

Learning Mathematics Through Videos Lines and Angles: How to Analyze Students' Understanding of Mathematical Concepts?

Riska Nur Rohmah¹, Wahyu Setyaningrum²

^{1,2}Department of Mathematics Education, Universitas Negeri Yogyakarta, Indonesia

riskanur.2020@student.uny.ac.id¹, wahyu_setyaningrum@uny.ac.id²

ABSTRACT

Article History:

Received : 27-01-2022

Revised : 25-02-2022

Accepted : 01-03-2022

Online : 12-04-2022

Keywords:

Mathematics learning
videos;

Lines and angles;

Conceptual
understanding;



The use of technology through learning videos has a high-quality impact on students' understanding of mathematical concepts. However, the facts show that the use of learning videos has not been fully utilized, especially in the lines and angles material. The purpose of this research is to determine and describe students' understanding on lines and angles concepts through the use of instructional videos. This study is a qualitative descriptive approach which employed interviews of students' conceptual understanding after their taking a test. This research involved two seventh-grade students of a junior high schools in Tulungagung, namely AL and YL. Both research subjects have studied the material of lines and angles in mathematics learning through the use of mathematics learning videos. The two students in this study were also students with high learning achievement categories. The results obtained from this study stated that the average ability of students to understand mathematical concepts was 80 out of a maximum score of 100 which can be categorized a good level of conceptual understanding. This implies that mathematics learning videos can be used as an alternative for teachers and other researchers in conveying material, and training students' abilities in understanding mathematical concepts, especially lines and angles material. As for further research, students' ability to understand mathematical concepts can be supported by using worksheets, media, or other learning approaches on lines and angles material.



<https://doi.org/10.31764/jtam.v6i2.7403>



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A. INTRODUCTION

In this developing era, students are required to have the skills to adapt to all the changes. Advances in technology and information that are growing so rapidly bring changes to the education and learning system (Retnawati, 2013). The utilization of technology allows the student-centered learning (Hao, 2016; Marsudi et al., 2021; Setyaningrum, 2018). One of the use technology in mathematics learning is through the use of videos. The learning videos can help in overcoming differences of students' abilities to understand the subject matter (Mahadewi et al., 2020). Students can practice thinking skills about phenomena that students often encounter in everyday life through the videos (Putri et al., 2019). The videos can help students to understand the material easier than using textbooks (Lo & Hew, 2017). This is

based on the fact that each video contains the content and objectives of important mathematical concepts to learn, so that students can more easily understand a concept (Akçayır & Akçayır, 2018; Anwar et al., 2020; Lalian, 2018; Steen-Utheim & Foldnes, 2017; Tomas et al., 2019).

Mathematics learning that integrates technology to solve real problems, could facilitate the 21st-century skills (Akgunduz, 2016). However, the results of the Assessment and Teaching of 21st Century Skills (AT21CS) survey found that the majority of secondary school graduates had deficiencies in mathematical understanding and skills (Trilling & Fadel, 2009). Even though the ability to understand mathematical concepts is one of the cognitive abilities that need to be mastered. The National Council for Mathematics Teachers revealed that it is important for students to have the ability to understand mathematical concepts (NCTM, 2000; Santosa et al., 2022). The ability to understand mathematical concepts is the basis for learning mathematics (Ibrahim, 2018; Utami et al., 2020). Students with the ability to understand mathematical concepts will apply concepts appropriately and help in learning new ideas (Yuliani & Suragih, 2015).

Students, however, still faced many difficulties in achieving a good understanding of mathematical concepts. It is a major problem in mathematics education (Brahier, 2016). Moreover, there are also differences in the ability to understand concepts and to relate them to new concepts (Saputra et al., 2021). Factors that make it difficult for students to understand concepts are the application of learning, learning assessment systems/procedures, and inappropriate use of technology (Haji & Yumiati, 2019). In addition, students also still experience conceptual errors in the lines and angles material (Rosdianah et al., 2019). This causes students difficulties. Students find it is difficult in answering questions related to lines and angles material, such as errors in facts, principles, concepts, operations, until a question is presented (Rahayu & Jupri, 2021). This is in line with the results of interviews with AL and YL teachers who revealed that students still have difficulty understanding the concept of lines and angles material. Students have not been able to solve a problem using facts, principles, concepts, and operations. Even students still have difficulty understanding concepts and calculating from the problems presented.

