Functional thinking profile of mathematics problems based on gender in senior high school

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Abstract. In learning mathematics, the functional thinking of students is very important so that they are expected to be able to understand mathematics material in depth and be able to overcome difficulties experienced gradually. Functional thinking is very necessary for mathematics because it is one of the main keys in algebraic thinking which includes generalization of functions. This study aims to describe the functional thinking of high school students in solving mathematical problems in terms of gender differences. This study used the descriptive qualitative method. The research subjects consisted four students of nasional senior high school students of class eleven grade which included excellent schools in Boyolali. The results show that the related activities determine the equation of the circle from two points. The subjects of this study were four students with two male students and two female students. Subjects of male and female students tend to have similarities in how to determine the circle equation from two points, namely by trial and error using existing mathematical operations. It can be concluded that the functional thinking of both subjects is relatively the same. It is just that the female subject is more specific in finding the equation of the circle if two points are known.

1. Introduction
The modern era when science and technology are progressing and developing surely requires an increase in knowledge and skills. Education is one way to increase knowledge and skills so that they will develop talents and interests. This is in accordance with section 9 subsection (1) of Law No. 23 of 2002, namely that every child has the right to obtain education and teaching in the context of his personal development and his level of intelligence in accordance with his interests and talents. In addition, education is a means to increase human resources [1]. In the Indonesian Republic Law No. 20 of 2003 concerning the national education system, it is stated that education is a conscious and planned effort to realize a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble
character, and skills needed by him, society, nation and state [2]. The planned learning process is the key to the success of education in developing their potential.

Nine-year compulsory education planning is one of the efforts to improve education. Mathematics is a compulsory subject in every level of education. In the Minister of National Education Regulation No. 22 of 2006 concerning Content Standards, it is stated that mathematics is one of the components of compulsory subjects available from elementary, junior high to high school. This shows that mathematics is a basic knowledge that must be possessed [3]. According to the Hobby of the most important subject, that is so instrumental in advancing the civilization of a nation and also to assist human beings in understanding and mastering other problems [4]. Suyitno stated that mathematics as a tool/means that can be used to help humans in overcoming the problems that exist in life [5]. Mathematics is important and becomes a basic subject that is useful in solving problems that exist in life.

Currently mathematics education in Indonesia is still far from other countries. Based on research conducted in 2015, PISA (Program for International Students Assessment) was conducted in Indonesia at 62 of 70 countries [6]. This means that the quality of education in Indonesia is still far different from other countries. This is because the problem given by PISA is not just a memorization problem but a higher level problem. This shows the ability of students to solve mathematical problems is still low. The low ability of students in solving problems because students are still familiar with the questions given by the teacher. If students are given questions that are slightly different in level, students will find it difficult.

The development of students’ abilities in solving problems is needed in solving mathematical problems. According to Corte and Eynde, as an active and structural process in learning mathematics, students need to undertake control and agency over their own learning and problem-solving activities [7]. According to Sari, problem-solving in learning mathematics is important because in addition to developing students’ ability to build new knowledge and reflect the problem-solving process [8]. The process of thinking on mathematical problem-solving by students is seen from the problem-solving step [9]. One of the problem-solving steps used is the steps of Bransford and Stein. The problem-solving introduced is IDEAL problem-solving, namely the problem-solving model that is able to improve thinking skills and improve skills in problem-solving processes [10]. According to Bransford and Stein, IDEAL problem-solving is designed to help identify and understand different parts of problem-solving, each letter symbolizing an important component in the problem-solving process. IDEAL stands for I-Identify problem, D-Define goal, E-Explore possible strategies, Anticipate outcomes and actions, L-Look back.

Mathematics in schools gives less attention to the thought process but is more product-oriented thinking. Even through learning that focuses on the process, students will be able to make the best planning to solve various problems [11]. The process of producing new mental representations through information transformation involving complex interactions between mental attributes such as judgment, reasoning, abstraction, imagination and problem solving is called thinking according to Suharnan [12]. The thinking process of students is very important in learning mathematics because students are expected to be able to understand the mathematical material in depth and also students can overcome the difficulties faced gradually[13].

