
\begin{align*}
\cos 2400^\circ &= \cos(6 \times 360^\circ + 240^\circ) \\
&= \cos 240^\circ \\
&= -\frac{1}{2}
\end{align*}
\]

Figure 2. Male student’s answers (S2).
As shown in Figure 2, S2 can analyze the problem by initiating the right strategy. S2 found the idea to change the problem to be a simple form. The strategy of S2 to solve the problem was the same as S1. Sequentially S2 could solve the problem by using the knowledge that they have. S2 wrote the steps twice in solving the problems, and it showed that mathematical reasoning from S2 was good because of the reflecting a problem stage he did not get it well.

3.2. Female students

Figure 3 shows that S3 can analyze the problem by making connections with previous work that he got in the previous lesson. After S3 got the idea to solve the problem, she strategized how the next steps should be taken to solve the problem. However, S3 made a mistake in writing the first step, namely \( \sin 3000^\circ = \sin (120^\circ + 3 \times 360^\circ) \). S3 continued her work to solve the problem. S3 solved the problem entirely and gave a note to make it easier for her to work on, for example, \( \sin \) was located in quadrant two meaning positive. In checking the solution, S3 was not aware that the first step was not right, but the next step was correct.

As shown in Figure 4, S4 cannot analyze the problem. She did not know how to solve the problem. Then, S4 applying the wrong method by multiplying \( \sin (60^\circ \times 50) \), from her answers she thought that \( \sin (3000^\circ) \) obtained from multiplication \( \sin (60^\circ \times 50) \). As well as \( \cos (2400^\circ) \) she was applying the wrong method by multiplying \( \cos (30^\circ \times 80) \). She did not find the ideas by seeking connections with the previous lesson either. This showed that she did not reason well or had low mathematical reasoning, so she could not solve the problem.

From some of the student’s answers, it can be seen that most students still have difficulties in solving problems related to reasoning. In line with the results of the research showed that scientific reasoning task is known to be solved by males more frequently than females [17]. The percentage obtained from
Figure 5 shows that Male students have 67% and 45% for female students. So, male students have mathematical reasoning higher than female students.

![Figure 5. Percentage mathematical reasoning from male and female students.](image-url)

4. Conclusion

Based on the results and discussion of this research, the researcher concluded that in general, the mathematical reasoning based on gender differences students in one of National Senior High School Pekalongan showed that male and female student can analyze the problem with initiating the right strategy. They both could choose mathematical concepts that may be applicable. Male students think flexibly while the female students tend to follow the strategy sequentially. Female students are less careful about checking a solution in solving the problem, and most of them cannot analyze the problem.

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