Tracing students' understanding ability is important in evaluating a lesson that has been done (Santosa et al., 2022). Research related to the ability to understand students' mathematical concepts has been carried out by previous researchers such as analysing the ability to understand mathematical concepts of junior high school students on set material (Asih & Imami, 2021), understanding mathematical concepts using mathematics learning video media in class III C (Salsabila et al., 2020), and the latest research conducted in 2021 analysing mathematical concepts understanding with e-learning based on Google Classroom (Hernawati & Pradipta, 2021). Some of the results of previous studies only explained some of the alternative learning media used in improving students' understanding of mathematics. However, no one has evaluated students' mathematical understanding of learning using learning videos, especially on lines and angles material. Based on the description above, the purpose of this research is to find out and describe how students use mathematics learning videos to understand concepts of lines and angles.

B. METHODS

This study uses a qualitative descriptive approach. The subjects of this study were two grade seven students of one of the junior high schools in Tulungagung in the second semester of the 2021/2022 academic year, namely AL and YL. They have studied the lines and angles in through the learning videos for five meetings. The videos used in this study are from the official website of the Ministry of Education and Culture as well as other videos (YouTube) that are relevant to the line and angle material for grade seven. The videos are selected based on the appropriateness of its content to the competencies in the Indonesian curriculum 2013, namely analyzing the angle relationship due to two parallel lines cut by a transverse line and solving problems involving the relationship between angles as a result of two parallel lines cut by a transverse line. Meanwhile, two students, namely AL and YL students, are students with high learning achievement categories from learning through the use of learning videos.

The data was collected using test on students' conceptual understanding of the line and angle material consisting of 5 questions (see Table 1) and interviews. It then followed by interviews to confirm the students' answers. Then students were asked to express what they think when doing the test. The student's conceptual understanding ability test was conducted at the last meeting (sixth meeting) for about 80 minutes. Then the researcher recorded the students' verbal expressions. After finishing with one student, the same process will be carried out on the second student. The conceptual understanding test consist of five questions including: (1) restating a concept; (2) identifying examples and non-examples of a concept; (3) developing the necessary or sufficient conditions for a concept; (4) using certain procedures, and (5) applying between concepts in a mathematical problem (adapted from (Suharto & Widada, 2019)). In line with that, the data processing technique of students' conceptual understanding ability scores in this study used the guidelines as shown in Table 1.

Table 1. Guidelines for Assessment of Ability to Understand Mathematical Concepts

Source: adapted from (Augustine et al., 2020)

Concept Understanding Indicator	Description	Score
Restate a concept	No answer	0
	Able to restate the concept but not yet correct	1
	Able to restate concepts appropriately	2
Identify examples and non-examples of concepts	No answer	0
	Able to express examples and non-examples but not correct	1
	Able to express examples and non-examples correctly	2
Develop necessary or sufficient conditions for a concept	No answer	0
	Able to elaborate the necessary or sufficient conditions for a concept but not yet appropriate	1
	Able to elaborate necessary or sufficient conditions of a concept appropriately	2
Using certain procedures	No answer	0
	Able to use procedures but not correct	1
	Able to use procedures appropriately	2
Applying between concepts in math problems	No answer	0
	Able to apply between concepts in math problems but not yet correct	1
	Able to apply between concepts in mathematical problems appropriately	2

The students' average test scores can be determined using the following formula:

$$\bar{x} = \frac{\Sigma x}{n} \times 100$$

Description:

Σx : the number of grades obtained by students

n : maximum score

The students' conceptual understanding ability are categorised based on the score as Shown in Table 2.

