

# Critical Thinking Profile of Junior High School Students in Solving Mathematical Problems Based on Gender

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DOI: <https://doi.org/10.52403/ijrr.20240408>

## ABSTRACT

The critical thinking profile in solving mathematical problems is a picture expressed by describing words based on the FRISCO criteria in solving mathematical problems. This research aims to describe the critical thinking profile of male and female students in solving mathematical problems. The research subjects chosen were two class VIII students at SMP Negeri 21 Makassar, namely one male student and one female student. In this qualitative research, data collection uses two problem solving tasks and interviews. The validity of the data obtained was tested through time triangulation. Next, the data was analyzed based on FRISCO critical thinking criteria. Based on the results of data analysis and discussion of critical thinking profile theory, it can be concluded that the two subjects determine the main problem, decide on the strategy to be used in solving the problem, and provide logical reasons in the process of drawing conclusions, know the situation in the problem so that they use information that is appropriate to the problem, explain the terms in the problem well, and double-check the answers found. However, in checking again, the male subjects only checked the final results, while the female subjects checked the answers for each step found until the final results.

**Keywords:** Critical Thinking, Gender, Problem Solving

## INTRODUCTION

Mathematics is a science that teaches strict logical thinking patterns, and mathematical concepts have a close relationship between one concept and other concepts. In other words, concept B cannot be understood if concept A is not understood, because concept A is the basis of Hudojo (2005). The Indonesian government realizes that to become a developed country and be on par with other developed nations, critical human resources are needed. Therefore, critical thinking skills are included in national education goals. This is stated in the Ministry of National Education (2006), which states that mathematics learning is expected to provide structuring of reasoning, critical thinking, formation of students' attitudes, and the ability to apply them in everyday life and in studying various sciences. In relation to solving mathematical problems, at least a student must have experience in the form of sufficient knowledge and skills. Without sufficient knowledge or skills, students will have difficulty solving these problems. One important aspect that teachers need to pay attention to in solving mathematical problems is the ability to think critically. Teachers need to know critical thinking skills in an effort to identify types of errors and forms of difficulties faced by students in solving problems.

According to Fisher (2008), critical thinking is a type of thinking that does not immediately lead to conclusions, or accepts

some evidence, claims or decisions for granted, without really thinking about it. Critical thinking clearly requires interpretation and evaluation of observations, communications, and other sources of information. Willingham (2009) stated that developing critical thinking skills can increase mastery and improvement of material. This opinion suggests that critical thinking skills must be tested carefully to determine the impact on content or material knowledge. In this regard, it is important to research students' critical thinking profiles, because by knowing students' critical thinking profiles, a theory about students' critical thinking profiles can be found so that it can be used as a reference in creating models, strategies, approaches and critical learning methods that can be implemented by teachers to produce critical students.

According to Gallagher and De Lisi (1994) gender differences are evidence in patterns of success and use of strategies in solving conventional and non-conventional or modern problems. Specifically, Gallagher and De Lisi stated that female students were more successful than male students in solving conventional problems using algorithmic strategies, while male students were more successful than female students in solving unconventional or modern problems using logical estimation or insight. The existence of gender differences, namely the differences between men and women, encourages experts to conduct research related to these gender differences. Specifically related to critical thinking, Verawati (2010) stated in the results of her research that there is no significant difference in critical thinking between men and women, especially for junior high school students in Malaysia. Arends (2008) explains that there are differences in cognitive abilities between men and women. This means that differences in thinking abilities and gender differences may influence students' critical thinking in solving mathematical problems. Female students are usually more careful and tend to be attached to the concepts explained by

the teacher. Meanwhile, men are usually less thorough, rush and tend to complete things in a short time.

Meanwhile Kurtezkii (1976) said that men are superior in logical reasoning, while women are superior in accuracy, precision and thoroughness of thinking and men have better mathematical abilities than women. Based on this opinion, researchers suspect that there are differences in the critical thinking of male and female students in solving problems.

The research results described above show the diversity of critical thinking research results based on gender in solving mathematical problems. Therefore, it is important to conduct research to see how gender-based cognition is used, especially in the critical thinking process in solving mathematical problems. Besides the results of this research enriching the theory about gender in critical thinking, it can also be a reference for learning in classes that are heterogeneous in gender, so that national education goals related to critical thinking can be realized.

Based on the information above, researchers focused on describing the critical thinking profiles of male and female students in solving mathematical problems. The critical thinking profile referred to in this research is a picture expressed with descriptive words based on the FRISCO criteria in solving mathematical problems.

