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The critical thinking abilities of female students at the level of Van Hiele abstraction

Septi Dariyatul Aini [1]*, Fetty Nuritasari[2], Lili Supardi[3], Siti Nafiah[4]

[1]Mathematics Education Study Program, Universitas Madura. Jl. Raya Panglegur km 3,5 Pamekasan, Jawa Timur, Indonesia

E-mail: [1] septi_math@unira.ac.id*, [2] fetty_math@unira.ac.id , [3] lilisupardi@unira.ac.id , [4] sitinafiah997@gmail.com

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ABSTRACT: Critical thinking abilities are very important to improve the quality of thinking and make students better understand the content that has been studied. But in reality, students' critical thinking skills are still very low. So it is necessary to have a study that describes the critical thinking skills of these students . The purpose of this study is to describe students' critical thinking skills at the abstraction level in solving space construction problems. This research is a qualitative descriptive type because it describes in detail the critical thinking ability of Van Hiele's abstraction level in solving space construction problems. The instruments of this research are the van Hiele geometry test, the space construction problem solving test, and the interview guide. The research subjects consisted of one student of class VIII of SMP Negeri 2 Pamekasan at the Van Hiele level of Abstraction. The selection of female subjects in this study was due to the fact that female subjects were more communicative in expressing what was in their minds making it easier for researchers to uncover critical thinking of students at the level of Van Hiele abstraction. The results showed that the subject solved the space construction problem according to the critical thinking indicator stage but was not perfect because the subject made an error when solving the problem (indicator evaluation), so that the final answer obtained was not correct. This affects the conclusions obtained (inference indicators) namely the subject draws conclusions but the answers are not correct.

Keywords: Abstraction; Critical Thinking; Van Hiele; Female Student

Kemampuan berpikir kritis mahasiswa perempuan pada level abstraksi Van Hiele

ABSTRAK: Keterampilan berpikir kritis sangat penting untuk meningkatkan kualitas berpikir dan memberikan pemahaman yang lebih baik bagi siswa saat mempelari materi. Namun pada kenyataannya kemampuan berpikir kritis siswa masih sangat rendah. Sehingga diperlukan adanya penelitian yang dapat menggambarkan kemampuan berpikir kritis siswa tersebut. Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir kritis mahasiswi tingkat abstraksi dalam menyelesaikan masalah bangun ruang. Penelitian ini berjenis deskriptif kualitatif karena digunakan untuk mendeskripsikan secara rinci tentang kemampuan berpikir kritis mahasiswi tingkat abstraksi Van Hiele dalam menyelesaikan masalah bangun ruang. Metode pengumpulan data dalam penelitian ini adalah tes geometri van Hiele, tes penyelesaian masalah bangun ruang, dan wawancara. Subyek penelitian terdiri dari satu siswa kelas VIII SMP Negeri 2 Pamekasan tingkat Abstraksi Van Hiele. Pemilihan subjek perempuan dalam penelitian ini dikarenakan subjek perempuan lebih komunikatif dalam mengungkapkan apa yang ada dalam pikirannya sehingga memudahkan peneliti untuk mengungkap pemikiran kritis pada level abstraksi Van Hiele. Hasil penelitian menunjukkan bahwa subjek menyelesaikan masalah bangun ruang sesuai dengan indikator berpikir kritis tetapi belum sempurna karena melakukan kesalahan saat menyelesaikan masalah (evaluasi indikator), sehingga jawaban akhir dari solusi yang diperoleh tidak tepat. Hal

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ini mempengaruhi kesimpulan yang diperoleh (indikator inferensi) yaitu subjek menarik kesimpulan tetapi jawabannya belum tepat.

