Analysis of the critical thinking process of junior high school students in solving geometric problems by utilizing the v-a-k learning styles model

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Abstract. The research aims to identify the critical thinking process of students in solving geometry problems. The geometry problem selected in this study was the building of flat side room (cube). The critical thinking process was implemented to visual, auditory and kinesthetic learning styles. This research was a descriptive analysis research using qualitative method. The subjects of this research were 3 students selected by purposive sampling consisting of visual, auditory, and kinesthetic learning styles. Data collection was done through test, interview, and observation. The results showed that the students' critical thinking process in identifying and defining steps for each learning style were similar in solving problems. The critical thinking differences were seen in enumerate, analyze, list, and self-correct steps. It was also found that critical thinking process of students with kinesthetic learning style was better than visual and auditory learning styles.

1. Introduction

Mathematics is a rapidly growing basic science. The development of mathematics could be seen from the material and the usefulness of mathematics itself. Math is very important in the development of science and technology. Therefore math becomes one of sciences that must be studied in school. The geometry is one of that materials, since geometry is an important branch of mathematics [1]. Geometry is used for solving problems associated with mathematics for other purposes [2].

Geometry is the main branch of mathematics that relates to the visual aspects of our surrounding [3]. Geometry requires students to relate concepts to other concepts in solving problems, so that students' critical thinking on the concepts have been studied.

The average results of Trends in International Mathematics and Science Study (TIMSS) in 2011 on geometrical material are 377 [4]. It shows that understanding of geometry material is still low. The low understanding of geometry is also clear from the results of the national examination on geometry material in 2016 at the Junior High School 2 Tawangmangu which is 36.69% lower than the Central Java provinces 40.26 and the national (Indonesia) 47.19% [5].

Mathematics learning in schools seems to be still memorized without material understanding that hinders students in learning mathematics, especially geometry. In addition, critical thinking has not been developed in the learning process. Lessons have taught only about the content of the
subject and put aside the teaching of thinking skills [6]. As a result, students can only do the problems well, but have yet to carry out a critical attitude to problems in daily life.

Problems cause anxiety to a person and lead to seek solutions using their own knowledge and experience [7]. Problem solving is the ability to analyze, interpret, reason, predict, evaluate and reflect [8]. Therefore, students should be trained to think critically in solving problems in learning mathematics, especially geometry.

Critical thinking is the art of flowing and evaluating with the aim of improving the thinking activity [9]. Critical thinking goes through several stages: formulating problems, giving arguments, doing deductions, inducing, evaluating, making decisions and taking action [10]. This stage has in common with the problem solving steps formulated Polya that is understanding the problem, planning the completion, carrying out the planner, and re-examining. Critical thinking prepares students to be successful citizens because they are able to make decisions and solve modern life problems with ingenious ways [11].

The critical thinking process has several steps, including: Identify (I), Define (D), Enumerate (E), Analyze (A), List (L), Self-Correct (S) or IDEALS [12]. The problem solving indicator can be seen in Table 1.

| Critical thinking step | Indicator |
|------------------------|-----------|
| Identify (I)           | Mention the subject matter |
| Define (D)             | Mention the facts that limit the problem, including what is known, asked, and unused information |
| Enumerate (E)          | Mention the choices of reasonable answers |
| Analyze (A)            | Analyze the options to decide the best way and answer |
| List (L)               | Mention the right reasons for the best way and selected answer |
| Self-Correct (S)       | Check back answers thoroughly |

The critical thinking process in solving problems influenced the factors in students, one of which is learning style. Learning styles, critical thinking, and academic achievement are closely related to each other [13]. Learning styles are combinations of how to absorb information easily, and process the information [14]. Learning styles are divided into 3 including visual, auditory and kinesthetic learning styles (V-A-K) [14]. The nature of the visual learning style is learning through what was seen, the learning style of auditory is learning through what is heard, while the learning style Kinesthetic is learn through movement or touch.

Based on the problems posed by the learning style, influence the critical thinking process of students in solving geometry problems. This is because each student has different characteristics in absorbing and processing information obtained from problems encountered.

2. Methods
This research is a descriptive analysis research using qualitative method. Moleong stated that qualitative research is a research that aims to know the phenomenon experienced by research subjects (e.g. behavior, perception, motivation, action, etc.) holistically and by way of description (in the form of words and language) [15]. The research aims to identify the critical thinking process of students in solving geometry problems, especially the matter of building a flat side space.

This research was conducted in Junior High School 2 Tawangmangu from March to May 2017. The subjects of this research were 3 students of class VIII selected by purposive sampling consisting of visual, auditory, and kinesthetic learning styles. Data were collected through tests of students’ critical thinking skills in solving geometry problems, learning style scales, interviews, and observations. The test of students’ critical thinking ability in solving geometrical problems is developed based on IDEALS critical thinking step. Learning style scale used in this research is Likert scale with 5 scale. Learning style instruments are developed based on visual, auditory, and kinesthetic
learning styles (V-A-K) taking several indicators relating to the domain and aspects of student learning styles. Interviews were conducted based on an interview guide sheet that also developed by the researcher based on several indicators related to the domains and aspects of student learning styles as well as taking into account IDEALS critical thinking steps. Observations are made when students perform the troubleshooting provided process. Instrument validated by 3 validators before ready to use. The researchers also tested the learning style instrument consisting of 30 items and 1 item of critical thinking ability test to measure internal consistency and reliability.