According to Marpaung [14], the type of thinking of students is divided into two types, namely the process of predictive thinking and functional thinking. Predictive thinking processes tend to see the relationship between two concepts or more in conclusions while the functional type thinking process
focuses more on looking at the chain and how to implement the decision. Furthermore, Schwank [15] states that it is very difficult to find subjects who think functionally. However, Schwank further stated that in Indonesia and China women can find functional thinking. Functional thinking is one of the main keys in thinking algebra that contains generalized functions that are very necessary for mathematics. According to Smith functional thinking is a representation of thinking that focuses on the relationship of two or more variations in numbers centered on relationships in general that produce functions [16]. Mathematical problem solving can train functional thinking skills because it requires an understanding of the mathematical concepts according to Siregar [13]. If students' understanding of the relationship between concepts is less then it will be seen in the solution. This is because the resolution process is considered not only the final answer.

Many factors must be considered as a study of mathematical ability and specific intelligence, a readiness of teachers and students, curriculum, and methods presented, a factor that is not important is the gender factor [17]. A gender difference that leads to differences in physiology and affects the psychological differences in learning. Male and female students' certainly have a lot of differences in mathematics learning [18]. Differences in abilities and potential possessed by male and female make it possible to differentiate between men and women in solving problems according to Susilowati [19]. So, based on the explanation, this research aims to describe the functional thinking problems based on gender differences in senior high school.

2. Research Method
This research used the qualitative descriptive method. Moleong defined that 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[20].

The research was conducted in Nasional Senior High School 3 which includes excellent schools in Boyolali eleven grade in year 2017/2018. The selected subject was done by purposive sampling. According to Creswell [21], the purpose of the selection of subjects with purposive sampling is that the researchers can choose individuals. The selected subjects of four students with details of two male students and two female students. Subjects selection based on good math ability tests and selection of communication skills and also the selection of subjects based on recommendations from the teacher. The research instruments were tested worksheets that had been adapted and developed from the problem of entering college. The data was obtained from the students' test answers.

3. Results and Discussion
The results of this study are to find out the functional thinking process of students in solving mathematical problems in circle material. Based on the answers of students, researchers can find out how students think functional processes through the students' steps in solving problems. In addition, we use here three modes of analyzing patterns and relationships, outlined by Smith [16], as a framework to discuss the kinds of functional thinking found in classroom data: (1) recursive patterning involves finding variation within a sequence of values; (2) covariational thinking is based on analyzing how two quantities vary simultaneously and keeping that change as an explicit, dynamic part of a function’s description (e.g., “as x increases by one, y increases by three”) (Confrey and Smith 1991); and (3) a correspondence relationship is based on identifying a correlation between variables (e.g., “y is 3 times x plus 2”).

Based on the description above, a functional thinking process will be presented in solving the problem adapted from Siregar et al [13], presented in Table 1 is following.

| Table 1. Aspects observed in the Functional Thinking Process |
|-------------------------------------------------------------|
| Identify problems                                          |
| Identify information contained in the problem.              |
Find out where the two points are in the circle
Know the point relationship with a circle
Determine the relationship between the two points with the circle equation
Determine the diameter of the circle from both points
Determine the circling finger
Determine the center of the circle
Determine the circle equation formula
Express the equation of a circle
Determine the general equation of a circle by substituting the circle point and circle radius in the circle equation

Table 1. shows aspects observed in the functional thinking process used to describe functional thinking student profile of math problems. The thinking process of students in male subjects and female subjects is condemned in every aspect of students' functional thinking in solving problems. The following description of functional thinkingproses male and female students.

1. Female Students

![Figure 1 Student Female Answer (SF1)](image)

**Identify Problems**

Based on Figure 1 it showed that students can identify information contained in the problems even if they do not write known and ask the question. Students understand the concept of work with describes the two known points on the question in the Cartesian coordinates for the center of the circle. The use of cartesius coordinates makes it easier for students to determine two points in a circle and to find out the point relationship with a circle.