Table 2. Categories of Understanding the Concept of Achievement Ability
Source: adopted from (Augustine et al., 2020)

Value Range	Category
$90 \leq x < 100$	Very good
$71 \leq x < 90$	Good
$61 \leq x < 70$	Enough
$x < 60$	Not good

In addition to using tests, this study also uses interview guidelines to ensure the process of understanding students' concepts based on their answers on the description test. In Table 3, the following is an explanation of the outline of the interview guidelines conducted in this study. As shown in Table 3.

Table 3. Interview Guidelines for Understanding Concept
Source: adapted from (Sina et al., 2019)

Concept understanding ability	Was there a symbol or meaning of the question that you didn't understand on the test?
	What makes it difficult for you to answer this question?
	What is your explanation for solving this problem?
	Are you sure about the answer you get?

C. RESULT AND DISCUSSION

This research was conducted on two seventh-grade students of one of the junior high schools in Tulungagung, namely AL and YL. They have studied the material of lines and angles using mathematics learning videos. They are students with the high learning achievement category. In this study, AL and YL students took the ability test for understanding mathematical concepts which consisted of 5 questions in the form of descriptions. Their scores on the mathematical concepts understanding are presented in Table 4.

Table 4. Students' Mathematical Concept Understanding Scores

Students	Score					Average Score
	Question No. 1	Question No. 2	Question No. 3	Question No. 4	Question No. 5	
AL	2	2	1	2	1	80
YL	2	1	1	2	2	80

The average student' conceptual undestanding scores are 80, which is categorised as a good category. The two students answered question number 1 and 4 correctly. Question number 2 only AL who answered correctly while question number 5 only YL answered correctly. Unfortunately, both of them answer question number 3 inccorrectly. The following are the questions and answers from the two students, as shown in Figure 1, Figure 2 and Figure 3.

Explain what you know about the definition and properties of angles!

Figure 1. Question Number 1

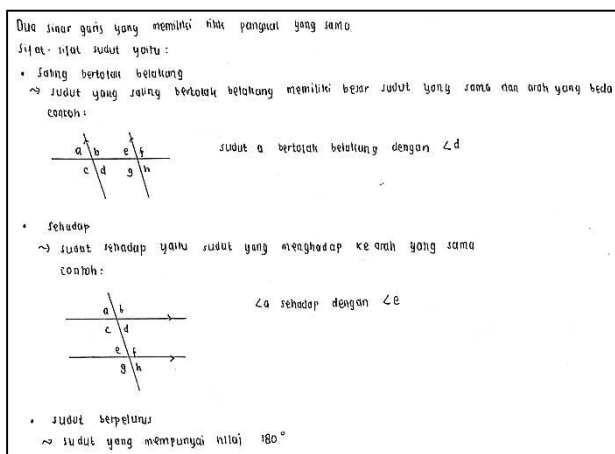


Figure 2. AL's Answer to Question Number 1

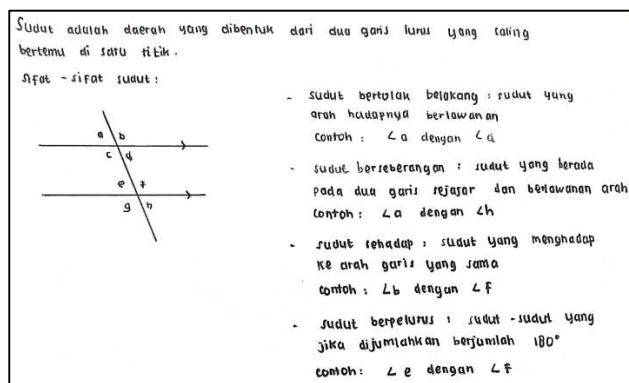


Figure 3. YL's Answer to Question Number 1

In the first indicator, students are given questions to demonstrate their ability to express the concept of lines and angles (see Figure 1). Based on answer number 1 (see Figure 2 and Figure 3), it can be seen that the two students did not have much variation. AL and YL can express concepts from their point of view when learn through videos. They are also able to write representations of angles formed by two parallel lines cut by a transversal line. This finding is in line with the results of research (Riayah & Fakhriyana, 2021; Yanti et al., 2020) which states that most students have a high ability to restate a concept from the material presented through the use of learning videos, as shown in Figure 4, Figure 5 & Figure 6.

