Student’s thinking process in solving word problems in geometry

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Abstract. This research aims to find out the thinking process of seventh grade of Junior High
School in solve word problem solving of geometry. This research was descriptive qualitative
research. The subject of the research was selected based on sex and differences in mathematical
ability. Data collection was done based on student’s work test, interview, and observation. The
result of the research showed that there was no difference of thinking process between male and
female with high mathematical ability, and there were differences of thinking process between
male and female with moderate and low mathematical ability. Also, it was found that male with
moderate mathematical ability took a long time in the step of making problem solving plans.
While female with moderate mathematical ability took a long time in the step of understanding
the problems. The importance of knowing the thinking process of students in solving word
problem solving were that the teacher knows the difficulties faced by students and to minimize
the occurrence of the same error in problem solving. Teacher could prepare the right learning
strategies which more appropriate with student’s thinking process.

1. Introduction
Mathematics has an important role in the mastery of science and technology used in various areas of
life. Mathematics also plays a role in shaping students into qualified human resources, this is because
mathematics also promotes the habit accuracy, logical, and order arrangements [1]. Problem solving is
the foundation of much mathematical activity. Through problem solving the students developed other
kind of mathematical ability such as mathematical comprehension (understanding) and representation
[2]. Based on interviews with teachers, teachers more often give examples of knowledge problems rather
than problems that require understanding in their completion of geometry learning. This made the
students only have skill in answering the knowledge problem rather than problem solving due to problem
solving less attention teachers in learning mathematics. An important point by the learning principle is
that memorization of facts or procedures without understanding often results in fragile learning [3]. The
purpose of studying mathematics is not only to solve knowledge problems but also to have the ability to
solve problems that included the ability to understand problems, design mathematical models, solve
models and interpret the solutions obtained [4]. Problems in mathematics are usually presented in word
form. The word problem is a word-shaped issue in which students must find out what is at stake in the
matter. Word problems are defined as the set of problems which in educational contexts are solved
through the application of various elementary arithmetic operations successively combined with one
another until a result is found (arithmetic procedure) or through the formulation of equations which are
later solved to obtain a result [5]. Solving of mathematical word problems is a process requiring multistep skills and strategies [6]. Learners are expected to understand the language and factual information given in the problem, to translate the problem into a numeric equation, and devise a plan that can be used to solve the problem. According Polya stated that problem solving in mathematics are consists of four steps that must be done that are: Understanding the problem, devising a plan, carrying out the plan, and looking back.

In learning, especially in a word problem solving of course occurs the process of thinking, because someone is said to think if he/she was doing mental activities. Montague argues that the mathematical problem solving is a complex cognitive activity that accompanied a number of processes and strategies. According [7] thinking is the cognitive process used to make sense of the world; questioning everyday assumptions will direct students to new solutions that can positively impact the quality of their lives. The process of thinking is the activity that occurs in the human brain. Process of thinking in problem solving that occur in the minds of students will end until they found the answers. According [8] the process of thinking in essence there are three steps, namely the cognition establishment, the opinion establishment, and decision-making or conclusion. The process of cognition establishment is the sense of eliminating the general characteristics of something so that only special features remain. The process of opinion establishment is the thought of combining some sense so that it becomes a sign of trouble. The process of making decision or conclusion that is the mind combines opinions and draws decisions from other decisions.

In the process of learning activities many students are involved both male and female where each student has the same opportunity to obtain information about the material from the teacher. One of the differences between male and female is the brain. Women perform better than men in verbal memory and men better in spatial ability [7]. In mathematics spatial ability is very important, at least in geometry. Differences between male and female in problem solving that male tend to be good in abstraction, mathematical reasoning and more accurate on the target, while female better understand concrete things, better in remembering and mathematical calculations [7]. In problem solving both male and female have different ways of thinking in accordance with their mathematical ability, so there were different ways to solve a problem too. Students’ mathematical ability has an effect on math problem solving. According the result of the research [8] found there are differences in students’ creative thinking process in mathematical problems solving in terms of mathematical ability. It is important for teachers to know the thinking process of students in solving a problem. The role of teachers is needed, which is to help students express how their thinking process when solving word problem solving.

In studies related to the differences of male and female in mathematics ability is still debated, so researchers interested doing research on the thinking process of male and female with differences in mathematical ability in solving word problem solving.