**The Student can determine the relationship between the two points with the circle equations**

The use of cartesius coordinates makes it easier for students to determine the center of the circle. Students look for the diameter of a circle by rooting the number of times the number of $x$ squares plus the number of points $y$ squared. Then look for the ring finger and multiply by half in diameter of a circle. Students can determine the circle equation formula correctly.

**Express the equation of the circle**

Students substitute the center of the circle and the radius in the circle equation. So, the student can express the equation of a circle.
Identify Problems

Based on Figure 2 it showed that students can identify problems even if they do not write known and ask the question. Students understand the concept of work with describes the two known points on the question in the Cartesian coordinates for the center of the circle. The use of cartesius coordinates makes it easier for students to determine two points in a circle and to find out the point relationship with a circle.

The Student can determine the relationship between the two-point with the circle equations

Students look for the diameter of a circle by rooting the number of times the number of $x$ squares plus the number of points $y$ squared. Then students use the Pythagoras formula to determine the length of the circle diameter. After that students can determine the radius of the circle by dividing the result of the diameter of the circle. Because it is calculated in the root, the root of 32 is divided 4.

Express the equation of the circle

The student can express the equation of a circle. Students substitute the center of the circle and the radius in the circle equation. But the student's answer is not correct because of the right sign (=) should be zero.

2. Male Students

Identify Problems

Figure 3 Student Male Answer (SM1)
Based on Figure 3 it showed that students can not identify problems even if they do not write known and ask the question. Students not understanding what will be done first but because they are not careful, there are errors in the process. Students cannot determine the relationship of two points in a circle and cannot know the point relationship with a circle.

The Student can determine the relationship between the two-point with the circle equations
Students write first to find the radius of the level but use a formula from the diameter of the circle. This can also happen because students are in a hurry at work. This error results in students not being able to determine the circle diameter value from both points. Students cannot determine the value of the radius of the circle and also cannot determine the midpoint of the circle. Students determine the circle circle equation formula correctly. Students can’t determine the relationship between the two points with the circle equation.

Express the equation of the circle
Students in substituting into the circle equation which should substitute the center point circle. Student instead substitutes the known point A(1,1) because students cannot know the center of the circle. So, the student can’t express the equation of a circle.

Identify problems
Determine the relationship
Express the equation of the circle

Figure 4 Student Male Answer (SM2)

Identify Problems
Based on Figure 4 it showed that students can identify problems even if they do not write known and ask the question. Students understand the concept of work with describes the two known points on the question in the Cartesian coordinates for the center of the circle.

The student can determine the relationship between the two-point with the circle equations
Students look for the diameter of a circle by rooting the number of times the number of $x$ squares plus the number of points $y$ squared. Then look for the ring finger and multiply by half in diameter of a circle.

Express the equation of the circle
Students substitute the point B (3,5) and the radius in the circle equation. Students substitute the point A (-1,1) and the radius in the circle equation. Students substitute the center of the circle (1,3) and the radius in the circle equation. So, the student can express the equation of a circle.

Based on the results of the above research, it can be seen that female students are superior to male students. Female students can solve problems with coherence while male students have errors in solving problems. This is consistent with the results of a study conducted by Krutetzkii, namely that female students are superior in accuracy, accuracy, accuracy, and inequality while male students tend to be less thorough, in a hurry to finish things briefly, especially in the thought process [22]. Furthermore, Schwank [15] stated that it was very difficult to find a functional thinking subject. However, this is the case for Indonesia and China that women perform functional thinking well.

4. Conclusion

Based on the results and discussion it can be concluded that the functional thinking activities of the female and male subjects have completed the completion of the aspects observed in the Functional Thinking Process. In identify problems though students did not write down they were known and asked but students could know the mathematical problems intended. But the way female and male are subjected to differences in solving mathematical problems. Female students are superior in determining the relationship between two points with the circle equation. So that in female students can show the equation of the circle. Male students can not determine the relationship between the two points with the circle equation because students are wrong in identifying problems. The completion of female students is more coherent and detailed while male students are less careful in the proces.

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