International Journal of STEM Education for Sustainability, Vol 3, No.2, 2023, pp. 268-285
e-ISSN 2798-5091. DOI. 10.53889/ijses.v3i2.236

Learning Obstacles of Islamic Junior High School Students on Angle Concepts

Submitted 1 July 2023 Revised 5 July 2023 Accepted 15 July 2023

Yuni Hajar[1*], Didi Suryadi[2], Dian Usdiyana [3]

[1,2,3]Department of Mathematics Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

Corresponding Email: *yuni@upi.edu

Abstract

Angle is one of the concepts from the field of geometry that is important for students to learn because there are basic concepts of geometry that can be used in other fields of mathematics and everyday life. Students still experience learning obstacles in angle concepts. This study aimed to identify learning obstacles experienced by Islamic junior high school students in angle concepts. The research method used is a qualitative method with a phenomenological approach. The samples in this study were 8-grade students and mathematics teachers from one of the Islamic junior high schools in Bandung district, Indonesia. The results show that students experience learning obstacles, and can be concluded as follows, (1) instrumental ontogenic obstacles, caused by students not being used to facing difficult problems; (2) conceptsual ontogenic obstacles, caused by low mastery of prerequisite concepts; (3) psychological ontogenic obstacles, caused by low student interest in learning; (4) epistemological obstacles, caused by low mastery of angle concepts.

Keywords: Learning Obstacle, Angle, Mathematics

INTRODUCTION

Angle is one of the concepts in geometry that is important for students to learn. Angle is a combination of two rays with the same endpoint, where the endpoint is called the vertex, and the ray is called the side of the angle (Faradisa, 2019). Research conducted by Crompton (2015) shows that it is a valuable mathematical context for introducing students to angles. So, the teacher should be introduced the angle concepts to students for their mathematical understanding. Angle concepts is also important because it is one of the important concepts that students need to understand for the next geometry knowledge process, as it is one of the most basic and fundamental geometry concepts. (Biber et al., 2013; Butuner, 2021; Mullis et al., 2015). Furthermore, Yan et al. (2020) explained that when studying line and angle concepts in geometry, students will initially understand points, lines, and basic graph angles. In addition, angle concepts is also the basic concepts that must be mastered by students before studying the concepts for flat shapes and spatial shapes (Nurhudha et al., 2022). That means angles are the basic concepts in geometry and need to be learned by students to understand the concepts in other fields of geometry.

The angle concepts can also be used in other areas of mathematics. Annisa et al. (2018) state that angles are important for understanding mathematical concepts in geometry, such as quadrilaterals and triangles, or in other mathematical fields, such as trigonometry. Tallman and Frank (2020) also state that identifying the factors contributing to ineffective instruction of

angle measures is, therefore, a priority for improving students' learning of trigonometry. The research conducted by Yadrika et al. (2019) discusses students who need to be reminded of the angle concepts before studying the circle concepts. That means angle concepts becomes prerequisite concepts students need to learn other mathematical concepts. Besides, angle concepts can also be applied to assist in solving problems in everyday life. As explained by Ramadhani and Prahmana (2019), the concepts of angle is an important concepts to learn and has many applications in everyday life. It can be exemplified in carpentry, buildings, architecture, transportation, and others, so the concepts is important to learn (Makgopela, 2010; Nursafitri & Anriani, 2023; Susilowati, 2017).

But in reality, students still experience obstacles when learning angles. Obstacles are anything that obstructs, impedes, hinders, or humans encounter in everyday life that come and go, thus creating obstacles for the individuals who experience them (Perbowo & Anjarwati, 2017). Obstacles can also occur during the learning process, referred to as learning obstacles. Creating conditions to facilitate mathematical thinking occurs during learning and through books so that students naturally experience learning obstacles, affecting their learning process (Komala et al., 2020; Sidik et al., 2021). There are three types of learning obstacles, according to Brousseau (2002), namely ontogenic, didactical, and epistemological. Ontogenic obstacles occur because the teaching and learning process does not follow students' readiness, didactic obstacles are obstacles that occur due to errors in the learning process that come from the learning system at school or come from the teacher's strategy used in learning certain mathematical ideas, and epistemological obstacles are essentially students' knowledge that is only limited to a certain context (Jatisunda et al., 2021).