Kata Kunci: Abstraksi; Berpikir Kritis; Van Hiele; Mahasiswa Perempuan

INTRODUCTION

Critical thinking is an intellectual activity of an individual to determine the steps in solving a problem in accordance with reasoning and emphasizing some abilities (Putri, et al, 2018). Wijaya (2007) also explains that critical thinking is an activity of analyze ideas in a more specific direction, empower optimally, select, identify, study and develop it in a better direction. Whereas according to Umam and Anti (2017), critical thinking is one of the mental processes to analyze or evaluate information. Riskiyah, et al (2018) also explain that critical thinking ability is the ability that allows a person to solve a problem logically and reflectively with the aim of drawing conclusions and decisions about what to believe. The evaluation ends with a decision to reject, accept, or doubt the truth of the statement in question. From some of these opinions it can be concluded that the ability to think critically is the ability to make decisions that make sense, use logic, especially in analyzing facts, sparking and organizing ideas, maintaining opinions, making comparisons of conclusions, evaluating arguments and solving problems. There are six indicators of critical thinking skills that can be used as assessment criteria are presented in Table 1.

Table 1. Indicators of critical thinking skills

No	Indikator	Sub Skill
1	*Interpretation*	Categorize and explain the meaning of the given problem.
2	*Analysis*	Explain the things needed in solving the problem
3	*Evaluation*	Assess the credibility of the statement
4	*Inference*	Draw logical conclusions about what was asked
5	*Explanation*	Explain the conclusions obtained
6	*Self-Regulation*	Re-review the answers given

Source: adapted from Fithriyah et al. (2016)

The importance of critical thinking skills in solving problems can improve the quality of thinking and make thinkers better understand the content they have learned. It also help, the students to think more systematic, more understanding and able to find solutions to solve a problem. This is in line Kusmanto (2014) that adding value to critical thinking will improve the ability to solve mathematical problems. Nugraha (2018) also added that critical thinking triggers a systematic process that allows students to evaluate the statement, evidence, assumptions, and language to have an understanding. But in reality, students' critical thinking skills are still very low (Walfajri & Harjono, 2019), (Kaniati, et al, 2018).

To improve students' critical thinking skills, stimuli are needed, one of them by giving solid figure problems. This is because learning geometry can improve the ability of intuition, visualization skills, intuition, critical thinking, perspective, making conjecture, deductive

reasoning, proof and logical argument. In addition, Hiele (1986) and Clement (2003) state that learning geometry requires a high level of thinking. Which is critical thinking is higher-level thinking skills, therefore students must often practice in improving their thinking skills in order to improve their thinking processes in solving problems, one of which is in solving geometry problems including space construction.

One theory of thinking that can be applied to geometrical material including space construction is Van Hiele's Thinking theory. According to Slameto (2003) Van Hiele states that there are 5 levels of children's thinking in studying geometry, namely visualization (level 0), analysis (level 1), abstraction (level 2), deduction (level 3), and rigor (level 4). Some research states that Van Hiele's theory of success has succeeded in achieving its goals as Chew & Idris (2012), Chew & Lim (2013) and Abdullah & Zakaria (2013) who stated that the application of Van Hiele's theory is indeed relevant if applied to mathematics learning and more specifically to improve critical thinking skills. So it's important to analyze students' critical thinking skills in solving problems of space construction as geometry based on Van Hiele's level of thinking.

The researcher chooses Van Hiele's level of thinking as the basis for classification in selecting research subjects, because: (1) focus on geometry; (2) examines the level of understanding of geometry; (3) explain the general description more operationally at each level described; (4) is accurate in describing the level of geometry thinking.

Based on the description above, the author is interested in researching "The Critical Thinking Abilities of Female Students at the Level of Van Hiele Abstraction". While the purpose of this study was to determine the critical thinking ability of eighth grade female student at the abstraction level in solving problems of space construction.

RESEARCH METHOD

Type of Research

This type of research is descriptive qualitative because it describes the critical thinking ability of female students at the level of Van Hiele abstraction in solving the problem of space construction.

Time and Place of Resarch

This research is conducted during the even semester of the 2019/2020 academic year at SMPN 2 Pamekasan class VIII.

