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# Analysis of Students' Mathematical Critical Thinking Based on Gender in the Topic of Linear Programming

**K D Permani[1], S Prabawanto[2]**

[1,2] Department of Mathematics Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
✉ [1]kaniadewipermani@upi.edu , ✉ [2]sufyani@upi.edu

**Abstract.** The critical thinking is an important skill for each students. The skill is needed in the process of solving mathematical problems. Students who have high critical thinking tend to analyze the problem situation that they met and evaluate the solution that they make either it is make sense or not. However, some reports show that the mathematical critical thinking of many vocational school students are still low and it should be increased. The research aims to analyze the students' mathematical critical thinking based on gender factors in the topic of linear programming. The method of the research was qualitative with a descriptive approach. The subject were 2 vocational school students in Bandung, consisting of one female and one male. The research results show that, both female and male tend to meet mathematics critical thinking indicators, namely: (1) providing a simple explanation (2) checking the truth of a statement (3) observing the criteria and giving an explanation/ reason of the answers (4) making considerations and assess the answer. But when solving the problem, female student is more systematic and more careful than male student.

**Keywords:** Mathematical Critical Thinking, Linear Programming, Gender.

**INTRODUCTION** ~ The days of life are increasingly competitive, this is because of repid development of science and technology. Because of the development of technology, a lot of incorrect information circulates. If we do not seek the truth of that information, then the wrong information will become a truth. One of the abilities that must be possessed in this era is critical thinking. Because critical thinking makes someone think in a skeptical and reasonable way. Critical thinking can be manifested in every school subject, including mathematics.In education, mathematics is studied by all students from the elementary school level to the tertiary level and is a measure of student success in pursuing an education level, as well as being a test material for the selection of recruitment of certain fields of labor. Seeing this condition means that mathematics is not only used as a reference for continuing higher education but also used in supporting someone's career.

Students have to think in learning mathematic, so they are able to understand the mathematical concepts that they have learned and be able to use these concepts to solve mathematical problems. Students must be able to make decisions that can believe to be true and take responsibility for what their gets. From that, mathematics learning can be used to train students to think critically.

But in reality, based on some research reports, students' critical thinking skills are still low. Learning mathematics in schools does not encourage students to think critically. This is because learning takes place in one direction, students are not given the opportunity to analyze and come up with new ideas. The questions

given are routine questions that are not challenging. According to Sabandar (2009) Math problems or problems that are challenging will provide opportunities for students to empower all their abilities or use higher-order thinking skills. So to develop their knowledge, students are required to think critically in searching the truth.

In solving problems students will use a variety of strategies. Problem solving strategies can be influenced by gender differences so that it also influences critical thinking processes. Gender differences open differences in class, such as physical differences, attitudes, motivation, skills, and thinking abilities. Some researchers believe that the influence of gender factors in mathematics due to biological differences in the brains of boys and girls is known through observation, that girls, in general, are superior in language and writing, while boys are superior in mathematics because better spatial ability. Women generally focus on things that are concrete, practical, emotional, and personal, while men are focused on things that are intellectual, abstract, and objective (Geary, Saults, Liu, & Hoard, 2000)

Based on research Ajai's, J.T. &Imoko, I.I. (2015) showed that female students were superior to male students in post test and retention, although not significantly. Meanwhile according to Kaliky&Juhaevah (2018) female and male students meet tend to meet 5 indicators of critical thinking skills. But female students tend to be more thorough and systematic than male students. This is in line with the results of Feriyanto's research (2018) which shows that male and female students have the same ability, but what happens in this research is that female students do not write conclusions on the evidence.

**Critical Thinking Ability**

The ability to think critically is a basic ability that students must possess. According to Cottrell (2005) Critical thinking is cognitive activity related to using the mind. Learning to think analytically and evaluatively means using mental processes such as attitudes, categorization, selection, and assessment. According to Ennis (Sabandar, 2009) there are six basic elements that need to be considered in critical thinking, which can be abbreviated as FRISCO, namely:

1. Focus: to focus attention on making decisions of existing problems.
2. Reason: to give a rational reason for the decision taken.
3. Inferences: identifying various arguments or assumptions and looking for other alternatives for solving the problem by questioning and considering the reasons proposed.
4. Situation: the condition or situation of the environment around us. This situation can affect individuals in carrying out activities of thinking and making conclusions
5. Clarity: provides an explanation of the meaning of the terms used.

6. Overview: to conduct a complete re-examination to determine the accuracy of the decision that has been taken.

Meanwhile, Fisher in (Hafni, 2019) identified the ability to think critically into several indicators, namely:

1. Identifying the elements in a problem
2. Identifying and evaluating assumptions
3. Clarify and interpret statements with ideas
4. Assess the acceptability, especially the credibility of a statement
5. Evaluate various arguments.
6. Analyze, evaluate, and produce solutions
7. Analyze, evaluate, and make decisions
8. Draw conclusions
9. Generate arguments.

