



## CRITICAL THINKING PROFILES OF JUNIOR HIGH SCHOOL STUDENTS IN SOLVING PLANE GEOMETRY PROBLEMS BASED ON COGNITIVE STYLE AND GENDER

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### ABSTRACT

This study aimed to describe the students' critical thinking processes in solving plane geometry problems based on cognitive styles and gender styles. This research used the descriptive qualitative method. The subjects of this study were four junior high school students selected based on differences in cognitive styles and gender styles. The instrument consisted of the main instruments are researchers and supporting instruments, namely problem-solving instruments, cognitive style instruments, and interview guidelines. The data were collected by means of tests and interviews. The results showed there is a significant difference in critical thinking based on students' cognitive styles. Students with field independent cognitive style tend to go through critical thinking stages more fully than students with field dependent cognitive style. Besides that, gender differences also have an impact, although not as significant as the cognitive style.

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## PROFIL BERPIKIR KRITIS SISWA SMP DALAM MEMECAHKAN MASALAH GEOMETRI BANGUN DATAR BERDASARKAN GAYA KOGITIF DAN GENDER

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### Kata Kunci:

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### ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan proses berpikir kritis siswa dalam memecahkan masalah geometri bangun datar berdasarkan perspektif gaya kognitif dan gender. Penelitian ini menggunakan metode kualitatif deskriptif. Subjek penelitian ini adalah empat orang siswa SMP yang dipilih berdasarkan perbedaan gaya kognitif dan gender. Instrumen terdiri atas instrumen utama yaitu peneliti dan instrumen pendukung yaitu tes kemampuan pemecahan masalah, angket gaya kognitif dan pedoman wawancara. Teknik pengumpulan dilakukan dengan teknik tes dan wawancara. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang cukup signifikan dalam berpikir kritis berdasarkan gaya kognitif siswa. Siswa dengan gaya kognitif *field independent* cenderung melalui tahapan berpikir kritis secara utuh dibandingkan siswa dengan gaya kognitif *field dependent*. Disamping itu, perbedaan gender juga memberikan dampak tersendiri walaupun tidak signifikan pengaruh perbedaan gaya kognitif.

## 1. INTRODUCTION

Mathematics learning activities involve two thinking processes, namely low-order mathematical thinking and high-order mathematical thinking. These two thinking processes will form student critical thinking skill. Critical thinking skill is very important to master because it will affect problem-solving ability. Several studies stated that if students' critical thinking skills are in the good category, students tend to think more logically, think openly, think systematically, mature in thinking, accept new ideas with a mature process of interpretation and analysis, and are full of curiosity [1]–[4].

The goal of critical thinking is to achieve a deep understanding [5]–[7]. With a deep understanding, students will be able to reveal the meaning behind the information obtained, so that they are able to make the right decisions in all actions. A critical thinker is often defined as someone who is good at asking questions and arguing. In fact, a critical thinker has the ability to do more than just 'often ask' and 'argue'. Previous research has explained that one of the characteristics of a critical thinker is being able to interpret and classify relevant and irrelevant ideas, and being able to draw conclusions based on valid data [8], [9]. Critical thinkers are able to find relevant information that is useful for solving problems, and know how they should use this information to solve the problem. In addition, critical thinkers can draw conclusions based on an information more accurately.

In further understanding, some researchers stated that critical thinkers will evaluate the implied thinking of what they hear and read, then examine their own thought processes, and make decisions or develop a new project or plan [4], [5], [10]. Critical thinkers do not easily accept information that comes to them, but they tend to prove the truth of the information. Also explained in another study, that "critical thinking as reasonable reflective thinking focused on deciding what to believe or do" [11].

Mathematics learning activities that can train critical thinking skills in the classroom include: activities to prove, compare, analyze, make contradictions, induce, generalize, sort, classify, evaluate, link, and make patterns of information/problems [4], [12]. While some education practitioners stated that critical thinking uses three indicators, namely: (1) Verification, is the ability to prove a statement deductively (using theories to prove a statement); (2) Generalization, is the ability to generate patterns on a problem for a broader category; (3) Problem solving is the ability to find the right solution or answer based on the problem identification process which includes: what is known, what is asked, and the adequacy of the elements needed in the problem, compiling a mathematical model, and checking the correctness of the results or answers [2], [6].

In addition, critical thinkers always evaluate their thinking process in any action or decision making. With critical thinking, someone will be more proficient in facing all the problems and challenges of life in the future. Critical thinking is also one of the goals of learning mathematics in schools [13].

Problem is something that cannot be separated from human life. In the process of achieving goals, a method or strategy is needed to solve the problem. Therefore, a problem is also defined as a situation where a person is required to solve non-routine problems or problems that have never been worked on and how the solution has never been understood, even though the knowledge they have can be used to solve the problem.