Research Instruments

This study uses three instruments. First, the Van Hiele Geometry Test (VHGT) is used to determine subjects at the Van Hiele abstraction level. Second, the Problem Solving Test of Space Construction (PSTSC) is used to analyze the critical thinking skills of female subjects at the level of Van Hiele abstraction. PSTSC is made in the form of problem finding assignments. The PSTSC instrument in this study is a non-routine problem that can reveal students' critical thinking skills. The test is given to research subjects to work on. Before being used, the PSTSC instrument was first validated by: (1) lecturers with a minimum of S2

degree and teaching / expert certification in the field of geometry; (2) mathematics teachers with a minimum of S2 or teaching certification at least 5 years. If the test is valid based on the validator's assessment a legibility test will be carried out, otherwise a new test draft will be prepared. The readability test was used to determine whether the PSTSC draft could be understood or not by giving the draft to 2 class VIII students who were not research subjects. If it can be read and understood, then the test is ready to be used as a research instrument, otherwise it will be revised until it is successful. Third, the interview guidelines is used as guidelines in interviewing subjects to confirm and obtain new data from the results of the PSTSC because not all of the subjects working on the PSTSC are written in the answer sheet. The following is a matter of problem solving tests used in this research.

Problem Solving Test of Space Construction 1 (PSTSC 1)

A closed car that has a length of 2 m, width 1,3 m, and height 1,5 m. It will be filled with an egg basket measuring 20 cm × 20 cm × 20 cm. If 1 basket can load 5 kg of eggs, then determine how many kilograms of eggs are loaded by the car!

Figure 1. Problem solving test of space construction 1 (PSTSC 1)

Problem Solving Test of Space Construction 2 (PSTSC 2)

A dairy home industry has a refrigerator box measuring 2 m × 2 m × 2 m. The box will be filled with milk box production results that have been packaged with the size of the package is 10 cm long, 5 cm wide and 17 cm high. If 1 box of milk can contain 25 ml of milk, then determine how

Figure 2. Problem solving test of space construction 2 (PSTSC 2)

Research Subject

The subject in this research was 1 female student of SMPN 2 Pamekasan VIII grade who was at level 2 (abstraction) Van Hiele. The selection of female subjects in this study was due to the fact that female subjects were more communicative in expressing what was in their minds making it easier for researchers to uncover critical thinking of students at the level of Van Hiele abstraction. This appropriate with the opinion of Aini and Hasanah (2019) that female subjects have a more detailed and communicative advantage in re-expressing problems and in planning problem solving. Amir (2013) also stated the same thing that female students are more motivated and organized in learning and superior in mathematical communication skills (verbal). The results of these two studies suggest that female students are more communicative than male students, where the background of the two studies examines the differences in the abilities of men and women in learning mathematics so that it strengthens researchers to take subjects in the form. Broadly speaking, the steps in

selecting research subjects are: (1) determining the class of research, namely VIII grade junior high school students; (2) provides a Van Hiele geometry test; (3) analyzing the results of students' Van Hiele geometry tests, then classifying students who are at level 2 (abstraction); (4) selecting a prospective subject consists of one woman, if there is more than 1 female subject who is at the level of abstraction then the determination of the subject also pays attention to teacher considerations related to the subject's ability to communicate to express ways of thinking orally or in writing. Subject communication skills are needed to make it easier to reveal students' critical thinking in solving building space problem; (5) asking the willingness of selected subjects to be given a test to solve the problem of space construction and being interviewed. The selected subject was then given a test to solve the problem of space construction to find out their critical thinking skills by doing on non-routine questions. Student answers were analyze based on indicators of critical thinking skills.

Research Procedure

Data collection in this study was carried out at least two stages. This aims to get valid data. To check the validity of the data from PSTSC and interviews in this study, a time triangulation was performed, where data validation in this study was carried out by comparing the results of the PSTSC 1 interviews with the results of the PSTSC 2 interviews at different times. If the results tend to be the same, then the data collection has been completed and can be concluded. However, if the interview data for PSTSC 1 and PSTSC 2 show different results, then a PSTSC 3 interview will be conducted (equivalent to the first and second questions). If the results tend to be the same as the interview data for PSTSC 1, then the critical thinking data for students at the Van Hiele level of abstraction in solving space construction problems obtained from the interview data for PSTSC 1 and PSTSC 3. 2, data on critical thinking students at the Van Hiele level of abstraction in solving space construction problems obtained from the results of interviews with PSTSC 2 and PSTSC 3. If the comparison of all data is still different, then do it again until valid data are obtained. Data is said to be valid if there is consistency, similarity of opinion or thoughts on the results of interviews that have been conducted by researchers. It is hoped that as a whole the data obtained are mutually reinforcing and provide an in-depth picture of the critical thinking skills of students at the Van Hiele abstraction level.