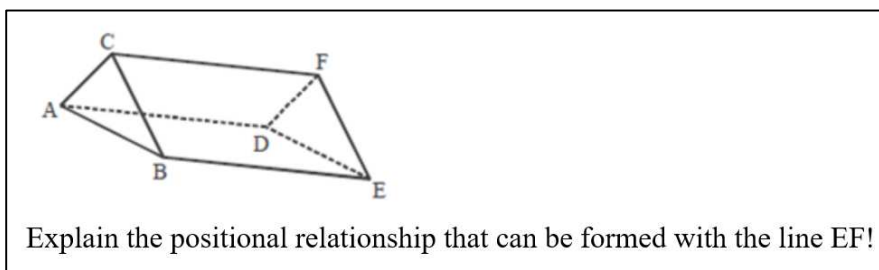


Figure 4. Question Number 2

\overline{EF} sejajar dengan \overline{BC}
 \overline{EF} tegak lurus dengan \overline{FC}

Figure 5. AL's Answer to Question Number 2

\overline{EF} dan \overline{BC} } garis yang saling sejajar
 \overline{EF} dan \overline{AB} }
 \overline{EF} dan \overline{FD} } garis yang saling tegak lurus
 \overline{EF} dan \overline{CF} }

Figure 6. YL's Answer to Question Number 2

In Figure 4, the indicator of the ability to understand concepts that must be achieved by students is to identify examples and not examples of a concept. In this case, students were asked to explain the positional relationship that can be formed with the line EF. As for the explanation of the answers, students are expected to be able to provide explanations and examples by providing examples of which line has a positional relationship with the EF line. Based on the answers written by the two students (see Figure 5 and Figure 6), it can be seen that AL have been able to provide examples and not examples correctly. While YL can give examples and non-examples but that is incorrect. YL revealed that line EF has a positional relationship that is parallel to line AB. After being explored further by interviewing YL, this happened because YL had not been able to read the concept of parallel lines in spatial geometry. However, when YL were interviewed with questions about parallel lines in a plane, YL could answer correctly. This shows that YL are still confused about which one is included in the examples and non-examples. This finding is in line with research (Irsal et al., 2017; Yanti et al., 2020) which revealed that students do not yet have a deep understanding of the concept, as shown in Figure 7, Figure 8 & Figure 9.

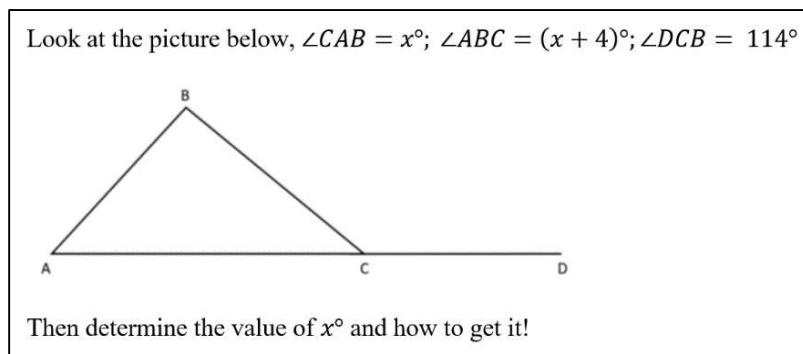


Figure 7. Question Number 3

$\angle CAB = x^\circ$
 $\angle ABC = (x+4)^\circ$
 $\angle DCB = 144^\circ$
 Nilai $x = 144^\circ + x^\circ = 180^\circ$
 $x^\circ = 180^\circ - 144^\circ$
 $x^\circ = 36^\circ$

Figure 8. AL's Answer to Question Number 3

$x = 180^\circ - 114^\circ = 66^\circ$
 $\angle CAB = 66^\circ$
 $\angle ABC = 66^\circ + 4^\circ$
 $= 70^\circ$