2. Methods
The research design used a descriptive qualitative approach. The purpose of this research was to find out the thinking process of seventh grade of Junior High School in solving word problem solving in material of square and rectangle. Data collection was done based on student’s word problem solving test used to find out the students’ thinking process, interviews were conducted to confirm the answers to students’ word problem solving test so the researcher could find out whether between test answers and interviews is consistent, and observation. There were 66 students given word problem solving test. Based on the results of the previous material values of lines and angles classified in to high, moderate and low category of mathematics ability. Interviews conducted to 6 students (3 males and 3 females) of junior high school Mojolaban 2 that were represented each level as subjects. Table 1 is a way to determine high, moderate, and low mathematical ability.
Table 1. Measurement Scale of Student’ Mathematical Ability [9].

| Interval                      | Category |
|-------------------------------|----------|
| \( x_i > \bar{x} + 0.5s \)   | High     |
| \( \bar{x} - 0.5s \leq x_i \leq \bar{x} + 0.5s \) | Moderate |
| \( x_i < \bar{x} - 0.5s \)   | Low      |

Information:
- \( x_i \): Score for each student
- \( \bar{x} \): Average score of all sample students
- \( s \): Standard deviation of the entire sample

3. Results and Discussion

Based on that measurement, the score is a high mathematical ability, is a moderate mathematical ability, and is a low mathematical ability. In this research using steps of Polya in word problem solving. The indicators of word problem solving steps in this research can be seen in Table 2

Table 2. Indicators of Word Problem Solving

| Steps of Word Problem Solving | Indicators                                                                 |
|-------------------------------|---------------------------------------------------------------------------|
| Understanding the problem     | 1. Student can determine sufficient terms (things that are known) and necessary terms (things that are asked). |
|                               | 2. Student can determine whether the sufficient requirement has been fulfilled to answer the necessary terms. |
|                               | 3. Student can re-express the problem with their own language (by creating a mathematical sentences). |
| Devising a plan               | 1. Student can determine other knowledge (formula/method) to solve the problem. |
|                               | 2. Student can create problem-solving plans. |
| Carrying out the plan         | 1. Student can run the steps correctly according to the plan that has been made. |
| Looking back                  | 1. Student can answer questions in algorithm accurately. |
|                               | 2. Student can believe the truth of the solution. |

Student’s word problem solving test used to find out the students’ thinking process. Interviews were conducted to confirm and obtain more in-depth information. It was the result of the students’ thinking process in solving the word problem solving between male and female at every level of mathematical ability.

3.1. Male with High Mathematical Ability (MH)

At the stage of understanding the problem, MH was able to understand and analyze the problem by mentioning the things that are known and asked. MH translated the word problem into mathematical sentences by using symbols that uncommonly used for easier understanding. At the time of the interview, MH could explain the meaning of the symbols he wrote and MH believed what known in the matter was enough to solve what asked. The thinking process used is the process of cognition establishment. At the stage of devising a plan, MH was able to create a problem-solving plan by linking what known and what asked, explaining the supporting knowledge, and then mentioning the formulas/concepts used. For example MH associated a circumference of a known rectangle to obtain its length and width. The thinking process used is the process of opinion establishment. At stage of carrying out the plan, MH could well use the planned steps and the proper calculation algorithm. The thinking process used is the process of making decision or conclusion. At the stage of looking back, MH could
estimate mentally by writing nothing he did. He only investigated and convinced the appropriateness of
the steps he arranged. The thinking process used is the process of making decision or conclusion.

3.2. Female with High Mathematical Ability (FH)
At the stage of understanding the problem, FH was able to understand and analyze the problem by
mentioning the things that are known and asked. FH translated the word problem into mathematical
sentences by using symbols that commonly used for easier understanding. FH believed what known in
the matter was enough to solve what asked. The thinking process used is the process of cognition
establishment. At the stage of devising a plan, FH was able to create a problem-solving plan by linking
what known and what asked, explaining the supporting knowledge, and then mentioning the
formulas/concepts used. At the time of interview, FH could explain why she choose the
formulas/concept she used to solve the problem. The thinking process used is the process of opinion
establishment. At stage of carrying out the plan, FH could well use the planned steps and the proper
calculation algorithm. The thinking process used is the process of making decision or conclusion. At the
stage of looking back, FH could examine and investigate the answers obtained and FH believed in the
correctness of the planned steps and the calculations. The thinking process used is the process of making
decision or conclusion.

3.3. Male with Moderate Mathematical Ability (MM)
At the stage of understanding the problem, MM was able to understand and analyze the problem by
mentioning the things that are known and asked. MM translated the word problem into mathematical
sentences by using symbols that uncommonly used for easier understanding. MM believed what known
in the matter was enough to solve what asked. The thinking process used is the process of cognition
establishment. At the stage of devising a plan, MM was confused to make a problem-solving plan. For
example MM wrote the surface area of the park first in advance where it was supposed to get the surface
area of the park in advance to find the length and width of the park through a known circumference. At
the time of the interview, MM knew he should have written circumference then surface area and MM
took a long time to make problem solving plans. MM could determine the required formula/concept.
The thinking process used is the process of opinion establishment. At stage of carrying out the plan,
MM could well use the planned steps and the proper calculation algorithm. The thinking process used
is the process of making decision or conclusion. At the stage of looking back, MM could estimate
mentally by writing nothing he did, he only investigated and convinced the appropriateness of the steps
he arranged. The thinking process used is the process of making decision or conclusion.