Subjects before being interviewed and observed completed the critical thinking skills test in solving geometry problems and learning style scales. The result of critical thinking ability test in solving geometry problem and learning style, interview, and observation scale are analyzed qualitatively to describe and know the characteristics of critical thinking process of students in solving problems according to student learning style. Data were analyzed with Miles and Huberman's steps of analyzing involve data reduction, display data, and verification [16].

### 3. Results and Discussion

The results consist of learning style, interview, observation and critical thinking process. Based on the learning style test can be found 3 students with each visual learning style, auditory, and Kinesthetic. After that the three students were given 1 test questions about the area of the cube to know the process of critical thinking in each learning style. In order to get more information then conducted an interview by observing the steps IDEALS to know the process of critical thinking of students. The discussion about the critical thinking process of students in solving problems in each learning style can be seen in table 2.

| Steps of critical thinking | Visual | Auditory | Kinesthetic |
|---------------------------|--------|----------|-------------|
| Identify (I)              | The subject matter of which paper can cover the skeleton of the cube. | The subject matter of which paper can cover the skeleton of the cube. | The subject matter of which paper can cover the skeleton of the cube. |
| Define (D)                | Fact cube framework of known issues, the paper with colors and different sizes of paper and asked where the cover frame cube. | Fact cube framework of known issues, and wake-shaped paper flat (rectangular square, and lozenges) and asked which paper cover frame cube. | The known fact issues cube frame size, and paper Flat shaped (square is a rectangle and rhombus) and asked extensive searching cube to get papers that could be covered. |
| Enumerate (E)             | The solution to the problem by sketching cube nets on paper then placed on a cube framework and all paper could be used to cover the cube framework. | The solution to the problems sketched nets cube and cube extensive searching and paper seta all paper could be used before looking extent. | The solution to the problems sketched cube nets, extensive searching each broad flat wake and find the cube as well as all the paper could be used before looking extent. |
| Analyze (A)               | The most right solution is to sketch the cube nets first. | The most right solution is to look for the area of paper and cubes then match it to the area of the cube. | The most right solution is to find the area of each wake flat and then match the width of the cube. |
| List (L)                  | The reason of the solution chosen for use sketch way sole and easier. | The reason for the selected solution is because it is faster than using a sketch. | The reason for the chosen solution is to find the area of each building flat and the cube first more accurate. |

**Table 2.** Critical thinking processes visual, auditory, and kinesthetic learning styles
Steps of critical thinking | Learning styles
---|---
Self-Correct (S) | Visual | Check back answers from beginning to end. | Check the way and answer used by correcting the final answer of the calculation. | Checking the answer process by reading the answer from the beginning to the obtained conclusion.

Based on table 2, the critical thinking process of students with visual, auditory and kinesthetic learning styles has similarities in solving problems that is identifying and defining steps. The difference in the critical thinking process lies in the solution and the reason for problem solving based on the facts given. In addition, in checking student answers with kinesthetic learning style more thorough than students with auditory and visual learning style. The critical thinking ability of the kinesthetic learning style is better than the students' critical thinking skills with auditory and visual learning styles [17].

Visual learning styles in analyzing problems and solving answers focus more on image and viewed objects shape, while the auditory learning style reads problem repeatedly to decide the rightest problem and solution. Kinesthetic forces in analyzing and solving problems with small movements such as moving a pencil. People with visual styles with visual associations, auditory learning styles speak for themselves while working, a physically oriented and kinesthetic learning style [14].

The kinesthetic learning style in problem solving in this study preferred to use the formula, the kinesthetic learning style should be explored to find the answer without using the formula. A kinesthetic learns through manipulation and practice [14]. This is because in the teacher's learning emphasis more on the formula without understanding of how to get the formula.

4. Conclusion
Based on the results and discussion conclude that the critical thinking process of students in solving the problem of geometry has not gone well. This can be seen from the selection of problem solutions to students of kinesthetic learning styles who have not able to find an answer without using the formula. The critical thinking process of students in solving geometric problems has similarities in each learning style in the identify and define steps. Students with kinesthetic learning styles in the critical thinking process solve problems better than students with visual and auditory learning styles. It is seen in analyze, list, and self-correct steps. Students with visual learning styles analyze the problem and choose a solution that focuses more on the viewed image, while the visual and auditory learning styles focus more on the existing formula. At the time of re-checking students with kinesthetic learning style more thorough than the visual and auditory learning style. Researchers suggest that in the learning process is to pay attention to the students’ thinking process in solving problems based on different learning styles. Therefore, further researchers are expected to develop strategies, methods that can improve students’ critical thinking skills for each learning style.

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