A number of studies have shown the existence of learning obstacles experienced by students in angle concepts. Research conducted by Bütüner and Filiz (2017) shows that students can experience misconceptsions in geometry because learning is done mostly by memorization, so students cannot fully understand the concepts. In addition, Devichi and Munier (2013) showed that students in Paris experienced ontogenic obstacles in understanding right angles. Barabash (2017) also claimed that the definition of a right angle is an ontogenic and didactic obstacle. In line with that, students experience epistemological obstacles in understanding the mutual relationship between two angles, unilateral and opposite angles, and also didactic obstacles in determining angle types (Annisa et al., 2018). These studies show that students experience learning obstacles in angle concepts, such as the type of angle and the relationship of two angles.

Previous research conducted by Setiadi et al. (2017) showed the following results: First, the lack of students' spatial ability. Second is the missing angular measure concepts in the student's book, teaching concepts, and teacher's explanation. Third, the lack of student understanding of prerequisite topics or concepts. Fourth, students mistakenly use the procedure in determining the angle between two intersecting objects. Fifth, the student used to solve three-dimensional problems only if it was the same as the example problem. Sixth, the teacher did not involve their teaching with constructing concepts activity. Rahmani (2021), in her research, shows that students experience ontogenic, didactic, and epistemological obstacles in online learning. The ontogenic obstacles that arise include writing the name of an angle without an angle symbol, students' mistakes in writing a degree without a degree unit, and limitations where students can work on problems if the problems given are similar to the examples. The didactical obstacles that arise are students' limited knowledge in understanding the concepts of right angles. The epistemological obstacles that arise are the limited understanding of students in the concepts of angles, the concepts of acute, obtuse, and right angles.

Seeing the importance of angle concepts and the reality in the field, the researcher aims to research to analyze the learning obstacles experienced by students, especially Islamic junior high school students, on the angle concepts. Madrasah Tsanawiyah (Islamic junior high school) is a junior high school with religious characteristics under the Ministry of Religion (Zahara, 2017). This means Islamic junior high school students get general learning equivalent to junior high school. But the learning load of Islamic junior high school students is heavier because of the addition of more religious subject concepts. No research has analyzed the learning obstacles of Islamic junior high school students on angle concepts. So the problem formulation in this study is, "How is the description of learning obstacles experienced by Islamic junior high school students on angle concepts?"

METHOD

The research method used is a qualitative method with a phenomenological approach. The samples in this study were 27 grade VIII (eight) students in one of the Islamic junior high schools in the Bandung district who had studied angle concepts and had one mathematics teacher. Data collection techniques were conducted through tests and interviews. The test contained six questions about angle concepts and was conducted to measure students' abilities and describe learning obstacles. The interview was semi-structured with six students to strengthen the findings of the test results and one math teacher. The test and interview data were then analyzed using the Miles and Huberman model, which consists of three activities: data reduction, data presentation, and conclusion drawing (Huberman & Miles, 2002). Data

reduction is done by taking the subthemes that will be studied based on the amount of data obtained, then reducing them back into the main themes that can be easily understood. Data presentation contains the data results that have been reduced in narrative form. Conclusions were then drawn based on data reduction and presentation results by verifying the theory to answer the research questions.

RESULTS AND DISCUSSION

This study analyzed learning obstacles, such as obstacles or constraints in understanding, constructing, and solving problems in angle concepts. The research was conducted through tests and interviews with students and mathematics teachers at one of the Islamic junior high schools in Bandung district. The test contains six questions about angle concepts given to class VIII (eight) students who have studied angle concepts. The following research results are obtained based on each test question.

In question number 1, the concepts discussed is about the definition of an angle. Students are asked to explain the definition of an angle according to their understanding. Below is an example of the results that have been done by student 1 (S1):

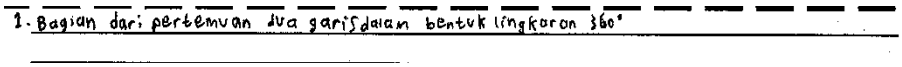

Figure 1. Student Answers to Question Number 1

In Figure 1, S1 answered that the definition of an angle is related to a circle, which is the meeting of two lines that form a 360° circle. At first glance, it appears that students misunderstand the definition of angle. Students may have misconceptsions about the definition of an angle due to false understanding, such as accepting curved shapes as rays. (Ozen Unal & Urun, 2021; Sarı et al., 2021).