In this study, researchers used the following indicators:

1. Providing a simple explanation
2. Checking the truth of a statement
3. Observing the criteria and giving an explanation/ reason of the answers
4. Making considerations and assess the answer.

## METHOD

This study was a qualitative research with a descriptive approach that aims to analyze the mathematical critical thinking skills of vocational students on linear program material in terms of gender. This research was conducted on students of grade X of a vocational schools in Bandung. In connection with this study, students were grouped into male and female groups. Based on data saturation from each group on gender, then the subject of this study was one male student (MT) and one female student (SN). Researchers try to dig up information through tests and interviews to determine students' critical thinking skills.

The data obtained from this study are critical thinking skills data in terms of gender. Critical thinking skills data obtained in the form of test results on linear program material, followed by an interview session to get in-depth data.

## RESULTS

The following will describe the results of the work of male students (MT) and female students (SN) on each indicator.

### 1. Providing a simple explanation

The first indicator in this study is to provide a simple explanation. This means that students are able to give clear explanations of what they find.

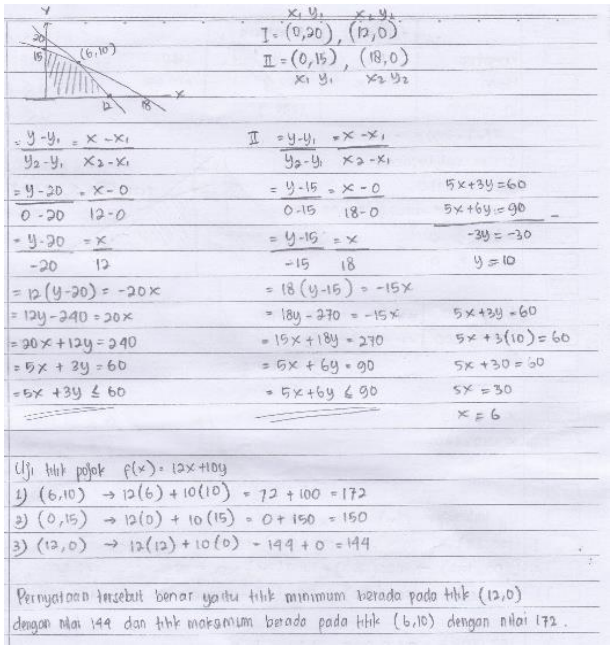


**Figure 1.** The Result of SN

From the results of the work of SN students, she explained in full how she looked for the inequality from the pictures given. During the interview he was clearly able to mention the formula for using it. In the conclusion section, SN is also able to provide conclusions clearly where the minimum value is at which point, and the maximum value is at which point.

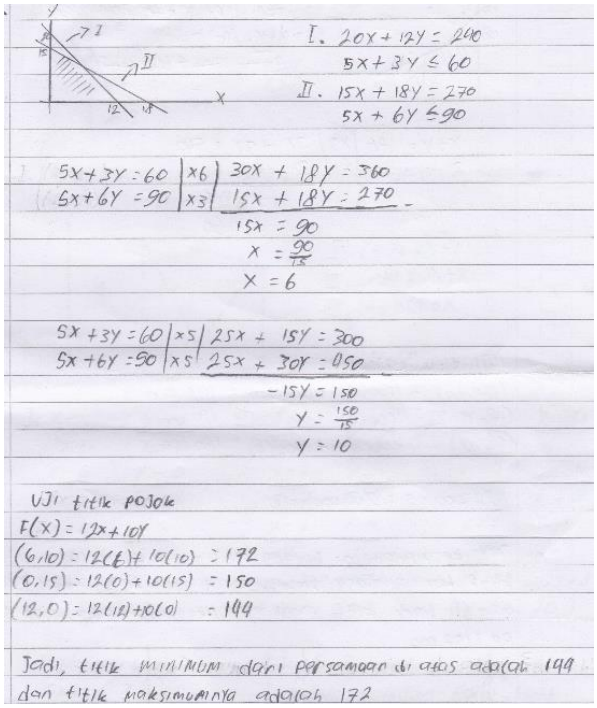


**Figure 2.** The Result of MT

For male students (MT) the results of the spelling are quite short. He did not explain how to determine the equation of a line through two points. During the interview,

students said that he used a quick way to look for a line when the drawing was known. In the conclusions section, the MT does not conclude completely. He only mentioned the minimum value, and the maximum value without mentioning where the point is.

**2. Checking the truth of a statement**

The second indicator in this study is checking the truth of a statement. Students are asked to express their opinions with the right reasons.