Figure 9. YL's Answer to Question Number 3

Then in question number 3 (see Figure 7), the indicator of the ability to understand concepts that must be achieved by students is develop necessary or sufficient conditions for a concept. Based on the presentation of Figures 8 and Figure 9, it implies that the answers of AL and YL already know that by knowing $\angle DCB = 114^\circ$, another angle (angle ABC) can be obtained from the subtraction operation of 180° (additional angle). However, they do not develop an appropriate concept. This is also based on the results of interviews which show that AL and YL assume that $\angle BAC = \angle BCA$, so they can find the size of the angle using the concept of straight angles. Meanwhile, AL made an error in writing the angle measurement, that is $DCB = 144^\circ$. This is in line with the findings of (Yanti et al., 2020) which revealed that students' abilities on the indicators of necessary and sufficient conditions were still low. Another finding also states the same thing, students have not been able to examine which conditions are necessary or sufficient for a concept because students rarely practice solving problems (Sepriani, 2021), as shown in Figure 10, Figure 11 & Figure 12.

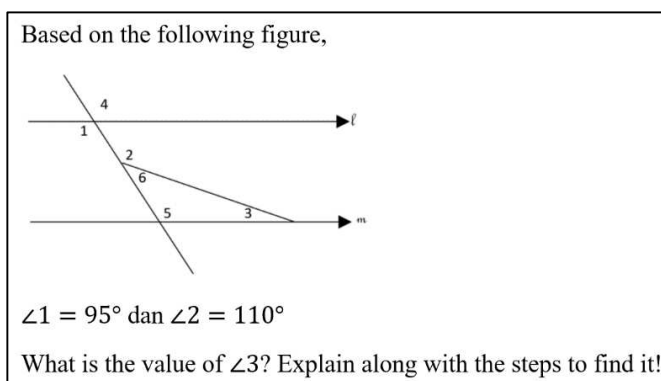


Figure 10. Problem Number 4

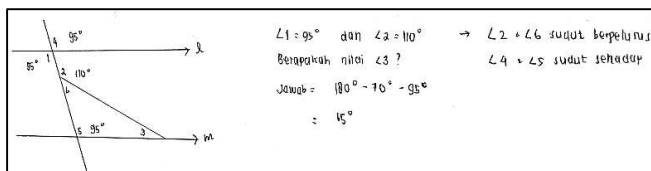


Figure 11. AL's Answer to Question Number 4

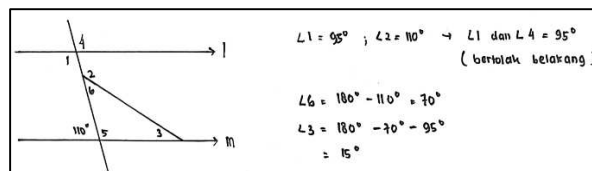


Figure 12. YL's Answer to Question Number 4

In number 4 (see Figure 10), the ability to understand concepts that must be achieved is use procedures on line and angle material. The presentation of AL' and YL' answers (see Figure 11 and Figure 12) on this indicator shows that they can use the procedure correctly. Based on the information provided in the question, it can be used to obtain the measure of other angles, namely by using the relationship of parallel lines cut by the transversal and the sum of the angles in the triangle. This is also in line with the results of interviews with AL and YL who explained that the measure of $\angle 4 = 95^\circ$ (as opposed to $\angle 1$). Then it is also obtained that $\angle 6 = 70^\circ$, came from the procedure for the concept of a straight angle with steps of $180^\circ - 110^\circ = 70^\circ$. So that the angle size can be obtained $\angle 3 = 180^\circ - 70^\circ - 95^\circ = 15^\circ$. The findings in this regard are also in line with the results of research (Agustina, 2018; Yanti et al., 2020) which states that students can use, utilize, and choose certain procedures or operations, as shown in Figure 13, Figure 14 & Figure 15.