Data Analysis Technique

This study uses data analysis techniques referring to the opinion of Miles & Huberman, namely (1) data reduction, (2) data presentation, (3) drawing conclusions. Data reduction is useful for sharpening, making data simpler and directing, removing unnecessary data and then organizing data so that valid data is obtained. The presentation of the data is done by classifying the data in order to obtain categorized and organized information so that it can be concluded. Drawing conclusions in this study is the stage of finding the core, information and possible arrangements, as well as the causes that arise. This conclusion is used to reveal the critical thinking ability of female students at the Van Hiele level of abstraction in solving space construction problems at SMPN 2 Pamekasan.

RESULTS AND DISCUSSION

Based on the data analysis of the results of the VGHT, obtained 3 male students and 10 female students were at level 2 (abstraction), 6 male students and 3 female students were at level 1 (Analysis), 1 female student was at the level 0 (visualization). Of the 10 female students who were at level 2 (abstraction), only 1 was chosen by paying attention to students' answers on the results of the Van Hiele geometry test that best represents the female subject of Van Hiele abstraction level, paying attention to teacher considerations related to communication skills and willingness to become research subjects. The reason researchers chose female subjects because female subjects tended to have better communication skills in expressing their critical thinking skills. This is also supported by the results of interviews with the mathematics teachers of class VIII-F that female subjects tend to be more communicative than male subjects. The researcher chooses the subject at level 2 (abstraction) based on Van Hiele's level of thinking because it is hoped that through this research, the researcher will get a complete picture of students' critical thinking skills in solving the problem of space construction so that it can be used as a reference in designing better learning tools. Based on previous studies, showed that the highest level of Van Hiele thinking level students in junior high school are still at level 2 (abstraction) and have not yet reached the stage of deduction (Zhui &Misri, 2013)

The following are the results and discussion about problem solving test of space construction and interviews obtained by researchers on the selected subject (female subject at the level of abstraction):

In the indicator of interpretation, the subject reads and understands the problem by stating the information that is known and asked about the problem correctly. The following are the results of interviews with subjects related to indicator interpretation.

R: What information did you get from the questions ?

S: The size of a car or a beam, the size of a basket or a cube, one basket of eggs contains five kilograms of eggs

R: Okay, so what else?

S: One basket can load five kilograms of eggs

P: That's all the information you got?

S: Yes

P: Could you reaffirmed the given information from the question?

S: The car length, then the car width is the same as the height of the car, p = 2 m, l = 1,3 m, t = 1,5 m and the size of the egg basket is the same 20 cm × 20 cm × 20 cm the same as each basket with 5 kg of eggs, then the questioner how many kg that can be loaded by the car body.

This is in accordance with the research results of Riskiyah et al. (2018) that at the interpretation indicator, the subject reads and understands the questions indicated by presenting the information contained in the questions based on what is known and correctly

asked. Filah et al. (2018) also strengthen the results of this study that students are able to understand the information from the problem, able to sort out what is known and what questions are asked and able to match the results obtained with those asked.

In the indicator analysis, the subject hooks the things that are known to the things that are asked, arguing that the information that has been obtained from the problem is sufficient and meets the requirements to solve the problem, using the words/sentences themselves to restate the original problem to have more understanding by the subject, and strategies used to solve the problem by first drawing the known shapes. The following are the results of interviews with subjects related to indicator analysis.

P: Okay, do you suppose there is a disconnection between the same known things that were asked just now?
S: There is.
P: What is the connection?
S: Yes, if you want to find the amount that can be loaded, you must calculate the car volume, then the egg basket volume first, after that, the volume of the car trunk is reduced by the volume of the egg basket, then the results will be multiplied by 1 basket, because there are 5 kilograms of eggs, so later multiplied by 5 kilograms, and then we can get the answer.
S: Already
P: Let's try again. Please, express this problem based on your understanding?
S: There is a car has a length of two meters, a width of 1,3 meters, and a height of 1,5 meters, then the car tub will be filled with an egg basket that is 20 centimeters each side, 1 basket contains 5 kilograms of eggs, then asked to find how many kilograms could be loaded like the car.
P: Okay, so what would you like to do to answer this question?
S: First, I am going to find the car volume, then the volume of the basket.