## **MATERIALS & METHODS**

This type of research is descriptive research with a qualitative approach. This research was carried out in the 2018/2019 academic year. The subjects chosen in this research consisted of one male student and one female student in class VIII of SMP Negeri 21 Makassar. Subject selection begins with determining the research class, namely students in class VIII of junior high school, giving students a math ability test. The questions used in this mathematics ability test were selected from questions from the National Middle School Examination for mathematics subjects whose material had

been studied by research subjects, especially class VIII material, which first eliminated alternative answers, thus requiring descriptive answers. In this study, research subjects are said to have equivalent mathematical abilities, if the mathematics ability test scores of these subjects have a difference of  $\leq 10$  for the value range 0-100. To facilitate the data transcription process, male subjects were given the code LK and female subjects were given the code PR.

The main instrument in this research is the researcher himself. The researcher collects, analyzes, concludes data, and reports the results of his research using supporting instruments, namely problem solving tasks and interview guidelines. The problem solving task instruments and guidelines were validated by PhD students in mathematics education and in consultation with supervisors.

There are two problem solving tasks given to research subjects, namely problem 1 and problem 2. Problem solving task 1 (TPM 1) is aimed at revealing the critical thinking profile of the two research subjects and problem solving task 2 (TPM 2) is aimed at validating or convincing the researcher. critical thinking profile used by both subjects. The results of student work and interviews are presented, validated, and analyzed or concluded. Data analysis is adjusted to the FRISCO critical thinking profile indicators.

## RESULT

### *Male Subject*

From the interview results on the focus criteria, it can be seen that the male subject retells the information contained in TPM 1 using his own words, but there are several sentences that still adopt what is in the questions seen in RM102. From the answers given, the male subject understood what was asked in the question. Meanwhile, the strategy decided by the male subject was to find the volume of the box, the volume of the first cheese cake, and the volume of the second cheese cake, then divide the volume of the box by the volume of the second

cheese which was seen at RM105 and RM106. Then the conclusion found by the male subject is correct. On this occasion the researcher did not ask the reason for the conclusion made by the male subject, because the indicator requirement only reached RM107.

From the excerpt from the interview results on the Reason and Inference criteria, in every decision or conclusion the male subject always gives reasons, including when the researcher asked why he used the block volume formula to find the volume of boxes and cheese cakes, the male subject's reason was Because the size of the box and the cheesecake are similar to the volume of the block which has length, width and height, and the size varies as seen at RM108. Next, the male subject calculated the volume of the second cheesecake by multiplying  $1/2$  times the size of the previous cheesecake. The researcher continued to ask why you divided the volume of the box by the volume of the second cheesecake, then the male subject gave the reason because what I wanted to look for was a lot of cheesecake in one box, where the volume of the second cheesecake was changed to  $1/2$  times the previous size, so the volume of the cake the second cheese is  $2 \text{ cm}^3$  and the volume of the box is  $240 \text{ cm}^3$ , then the volume of the box is divided by the volume of the second cheese cake. The result is 120 cheesecakes in one box seen at RM112. From this quote, it appears that the reasons given by the male subject are very relevant so they can make good inferences.

From the excerpt from the Situation criteria interview, the information used to solve the problem is that the male subject stated that Ulvia packed her cheese cakes in a wrapping box measuring  $10 \text{ cm} \times 6 \text{ cm} \times 4 \text{ cm}$ , where each box contained 15 cheese cakes, each cheese cake measuring  $4 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm}$ . Then Ulvia changed the size of the cheesecake to  $1/2$  times the previous size seen at RM114. When the researcher asked again what information was not used, the male subject answered that Ulvia had a

pastry shop in front of her house. He sells various kinds of pastries, one of which is cheese cake which is the most popular with customers. So that the cheese cakes sold by Ulvia vary in shape, color and size, it can be seen at RM115. So it can be seen that male subjects can differentiate which information is used and which is not used in solving problems.

From the interview quote, clarity criteria. The male subject was able to explain the terms in the first TPM well, namely what is meant by  $1/2$  times the previous size. The male subject explained that the length, width and height of the cheesecake were first multiplied by  $1/2$ , so if the size of the cheesecake was multiplied by  $1/2$ , then the size of the cheesecake would be smaller than the previous size seen at RM118. Male subjects were also able to create questions similar to those in the first TPM, but tended to be the same, only changing the size and name as seen in RM119. To check understanding of the questions created, the researcher asked again how to solve the questions created. The male subject explained that it was the same as before, only the numbers or sizes were different.