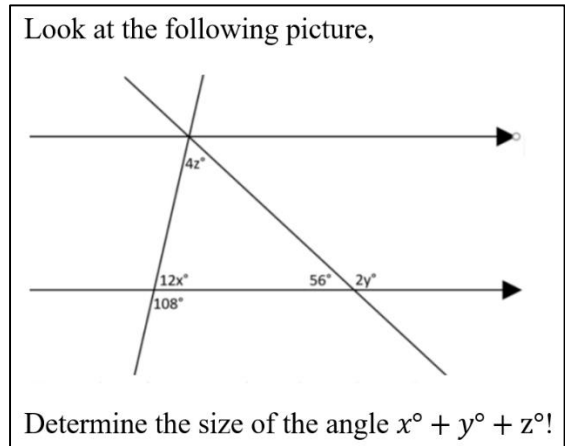


Figure 13. Question Number 5

$$\begin{aligned}
 12x^\circ + 108^\circ &= 180^\circ & \rightarrow 2y^\circ &= 180^\circ - 56^\circ \\
 56^\circ + 2y^\circ &= 180^\circ & 2y^\circ &= 124^\circ \\
 & & y^\circ &= 62^\circ \\
 \rightarrow 12x^\circ + 108^\circ &= 180^\circ & x^\circ + y^\circ + z^\circ & \\
 12x^\circ &= 180^\circ - 108^\circ & &= 6^\circ + 62^\circ + z^\circ \\
 12x^\circ &= 72^\circ & & \\
 x^\circ &= 6^\circ & &
 \end{aligned}$$

Figure 14. AL's Answer to Question Number 5

$$\begin{aligned}
 12x + 108 &= 180 & 4z + 12x + 56 &= 180 \\
 12x &= 72 & 4z + 12(6) + 56 &= 180 \\
 x &= 72 : 12 & 4z + 72 + 56 &= 180 \\
 x &= 6^\circ & 4z + 128 &= 180 \\
 & & 4z &= 52 \\
 2y + 56 &= 180 & 4z &= 52 : 4 \\
 2y &= 180 - 56 & z &= 13^\circ \\
 2y &= 124 & & \\
 y &= 62^\circ & &
 \end{aligned}$$

$$\begin{aligned}
 x^\circ + y^\circ + z^\circ & \\
 &= 6^\circ + 62^\circ + 13^\circ \\
 &= 81^\circ
 \end{aligned}$$

Figure 15. YL's Answer to Question Number 5

The indicator of the ability to understand the concepts in question number 5 (see Figure 13) is applying between concepts in a mathematical problem. Based on the answers to this question (see Figure 14 and Figure 15), YL can apply concepts in math problems correctly and confidently apply the concepts of straight angles and the sum of the angles of a triangle to the given problem. Meanwhile, AL experience difficulty in applying concepts in a mathematical problem correctly. This is because AL do not know the relationship between the results of the angles that have been obtained and the question given. This finding is also in line with research (Irsal et al., 2017) which revealed that in general students understand these concepts, but cannot understand how to use these concepts in a given problem. This fact is also supported by research (Yanti et al., 2020) which reveals that students' ability to apply concepts algorithmically is still relatively low.

D. CONCLUSION AND SUGGESTIONS

Based on the test and interview data, it appears that AL have the understanding to restate a concept, identify examples and non-examples of a concept, and use certain procedures. AL, however, have limited understanding to describe necessary or sufficient conditions for a concept and apply between concepts in a mathematical problem. Meanwhile, YL have the understanding to restate a concept, use certain procedures, and apply between concepts in a math problem. However, YL still inadequate understanding on the ability to identify examples and not examples of a concept and describe the necessary or sufficient conditions for a concept.

The results of the two research subjects in the high learning achievement category showed that the ability to restate a concept and use certain procedures was an ability that students could do well. Meanwhile, the ability to elaborate on the necessary or sufficient conditions for a concept is still not good. The ability to implement procedures or operations is good, but still lacking in developing a concept. The results of the average value of the two research subjects were 80, namely the ability to understand students' concepts was included in the good category.

This study concludes that video can be used to achieved a good conceptual understanding of line and angle. The use of mathematics learning videos, therefore, can be used as an alternative for teachers and other researchers in conveying material, and training students' abilities in understanding mathematical concepts, especially lines and angles material. As for further research, students' ability to understand mathematical concepts can be supported by using worksheets, media, or other learning approaches on lines and angles material.

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