This is in accordance with the opinion of Riskiyah et al. (2018) which states that the subject analysis indicators express the relationship between things that are known and the things that are asked, the information on the questions meets the requirements to solve the problem, restates the original question to a simpler form based on what is understood , and able to express the strategy used to solve the problem.

In the evaluation indicator, stating the reasons for using how to draw first in solving the problem because this method will make it easier and faster for the subject to solve the problem, then the subject explains the steps for the results of the work and suggests important things that need to be considered among the steps in the process However, the subject was less careful in the final stage of solving the problem, namely when determining the total number of egg baskets that could be put in the car tub and determining the number of milk boxes that could be loaded in the refrigerator box. The subject only adds up the whole after determining the number of egg baskets and exact milk packaging, which

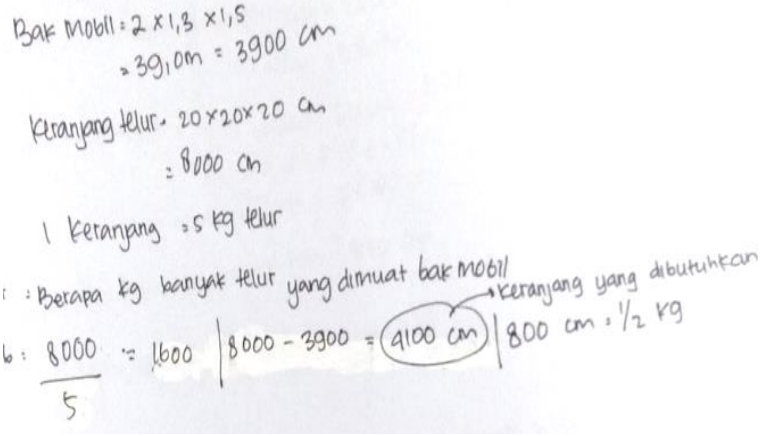
should have been known if the number of baskets or milk boxes on each side needs to be carried out further calculations, namely to find out the number of egg baskets that can be inserted into the car tub by calculating the volume ($V = p \times l \times t$) while to find out how many boxes of milk can be loaded into the refrigerator ($V = s \times s \times s$). Meanwhile, the subject only adds up the number of shapes after knowing each side. The following are the results of interviews with subjects related to evaluation indicators.

P: Why do you use this method?

S: Because according to my understanding it's easier.

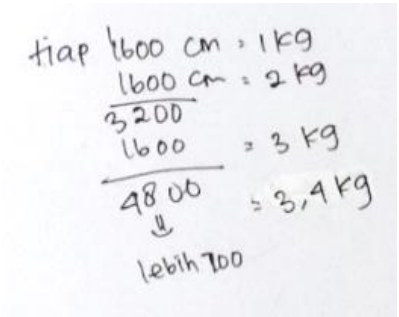
P: would you mind to give detail explanations

S: The size of the car is 2 x 1,3 x 1,5 = 39 m, it becomes 3.900 cm, which means 8.000 – 3.900 = 4.100 cm, so every 1.600 baskets contains 1 kilogram of eggs, if 3 kilograms is 4.800, this means 700 more than 4.800, it's approximately 3,4 kilograms. (This bellow picture shows the solving procedures steps)



P: What is the most important things from those steps?

S: Every 1.600 cm contains 1kilogram of eggs, it needs to be considered to determine how many kilograms of eggs can be loaded like a car



This is in accordance with the opinion of Muslim (2017) which states that subject's answer at the level of informal deduction is not entirely correct but clearly shows the flow of thought. Filah et al. (2018) also state that the subject is able to understand information from the problem, and is able to sort out what is known and what is developed. However, the subject was not able to solve the problem correctly.

In the inference indicator, the subject is able to draw conclusions/solutions but the conclusion is not the correct answer, this is because at the time of completing the question

(indicator evaluation), the subject made an error so that the final answer of the solution obtained was incorrect. The following are the results of interviews with subjects related to inference indicators.

P: Okay, After you did a calculation, what is the result?