Problem solving is the focus of learning mathematics. To improve problem solving skills, it is necessary to develop mathematical critical thinking skills. Improving mathematical critical thinking skills is very important. The standard of skills that must be achieved in learning mathematics is: (1) mathematical reasoning, (2) mathematical representation, (3) mathematical communication, (4) mathematical connection, (5) mathematical problem solving.

Problem solving is an attempt to find a way out of a difficulty in order to achieve a goal. To achieve this goal, a problem-solving strategy or step is needed that involves thinking processes, especially how the cognitive processes in understanding problems, planning problem solving, implementing plans, and re-checking results or solutions [14]. Problem solving is an attempt to find a way out of a difficulty in order to achieve a goal. To achieve this goal, a problem-solving strategy is needed that involves thinking processes, especially cognitive processes in understanding problems, planning problem solving, executing plans, and re-checking results or solutions.

The cognitive style can be divided into two, the field dependent cognitive style (FD) and the field independent cognitive style (FI). The field dependent cognitive style is a learning style that accepts information more globally or is more influenced by the environment, while the field independent cognitive style is a student learning style who tends to declare an object without seeing the background and is able to distinguish objects from the surrounding context [15], [16]. The explanation from previous research did not directly state that the FI and FD learning style groups are male or female respectively, but both sexes are most likely to be found in each of these groups. Critical thinking is closely related to the types of students' cognitive styles and gender differences. Rifqiyana stated that differences in cognitive styles affect students' critical thinking processes [16]. Then, Syafruddin's research stated that there is a correlation between critical thinking and gender, where gender differences in students have an impact on differences in critical thinking processes [17]. Therefore, following up on the gap analyzes from previous studies, this study will further investigate the differences in critical thinking skills in solving math problems between male and female students who have different cognitive styles.

## 2. METHOD

This research was a qualitative descriptive research which aimed to describe the critical thinking process in solving geometric problems for male and female students who have a field dependent and field independent cognitive style. The object of this research was selected by using purposive sampling technique. The object of this study was four junior high school students who were selected based on differences in cognitive styles. Furthermore, for each cognitive style one sample of male students and one sample of female students were selected with the criteria of having relatively the same mathematical ability. Information about students' mathematical ability is obtained from their math teacher. Thus, there are four samples in this study, one male student with a field dependent cognitive style, one female student with a field dependent cognitive style, one male student with a field independent cognitive style, one female student with a field independent cognitive style. each has relatively the same mathematical ability. This sample selection aimed to reveal the differences in critical thinking between male students and female students, each of which has a field dependent and field independent cognitive style. Whereas information about students' cognitive styles is based on the results of the GEFT (Group Embedded Figures Test) perceptual test developed by witkin and has been standardized.

The instruments in this study consisted of the main instrument (researchers) and several supporting instruments, including critical thinking tests, cognitive style tests, and interview guidelines. Practically, the data collection process was carried out by giving the respondents a critical thinking ability test 1 and then being interviewed. At different times, respondents were also given a critical thinking ability test 2 and then interviewed. The data from the test and interview results were then analyzed. The data analysis technique referred to Miles and Huberman, who stated that there are 3 stages of analyzing data, namely data

reduction, data presentation and drawing conclusions [18]. After the data was collected, the data was then reduced, where the researcher filtered the data that was not needed in the study. After the reduction, the researcher presented the data. After obtaining credible data, the final step was drawing conclusions. The conclusion described the critical thinking profile of junior high school students in solving plane geometry problems based on cognitive style and gender.

### 3. RESULTS AND DISCUSSION

The student's critical thinking profile was described according to the FRISCO stages. Ennis in 1985 introduced six critical thinking criteria (which were shortened to FRISCO) including: (1) focus, which is knowing the main points of something being faced, usually in the form of a conclusion. (2) reason, provides reasons that support the conclusion. (3) inference is the process of drawing reasonable conclusion or the process from reasoning to conclusion. (4) situation, namely to reveal important factors that need to be considered in assessing or deciding on a solution. (5) clarity, which explains the terms used in opinion. And (6) overview is checking all actions that have been taken [19]. The following shows the critical thinking profile of junior high school students in solving plane geometry problems based on cognitive style and gender.

#### 3.1 *Male Student with Field Independent (FI) Cognitive Style*

At the focus stage, male student who had an independent field cognitive style was able to identify what was known and what was being asked in the questions. At the reason stage, student thought of the right solution to solve the problem. In fact, he had more than one alternative answer. Student got these ideas based on the knowledge he had acquired during the learning process. Another learning resource was in the form of student handbooks. Inference, at this stage the student decided to use the first method to solve the problem because he thought it was the most appropriate and efficient. Situation, at this stage, student understood very well the stages he went through in accordance with the solutions he has planned. This condition was supported at the next stage, clarify, at this stage student was able to explain the entire completion process in detail. At the overview stage, student did not re-check the results of his work due to insufficient time and he was quite sure about the results of his work. However, student solved the questions correctly.