From the interview excerpt of the overview criteria, after working on TPM 1, the male subject checked again, only the final results were not complete.

### ***Female Subject***

From the transcript of the interview results, the focus criteria for the female subject stated what was known and what was asked in the question, but was very careful in retelling the story so that the time used for the interview tended to be long (PR102 and PR103). Determine the main problem by referring to what is known and asked in the question; that is, how many cheesecakes can be put at most in a box measuring 10 cm x 6 cm x 4 cm, while the cheesecake measures  $1/2$  times the previous length, width and height and the size of the cheesecake is now 3 cm x 2 cm x 1 cm (PR104). Deciding the strategy to be used with reference to the main problem; that is, finding the volume of

the box, the volume of the first cheesecake and the volume of the second cheesecake which has been resized to  $1/2$  times the previous size. Then determine whether it is true that a box with a volume of 240 cm<sup>3</sup> contains 5 cheesecakes, the volume of one cheesecake is 48 cm<sup>3</sup>, by dividing the volume of the box by the volume of the first cheesecake (PR105).

From the transcript of the interview results on the Reason and Inference criteria for the female subject using the formula that has been chosen, namely the block volume formula (PR106). Present the symbols used in the block volume formula; namely, V is volume, p is length, l is width, while t is height (PR107). State the reasons for using block volume; namely, a cheesecake shape and a block-shaped box, which has a length, width, and height (PR108). Put forward the rationale for dividing the volume of the box by the volume of the first cheesecake and the second cheesecake; namely, to determine whether there really are 5 cheesecakes in a box with a volume of 240 cm<sup>3</sup>, where the volume of one cheesecake is 48 cm<sup>3</sup> and to find the number of cheesecakes in one box. The volume of the second cheesecake is 6 cm<sup>3</sup> and the volume of the box is 240 cm<sup>3</sup>, so the volume of the box is divided by the volume of the second cheesecake to produce a maximum of 40 cheesecakes in the box (PR109 and PR110). Describes the position of the cheesecake in the box (PR112), explains the drawing created in PR112; that is, the upward sloping line is the height of the box, the horizontal line is the length of the box, while the upward sloping line is the width of the box. And a lot of cheesecakes in the box there are 40 cheesecakes (PR113). Describes the position of the cheesecake in a box that is not completely filled with cheesecake (PR115), asking if it is okay if there is something empty in the box (PR116). Give reasons why there should be no blanks in the box; that is, the volume must be all filled, while this image is empty (PR117). Decide on the answers found and the reasons (PR118 and PR119).

From the interview transcript, it was revealed that in the Situation criteria, the female subject presented information about a block-shaped packaging box measuring 10 cm x 6 cm x 4 cm, where each box contained 5 cheese cakes, each cheese cake measuring 6 cm x 4 cm x 2 cm, and Ulvia changed the size of the cheese cake to 1/2 times the previous size (PR120). Disclosing unused information; namely, Ulvia has a pastry shop in front of her house. He sells various kinds of pastries, one of which is cheese cake which is most popular with customers (PR121). State the reasons for not using the information in PR121 (PR122).

From the transcript of the interview results it was revealed that in the Clarity criteria the female subject explained the terms in TPM 2 well; that is, the volume of the box is reduced to half the volume of the previous box, where the volume of the previous box is 800 cm<sup>3</sup> after changing it 1/2 times to 400 cm<sup>3</sup> (PR230).

From the transcript of the interview results, it was revealed that in the Overview criteria the female subject re-examined the answers obtained at each step found until the final result (PR125). And be confident in the answers obtained by providing reasons; that is, the volume cannot be empty, whereas in the picture in the box the box is full of cheesecake, so the maximum number of cheesecakes included is 40 cheesecakes per box. Then my first answer, sis, was the volume of the box divided by the volume of the second cheese, the same answer as the one using the picture (PR126 and PR127).

## **DISCUSSION**

### ***Male Subject***

In the Focus criteria, the subject determines the main problem contained in the question briefly, namely about the number of cheese cakes that can be put in a box measuring 10 cm x 6 cm x 4 cm, where the cheese cake measures 1/2 times the length, width and height. beforehand, and decide on the strategy to be used by finding the volume of the box and cheesecake then dividing the volume of the box by the volume of the

second cheese. In this case the subject shows things that are relevant to the problem being solved, as well as looking for effective strategies in solving the problem. This is in line with the opinion of Ennis (1996) who states that the first thing to do in understanding a problem is to determine the main problem contained in the problem and decide on the strategy that will be used to solve the problem.