S: the eggs that can be loaded is 3,4 kilograms.

In the explanation indicator, the subject explains the solution obtained by stating that the solution obtained is in accordance with the problem questions and reveals that the solution obtained is correct, this can be proven by the subject's answer. The following are the results of interviews with subjects related to explanation indicators.

P: Would you mind to give further explanation?

S: Because every 1.600 cm = 1 kilogram, that means 3.200 cm = 2 kilograms and 4.800 cm is more than 700 so i estimated it to be 3,4 kilograms

This is in accordance with the opinion of Muslim (2017) which states that the two respondents who are at the van Hiele informal deduction level have not met the indicators of drawing conclusions, this is shown from the results of the conclusions given by both of them that are not correct. Riskiyah et al. (2018) also state that on the inference indicator, the subject is not able to draw conclusions/solutions appropriately.

On the *Self-Regulation* indicator, the subject states that the answers obtained are correct, and re-checks the steps by examining the completion steps carefully whether the results are correct or not, and give a states that the results obtained are correct. The following are the results of interviews with subjects related to *Self-Regulation* indicators.

P: do you want to recheck your answer?

S: Hmmm ... yeah more or less

P: Okay, are your completion steps correct / do you still need anything else to improve? (The subject rechecks the answer)

S: I'm sure

P: So, don't you need to check anything?

S: Yes

P: Okay, how do you answer that?

S: So, the eggs that can be loaded is 3,4 kg

This is in accordance with the opinion of Filah et al. (2018) that students are able to provide explanations and match the results obtained with the questions posed on the questions. Riskiyah et al. (2018) also state that on the self-regulation indicator, the subject checks the results of the work and states that the results of the check are correct and there is nothing that needs to be corrected.

It can be seen that the subject has the ability to solve the problem of space construction according to the indicators of critical thinking stages but is not perfect because at the time of solving the problem there are still errors (indicator evaluation) so that the final

answer of the solution obtained is not correct. This is in line with Ansori's research (2014) that subjects with high thinking ability *Informal Deduction Levels* are able to compare geometric shapes based on their properties and have been able to solve problems by using its recognizable characteristics, but they are still not very thorough in the calculation process. The connection between the results of Ansori's research (2014) with the results of research on the critical thinking skills of the subject of level 2 (abstraction) in solving the problem of space construction is the ablity to state the information contained in the problem (what is known and asked) completely and precisely equivalent to the indicator interpretation, identifying the relationship between questions equivalent to the analysis indicator, explaining how to solve, but they are still not very thorough in the calculation process especially on volume of cubes and beams (evaluation indicators), drawing conclusions and the reasons are equivalent to inference and explanation indicators, able to check results as a whole but the end result is not correct because of some errors when working according to the steps (self-regulation indicator).

The weaknesses in this study are (1) the test instrument used is less representative of the overall problem of space construction because it is only limited to essay related to cubes and beams, so that for further research it is expected to cover more mathematical material but the material still requires critical thinking processes in completing it; (2) the subjects used in this study were only carried out at the level of the junior secondary school, so the results obtained might make a difference if it was done at a different level.

CONCLUSSION

Based on the results of data analysis, it is concluded that female subjects at level 2 (abstraction) have the ability to solve space construction problems according to the indicators of critical thinking but are not perfect. The details are: (1) interpretation indicators, able to reveal the information contained in the subject completely and mention what is known and made correctly; (2) indicator analysis, the subject is able to explain the relationship between questions; (3) evaluation of indicators, the subject explains how to solve the problem but is still not thorough in the final calculation; (4) inference indicator, the subject is able to draw conclusions but not the correct answer because there was an error in the last stage of problem solving; (5) explanation of indicators, the subject is able to explain what is obtained; (6) self-regulation indicators, the subject can re-check the results of the work but the final results are less precise due to the influence of errors when working on the completion steps.

As for suggestions for further research, namely in order to obtain a more complete analysis of critical thinking, it is necessary to conduct verification research with: other materials, such as algebra, numbers, Arithmetic; different units of education level, for example high school students, college students; different instruments, such as problem-posing; different views, such as differences in mathematical ability, gender differences, or cognitive styles.

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