#### 3.2 *Female Student with Field Independent (FI) Cognitive Style*

At the focus stage, female student who had a field independent cognitive style understand the problem well. Student read the instructions in the questions and was able to identify what was known and what was asked. At the reason stage, student thought of the right solution to solve the problem. Student got these ideas based on the knowledge she has obtained from the teacher during the learning process. Another learning resource was in the form of student handbooks. Even she had more than one mathematics learning handbook. At the inference stage, student decided to use the first method to solve the problem because she thought it was the most appropriate and efficient. In the situation stage, student understood very well the stages she went through in accordance with the solutions she has planned. This condition was supported at the next stage, clarify, student was able to explain the whole process of completion, step by step. In the overview stage, different with male student, female student re-checked the results of her work, starting from re-understanding the instructions in the questions and checking step by step the problem-solving process to the results. Student found technical errors in solving problems. In the end, she solved the problems correctly.

### 3.3 *Male Student with Field Dependent (FD) Cognitive Style*

At the focus stage, male student who had a field dependent cognitive style read the instructions in the questions and was able to identify what was known and what was asked. At the reason stage, student thought of an appropriate solution to solve the problem. Student only relied on the knowledge he has obtained from the teacher during learning as the main learning resource. At the inference stage, student decided to use a certain way to solve the problem because she thought that way was the most appropriate. Situation, at this stage, student did not really understand the stages he went through, this condition caused student to be unable to explain the entire completion process in detail (Clarify). At the overview stage, the student repeatedly re-checked on the results of his work, because he was not sure about the results. The results of student work were still inaccurate because the formula used did not match the problem.

### 3.4 *Female Students with Field Dependent Cognitive Style (FD)*

At the focus stage, female student who had a field dependent cognitive style read the instructions in the questions but did not fully understand the problem. Students could not identify what they know with precision. However, student knew what was asked in the questions. At the reason stage, student could not think of the right solution to solve the problem. Student only relied on the knowledge obtained from the teacher during learning as the main learning resource. Student relied on the notes they have obtained during learning. These conditions had an impact on the next stages. Student did not meet the inference clarification stage and situation. However, at the Overview stage the student repeatedly checked the instructions in the questions as an effort to understand the problem.

In general, the profiles of students' critical thinking processes were different. Previous research has shown that there were differences in students' critical thinking processes in solving math problems [20], [21]. Of course, many factors influence these differences, including cognitive style and gender.

Based on the results of this study, it shown that there is a strong difference between students' critical thinking profiles in terms of differences in cognitive style in the field independent and field dependent. This condition is in line with the results of previous research which stated that students' critical thinking was not always the same when viewed from different cognitive styles [16], [22], [23]. Concretely, from these differences, students with field independent cognitive style tend to have a more complete critical thinking process which has an impact on better problem solving than students with field dependent cognitive style. This result is in line with the results of Amini et al's research which stated that students with field independent cognitive style think better than students with field dependent cognitive styles [24].

In addition, gender is one aspect that influences the critical thinking profile of students. The critical thinking process of male students and female students is relatively different. Previous research also stated that gender is one of the factors that affect students' critical thinking skills [17], [25].

Based on the results of this study, it appeared that there are differences in the critical thinking of male and female students, this showed that gender affects students' critical thinking skills, although the effect is not as strong as the effect of students' cognitive styles. Based on the results of research presented by Kaliky and Juhaevah, female students tend to be more careful and systematic in their critical thinking processes [17].

#### 4. CONCLUSION

Based on the previous discussion, it was concluded that male student with the field independent cognitive style had every characteristic of critical thinking. He was able to understand problems, made plans and decided on appropriate solutions, and students explained the completion process well. He was sure that the solution he had planned was correct so he did not review (re-check) his work. Similar condition, female student with field independent cognitive style also had critical thinking characteristics. However, the difference between the two was that female student only had one alternative answer. At the overview stage, the female student also re-checked the overall results of her work. Male student with a field dependent cognitive style also had critical thinking characteristics. He was able to understand problems well and be able to determine the right solution. However, he was unable to fully explain the completion process he had done. So, at the overview stage he tried to re-check his work, because he was not sure about the results. Female student with a field dependent cognitive style did not have the characteristics of critical thinking as a whole. She understood the problem just limited to what was asked. She was unable to identify what was known in the problem. This condition resulted in students not going through the inference, situation and clarify stages. However, at the overview stage, she tried to re-check the instructions in the problem.

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