Then to further explore the findings, the researcher conducted interviews with students with the following results:

P : In the first question you answered, the meeting of two lines that form a circle, what was your thought?

S1 : There are two lines, and then the end of the first line meets the end of the second line until the angle is 360°.

P : Do you think problem number one is difficult or not?

S1 : It's a bit difficult, because I don't know the definition of an angle.

Based on the results of interviews with students, it can be seen that the reason students have a false understanding of the meaning of angles is because students do not remember or forget. So that students answer with an understanding that has no foundation of truth.

Furthermore, the researcher conducted an interview with the teacher with the following results:

P : About learning in class, what is the attitude of students during math learning?

G : The response is normal, there is enthusiasm, some are serious, some are relaxed, some are sleepy.

It can be seen in interviews conducted with teachers that there are various kinds of student reactions to learning mathematics. Some students' responses look interested in learning, some just casually respond to learning, and some students are sleepy when the learning process is happening. An important aspect of mathematics related to motivation is interest, the higher the interest in learning will make students have a positive attitude towards mathematics. (Azmidar et al., 2017; Lopes, 2022). Students who give sleepy responses can indicate low student interest in learning mathematics.

In this case, it means that students experience psychological ontogenic obstacles. This obstacle occurs due to students' unreadiness to learn due to psychological aspects such as motivation, interest, behavior, and interest in the concepts being studied (Suryadi, 2019). According to Lestari (2015), interest in learning is an inner drive that grows from a student to improve learning habits. Student interest has a relationship with the forgetfulness experienced by students regarding learning concepts. Amany and Puteri (2023) state that student learning outcomes will be maximized if students are highly interested in learning mathematics. As interest grows in a person, it will generate attention to do something diligently over a long period and easily remember what is learned (Sirait, 2016).

Then question number 2 contains concepts about the parts of the angle. Students need to draw the parts of the angle and explain their meaning. The following is an example of a student's answer shown in Figure 2.

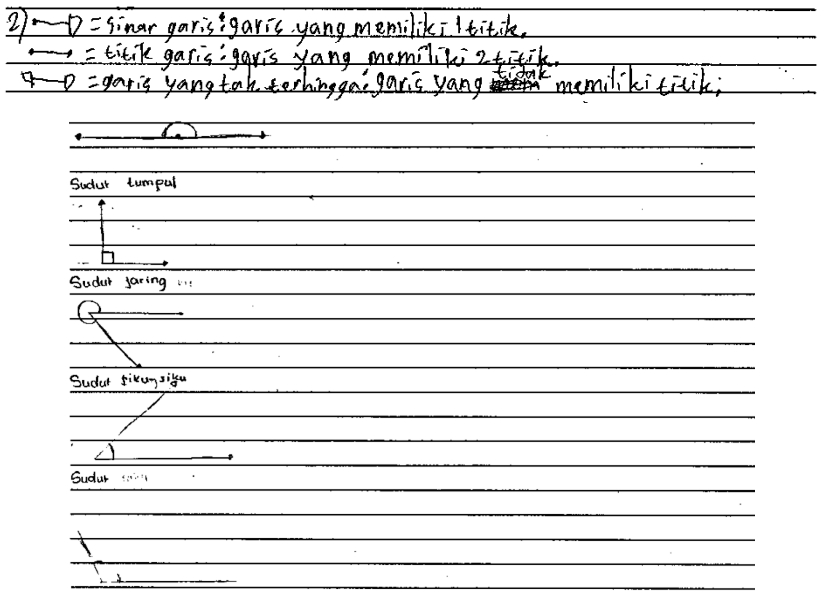

Figure 2. Student Answers to Question Number 2

Based on Figure 2, it can be seen that student 2 (S2) answered that the parts of the angle are line rays, line points, and infinite lines. Students also include illustrations of images and definitions of each form. Students' answers are not aligned with the concepts of the parts by angle, so it is indicated that students have a wrong understanding of the concepts.