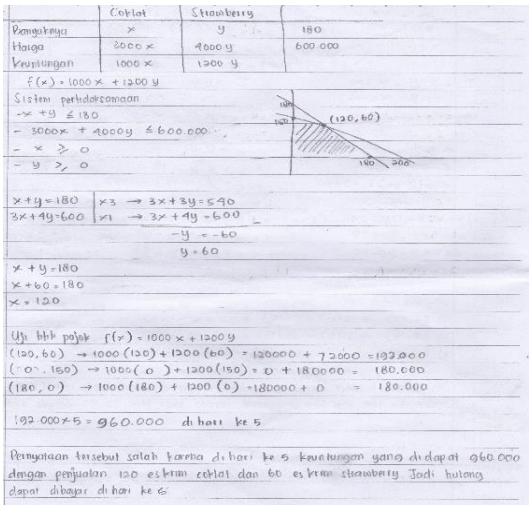


**Figure 3.** The Result of SN

From the results of the process, SN students explained in full. She uses tables to make mathematical models of story problems. Then she determines the inequality system precisely. At the end of the conclusion, she draws the conclusion correctly.

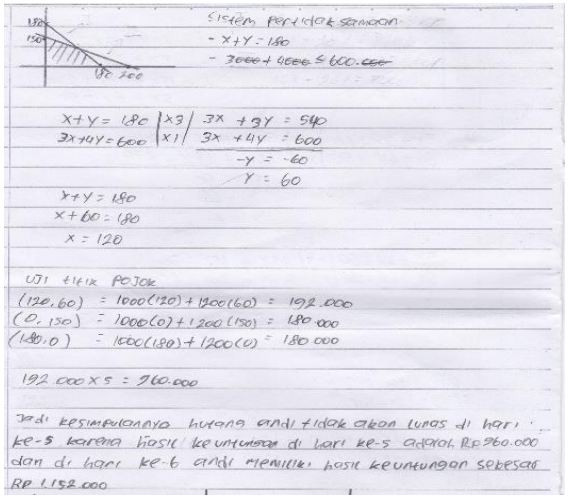


**Figure 4.** The Result of MT

From the results of the work of MT, he did not make a mathematical model of story problem. And he did not provide a complete inequality system. From the results of the interview, he admitted that he only wanted to do it quickly. At the end

of his conclusion, he made a statement correctly and provided alternative answers.

### 3. Observing the criteria and giving an explanation/ reason of the answers

The third indicator is to observe the criteria and provide an explanation / reasons for the answers. In this indicator, students are given picture problems and inequality system choices. Then students are asked to choose roughly the inequality system which is suitable for the picture and give reasons

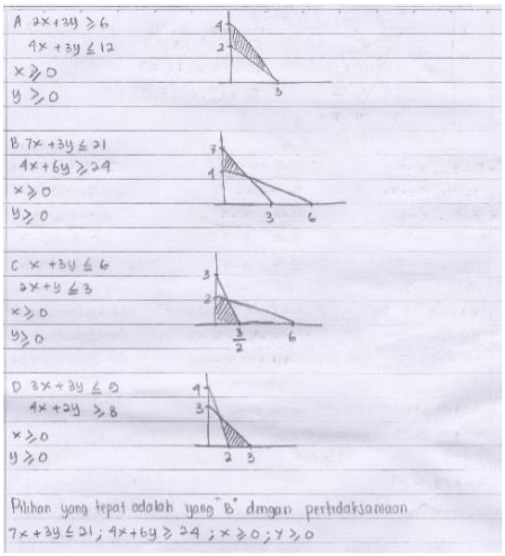


**Figure 5. The Result of SN**

From the results of the process the SN students prove one-on-one from each given inequality system. From the results of the interview, SN said that she had to prove every choice of answers in order to know the correct answer. In the conclusions, she did not give a complete statement why the answer she chose was right and the others were wrong.

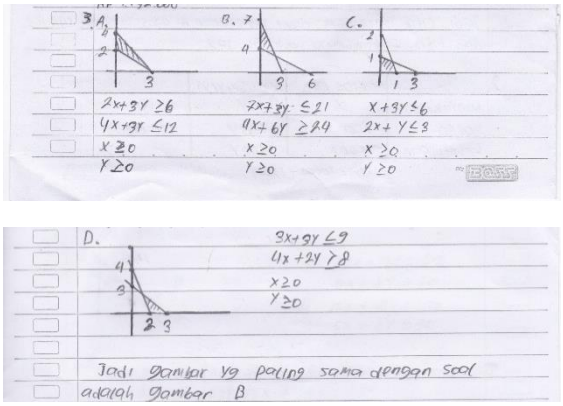


**Figure 6. The Result of MT**

Just like SN students, MT proves one-on-one from each choice of inequality system given. In the conclusions, he did not give a complete statement why the answer he

chose was right and the others were wrong.