In the Reason and Inference criteria, the subject uses the block volume formula on the grounds that boxes and cheesecakes are block-shaped. Next, the subject divided the volume of the box by the volume of the second cheesecake with the reason to find the number of cheesecakes in the box if the volume of the second cheesecake was changed to 1/2 times the previous size, and the volume of the box remained the same. Finally, the subject explains the box image that has been created and decides on the answer found and the logical reasons. This is in line with the opinion of Ennis (1996) which states that it is important to know the reasons that support or contradict decisions made based on relevant facts. The reasons can come from known information or theorems, properties and so on. Reasons are the basis for a process of drawing conclusions.

In the Situation criteria, the subject uses information that is appropriate to the problem contained in the question; namely, a block-shaped wrapping box measuring 10 cm x 6 cm x 4 cm and a block-shaped cheese cake measuring 6 cm x 4 cm x 2 cm and ignoring some unimportant information; namely, Ulvia has a pastry shop. He sells various kinds of pastries, one of which is cheese cake which is the most popular with customers. This is in line with the opinion of Ennis (1996) stating that to know the meaning of key terms, relevant parts as support.

In the Clarity criterion, the subject explains the terms in the problem well; that is, the length, width and height of the first cheesecake are multiplied by 1/2, so that the size of the cheesecake becomes smaller than

the previous size. This is in line with the opinion of Ennis (1996) in explaining the meaning or terms used in giving opinions both orally and in writing.

Meanwhile, in the Overview criterion, the subject believes that the answer was found because he checked the results of his work again, even though only the final result, and stated the reason for only checking the final part of the answer found. This is contrary to the opinion of Ennis (1996) stated in reviewing and thoroughly examine the decisions taken.

### ***Female Subject***

Based on the Focus criteria, the Subject determines the main problem contained in the problem slowly so that the time used is long enough, and decides the strategy that will be used to solve the problem; that is, finding the volume of the box, the volume of the first cheesecake and the volume of the second cheesecake which has been resized to 1/2 times the previous size. This is in line with the opinion of Ennis (1996) who states that the first thing to do in understanding a problem is to determine the main problem contained in the problem and decide on the strategy that will be used to solve the problem.

In the Reason and Inference criteria, the subject states the reasons for using the block volume formula, provides an explanation when dividing the volume of the box by the volume of the first and second cheesecakes, and explains the picture of the position of the cheesecake in the box that has been made, and explains the answer found. This is in line with the opinion of Ennis (1996) which states that it is important to know the reasons that support or contradict decisions made based on relevant facts. The reasons can come from known information or theorems, properties and so on. Reasons are the basis for a process of drawing conclusions.

In the Situation criteria, the subject knows the situation well, it can be seen that the subject uses information that is appropriate to the problem in the question; namely, a

block-shaped packaging box measuring 10 cm x 6 cm x 4 cm, where each box contains 5 cheesecakes, each cheesecake measuring 6 cm x 4 cm x 2 cm, and Ulvia changed the size of the cheesecake to 1/2 times the previous size. (1996) states to know the meaning of key terms, relevant parts as support.

In the Clarity criterion, the subject explains the terms in the question well; namely the length, width and height of the first cheese cake multiplied by 1/2, so that the size of the second cheese cake is 3 cm long, 2 cm wide and 1 cm high. This is in line with the opinion of Ennis (1996) in explaining the meaning or terms used in giving opinions both orally and in writing.

Meanwhile, for the Overview criteria, the subject re-examines the answers obtained at each step found until the final result, and is confident in the answers obtained by providing reasons; that is, the volume cannot be empty, while the image of the box is full of cheesecake, so the maximum number of cheesecakes included is 40 cheesecakes per box. This is in line with the opinion of Ennis (1996) stated in reviewing and thoroughly researching the decisions taken.

### **CONCLUSION**

Both students determine the main problem in the problem, decide the strategy that will be used in solving the problem, provide logical reasons and make a process of drawing conclusions based on appropriate reasons, use all information appropriate to the problem, explain the terms used in solving the problem and double check the answers found. The difference in critical thinking profiles of male and female students can be seen in the Overview criteria where male students recheck their work results only at the final result, while female students recheck their work results at every step found until the final result.

### ***Declaration by Authors***

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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How to cite this article: Andi Mulawakkan Firdaus. Critical thinking profile of junior high school students in solving mathematical problems based on gender. *International Journal of Research and Review*. 2024; 11(4): 69-75. DOI: [10.52403/ijrr.20240408](https://doi.org/10.52403/ijrr.20240408)

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