Student 3 (S3) answered that the parts of an angle are straight angle, obtuse angle, net angle, right angle, and obtuse angle, as well as illustrations of each angle shape. However, students do not include the meaning of each angle shape. At first glance, it appears that students have a false understanding of the parts of an angle. Because instead of writing the parts of angles, students write the types of angles.

Then the researcher conducted an interview with S2 with the following results:

P : What is number 2 asking?

S2 : About the line, as far as I remember

P : What is your way of thinking?

S2 : I thought so, but I don't know if it's true or not.

P : But you have studied it before

S2 : I have, as far as I remember there were other types, from that point, but I forgot.

Based on the results of the interview, it can be seen that the reason students are indicated to have a wrong understanding is because what they remember is the line concepts. The concepts is the one taught to students before getting into the angle concepts. So that students answer with the knowledge they remember at that time.

Then the researcher also conducted an interview with S3 with the following results:

P : Number 2, what are you thoughts?

S3 : I remember this, then this is what I remember (pointing to the figure), but forgot again.

Based on the interview results, it can be seen that students remember the concepts of the types of angles as parts of the angle. Moreover, students doubt their understanding because they need to remember the concepts to understand the parts of the angle concepts.

It can be seen from the results of interviews with S2 and S3 that the forgetting experienced by students in this study occurs because students' memories are piled up with concepts before or after the new concepts learned at that time. If not used, information that has been obtained and stored in memory will fade and disappear over time (Pudjono, 2015). This means that students experience psychological ontogenic obstacles because of students unreadiness to learn. So that students need to be reminded of the concepts they have learned in apperception so that students do not experience ontogenic obstacles. Apperception is a motivating activity, arousing the interest and attention of the students at the beginning of the lesson by combining old and new experiences (Musthofa & Sujadi, 2020; Umardiyah & Handhayani, 2022).

We also explored the findings by conducting an interview with the teacher. The following is an excerpt of the interview conducted:

P : If I may ask, why do you think students can experience learning obstacles in angle concepts?

G : It could be because the angle is visual, so the children's visual is also still lacking.

Based on the interview results, it can be seen that the teacher indirectly confirmed the obstacles experienced by students with angle concepts. The teacher also explained that students with low visualization skills can cause them to experience epistemological obstacles in angle concepts. Visualization in mathematics is the process of forming images (mentally, using pencil and paper, or using some technology). Then these images are used for mathematical discovery and understanding of mathematical problems (Pachemska et al., 2016). According to Fajriah (2015), visualization can obscure student understanding, especially students who do not understand mathematics well. This means visualization skills can affect student understanding and cause learning obstacles.

In question number 3, the concepts contains the types of angles based on the angle measure. Students need to measure the angle and determine the type of angle based on the angle measure. There are examples of student answers, as shown in Figure 3.