**4. Making considerations and assess the answer.**

The fourth indicator is making a judgment and evaluating it thoroughly. In this indicator students are given a picture and inequality system. Then he must determine whether the inequality system is correct or not, by considering the information that has been given.

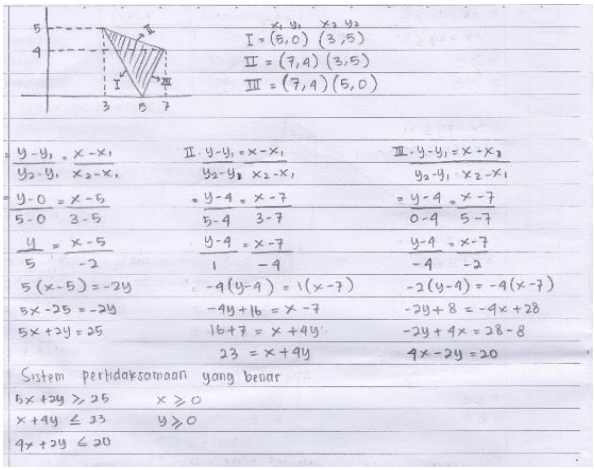


**Figure 7. The Result of SN**

From the results of the work of SN Students, she looks for the inequality system of the drawing by using the formula to find the equation of a line through two points. At the end of her work, she gives the answers that should be.

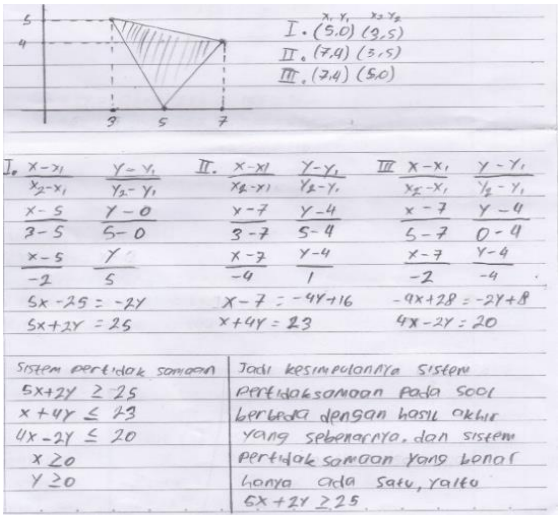


**Figure 8. The Result of MT**

Just like SN students, MT students first look for the inequality system of images by using the formula to find equations of lines through two points. At the end of his work, he gives an explanation of the answers that should be.

**DISCUSSION**

From the results of the work of female students (SN) and male students (MT), the test results show that both have the same mathematical abilities. In the process, female students (SN) are more systematic and conscientious, while male students (MT) more often use fast methods that result in a lack of complete answers. This is in line with the results of Kaliky&Juhaevah (2018) research that female students tend to be systematic compared to male students. According to Ennis (1996) it is very unfortunate if someone does not have a caring attitude, because it will lead to unfair decisions, caring for something is an element of critical thinking. Judging from the process, female students (SN) use more strategies than male students (MT). In the first indicator, male students want a faster and more practical way to make time efficient. But that does not mean the work of male students is wrong, he just chose a more practical way. According to Ahmad, Jelas, Ali (2010) learning strategies have an impact on student academic achievement. On the other hand, learning styles only have an indirect impact on achievement through learning strategies. This shows that students who use their chosen learning style will choose a more positive learning strategy, which can ultimately help improve their academics. According to Fisher (2001) someone who has the ability to think critically can know when he criticizes something when it is not in accordance with his condition. As is the case with female students (SN) and male students (MT) he decides to prove the answers using the strategy he chose. Both of them gave the right answer even though with different strategies. In each indicators, female student (SN) and male student (MT) validate to reach the correctness. This is in accordance with the opinion of Prabawanto (2019) that when students solve a problem, they usually validate the results obtained by searching for truth and sensibility. Students look for mathematical correctness by searching for errors and inconsistencies in the process. To do this, they can review the process to ensure that the selected procedure is feasible. If students are accustomed to validating their work, it is good to bring up their critical attitude. According to Fisher, if the ability to think critically is always accustomed, it will increase understanding in various contexts

**CONCLUSION**

From the results of the analysis of critical thinking skills in terms of the gender that has been described, students who are male and female tend to meet 4 indicators, namely: (1) providing a simple explanation (2) checking the truth of a statement (3) observing the criteria and giving an explanation/ reason of the answers (4) making considerations and assess the answer. But when solving the problem, female students are more systematic and more careful than male students.Critical thinking skills are very useful for anyone, if accustomed to using it can increase understanding in various

contexts. Not only used in the classroom, critical thinking skills are very useful in everyday life

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