3.4. Female with Moderate Mathematical Ability (FM)
At the stage of understanding the problem, FM confused to change the word problem in to mathematical
sentences it could be seen from the graffiti in the answer sheet when mentioned the things that known
and asked, even though in the end FM could make the mathematical sentences correctly. At the time of
the interview FM read the problem repeatedly to understand the problem by mentioning the things that
known and asked. FM took a long time to translate the word problem into mathematical sentences by
using symbols that uncommonly used for easier understanding. FM believed what known in the matter
was enough to solve what asked. The thinking process used is the process of cognition establishment.
At the stage of devising a plan, FM couldn’t create a problem-solving plan by linking what known and
what asked but could determine the required formulas. The thinking process used is the imperfect
process of opinion establishment. At the stage of carrying out the plan, FM couldn’t use the plan steps
due to an error that made a plans in the previous step and FM made an error of calculation algorithm.
For example MM didn’t change the surface area from to . The thinking process used is the imperfect
process of making decision or conclusion. At the stage of looking back, FM able to examine the answers
but FM not sure of the truth of the steps that have been planned and the calculation. The thinking process
used is the imperfect process of making decision or conclusion.
3.5. Male with Low Mathematical Ability (ML)
At the stage of understanding the problem, ML was able to understand and analyze the problem by mentioning the things that are known and asked. ML translated the word problem into mathematical sentences by using symbols that commonly used for easier understanding. ML believed what known in the matter was enough to solve what asked. The thinking process used is the process of cognition establishment. At the stage of devising a plan ML couldn’t create a problem-solving plan by linking what known and what asked perfectly and couldn’t determine the required concept. For example looking for the trees needed by divided surface area to the distance between trees. The thinking process used is the imperfect process of connection establishment. At the stage of understanding the problem, FL read the problem repeatedly to be able to understand the problem by mentioning the things that are known and asked but she couldn’t translate the word problem into mathematical sentences and FL didn’t write what known and asked of question completely. FL didn’t believed what known in the matter was enough to solve what asked. The thinking process used is the imperfect process of opinion establishment. At the stage of devising a plan FH couldn’t create a problem-solving plan by linking what known and what asked perfectly and couldn’t determine the required concept. For example looking for the trees needed by divided surface area to circumference. The thinking process used is the imperfect process of opinion establishment. At stage of carrying out the plan, couldn’t use the plan steps due to an error that made a plans in the previous step and made an error of calculation algorithm. For example FL wrote the ratio of length and width as length and width values so wrong in obtaining a circumference of rectangle. The thinking process used is the imperfect process of making decision or conclusion. At the stage of looking back, FL couldn’t examine the answers obtained perfectly. FL not sure of the truth of the steps that have been planned and the calculation. The thinking process used is the imperfect process of making decision or conclusion.

There was differences of thinking process in each category of mathematical ability between male and female. According [10] any conclusion that attributes differences between male and female in mathematical problem solving to a single factor is clearly problematic. In order to investigate differences in mathematical problem solving patterns it may not only focus to assume that girls are inferior group while boys are a superior group or vice versa [10]. But also differences in mathematical abilities of male or female students have different effects on student learning outcomes due to different thinking processes. The higher mathematical ability of student is higher his/her achievement in mathematics and the lower mathematical ability of student is lower his/her achievement in mathematics [9]. A clear relationship exists specifically between mathematical skills and critical thinking/problem-solving proficiency [11]. So that there are differences of students in problem solving is possible the difference of thinking process. A thing that needs to get teachers’ attention when students solve problems was the process of thinking. The process of thinking was necessary to know the teacher to help students minimize the occurrence of the same error in solving word problem solving. And teacher can improve the ability of students in solving word problem solving. The difference of thinking process brought the difference to solve the word problem solving. Teacher could prepare or design the right learning strategies which more appropriate with student’s thinking process.

4. Conclusion
Based on the result of the research it could be drawn some conclusion, as follows. In high mathematical ability between male and female have a same thinking process. Male with moderate mathematical ability used thinking process of cognition establishment to understand the problem, used thinking process of opinion establishment to devise a plan, used thinking process of making decision or conclusion to carry out the plan, and used thinking process of making decision or conclusion to look back of solution. While, female used thinking process of cognition establishment to understand the problem, used imperfect thinking process of opinion establishment to devise a plan, used imperfect thinking process of making decision or conclusion to carry out the plan and used imperfect thinking process of making decision or conclusion to look back of solution. And researcher found that male with moderate mathematical ability took a long time in the step of making problem solving plans. While female with moderate mathematical ability took a long time in the step of understanding the problems. In low mathematical ability, male
used thinking process of cognition establishment to understand the problem, while female used imperfect thinking process of cognition establishment. While at the stage of devising a plan, carrying out the plan, and looking back between male and female has no difference on the thinking process. The importance of knowing the thinking process of students in solving word problem solving that the teacher knew the difficulties faced by students and to minimize the occurrence of the same error in word problem solving. The difference of thinking process brought the difference to solve the word problem solving. Teacher could prepare or design the right learning strategies which more appropriate with student’s thinking process.

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