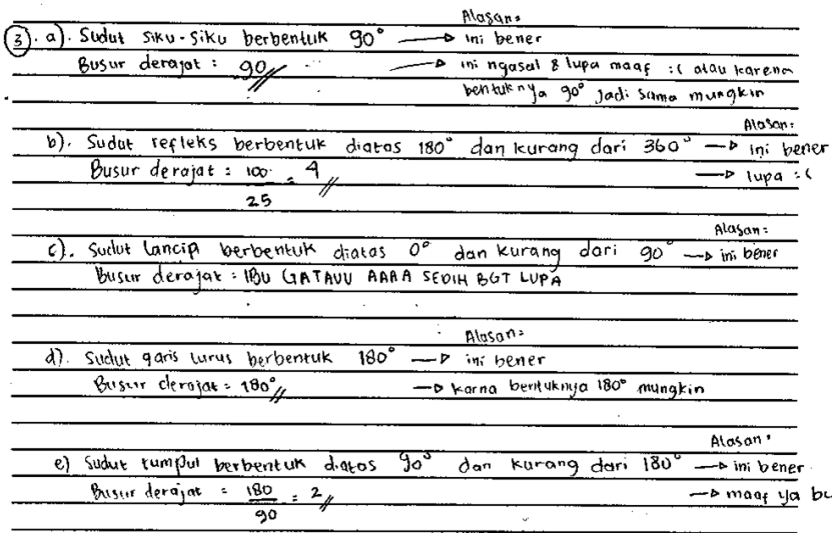

Figure 3. Student Answers to Question Number 3

Based on Figure 3, it can be seen that Student 4 (S4) wrote the angle measure, the types of angles, and the explanation of the reason for the answer. However, the student needed clarification on the reason for the answer he wrote. It can be seen from some student writings, which hints that students made it up, doubted, and forgot. Students often have difficulties understanding that the size of an angle does not vary with the length of the sides because they tend to consider the angle to be part of the plane limited by two rays (Piu et al., 2021). In addition, students also wrote that students did not know about protractors. So students indicated to have a false understanding of angle measurement.

Furthermore, the researcher conducted an interview with S4 with the following results:

P : Can you give an example of how to use a protractor?

S5 : For a, it's the one with the right angle was 90 degrees, so I just thought 90 degrees on the protractor.

P : Do you remember how to use the protractor?

S5 : No, I don't.

P : That means the type, the name, this because of what?

S5 : Because of its shape

P : If you don't use a protractor, then what is your reasoning?

S5 : For b, it's 100, then divided by 25 to make 4, like a square shape. Then for e, 180 is divided by 90, I didn't use the protractor.

Based on the results of the interview, it can be seen that students do not use a protractor to determine the angle measure in the figure. Students use their understanding of types of angles and flat shapes, such as squares to guess the measurement of the angle. Because the student cannot remember how to use a protractor. In the interview, it is known that students experience

epistemological obstacles due to their lack of understanding of the angle concepts, especially the measurement of angles. Research conducted by Özerem (2012) showed that incorrect use of protractors and angle rules can result in measurement errors in problems.

This is consistent to the findings from the interview with the teaching teacher which shows the following results:

P : Are there any learning obstacles that appear when learning angles?

G : So there are some students who still can't use a protractor. in fact, there are still students who are confused about distinguishing acute, obtuse angles.

Based on the interview results, it can be seen that the teacher confirmed that some students still had difficulties using the protractor. In addition, the teacher also said that some students still need clarification in distinguishing the types of angles. So students experience obstacles in measuring angles, especially protractors and concepts on types of angles. This finding is also similar to the research in the introduction, which Rahmani (2021), shows students experience epistemological obstacles due to students' limitations in angles, the concepts of acute, obtuse, and right angles.

Then question number 4 contains concepts about complementary angles presented in the form of story problems and connected with square concepts. Students are asked to interpret the story problem and determine the angle measure in question along with the illustration image. Figure 4 shows the results of student answers.

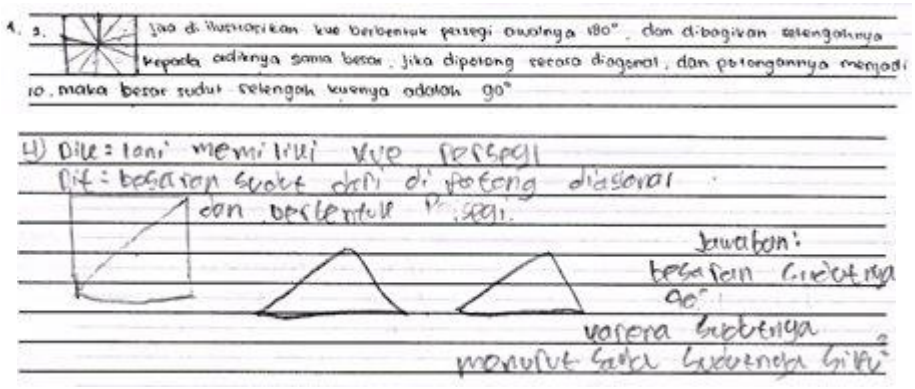

Figure 4. Student Answers to Question Number 4

Based on Figure 4, it is known that Student 6 (S6) thinks that if a square has an angle of 180°, then when divided equally diagonally, there will be ten pieces, and the angle will be 90°. At first glance, it seems that students have a false understanding of square concepts, division of fractions, and complementary angles.

Student 7 (S7) answers show that students understand the square. However, students needed to understand what is asked in the question and connect it to a complementary angle so that the illustration of the figure was wrong and affected the conclusions made by students.

We then conducted an interview with S6 with the following results:

P : Number 4, what is your thought?

S6 : This is a square, then divided, there are 10 of them so the answer is 90 degrees.

P : Then how many degrees do you think the angle in question is?

S6 : 90 degrees

P : But if it's a story problem in angle concepts, have you ever studied it?

S6 : No

Based on the results of the interview, it can be seen that students are mistaken about what is asked in the question so that the student's argumentation is not strong in answering the question. Students also explained that students had never encountered story problems in angle concepts before.

Then the researcher also conducted an interview with S7 with the following results:

P : Number 4, what are your thoughts?

S7 : The square has all the same angles so this is 90 (pointing to the corner of the square).

P : So what is the size of the angle in question?

S7 : It's the same, so there's no difference. 90

P : Have you ever studied square before?

S7 : I don't know, I forgot, hehe

Based on the results of the interview, it can be seen that the student has an understanding of the square, although the student still looks doubtful of his own understanding. However, students cannot understand what is asked in the problem, so students think that there is no action that needs to be taken to solve the problem other than their understanding of the square.

An interview was also conducted with the math teacher, with the following results:

P : Are there any other learning obstacles that appear when learning about angles?

G : Other barriers are for example about recognizing, so there are straight angles, right angles. If I don't include, for example, algebra, they can do it. But if I include algebra, students can't do it, they get dizzy. The point is that if I give the same type of problem but a little different, even though it is still a right angle, when I increase the difficulty, the students are confused. Even though it's still the same concepts.

The results of the interview with the teacher showed that students were not used to facing problems different from the example problems given during the learning experience. Students cannot utilize their prior knowledge to process new knowledge. So teachers also rarely give difficult or modified problems such as story problems. That means students experience instrumental ontogenic obstacles. This obstacle occurs because students lack readiness

regarding technical/key matters of a learning process (Suryadi, 2019). This is similar to research conducted by Fitri and Abadi (2021), that students have difficulty working on non-routine problems, such as difficulty understanding problems, transformation difficulties, process skills difficulties, and difficulties concluding. In addition, students also experience obstacles when working on problem number 4 regarding right-angle concepts in the form of story problems. Obstacles in story problems can occur because students are not careful and thorough in reading the problem, ignore the questions in the problem, and lack student understanding in interpreting sentences in story problems (Farida, 2015; Qomariyah, 2022; Utari et al., 2019).

Problem number 5 discusses the concepts of the relationship between two angles, namely the opposite angle, which is connected to the concepts of algebraic operations of two variables. Students are asked to determine the value of the x and y variables contained in the opposite angle, then determine the type of angle created from the sum of the x and y variables. Students' answers can be seen in Figure 5.

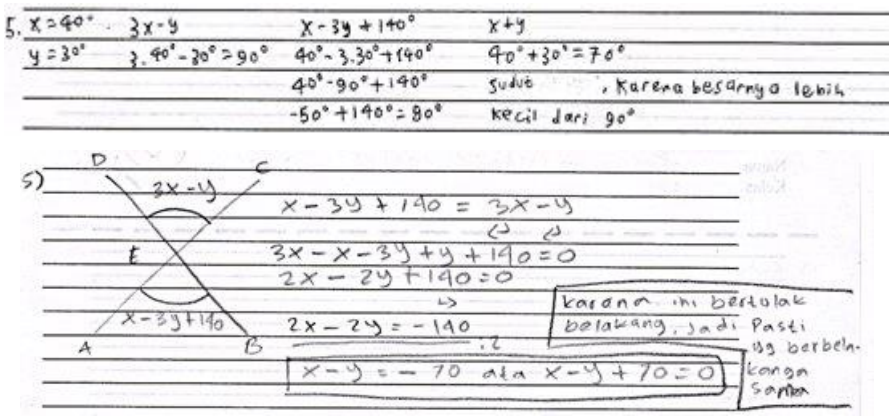

Figure 5. Student Answers to Question Number 5

Based on Figure 5, it can be seen that Student 8 (S8) understands the concepts of integer operations and substitution and understands what is asked in the problem. However, the student's argumentation for his answer became doubtful because there was no proof that the student could get the values of the x and y variables he wrote.

Then Student 9 (S9) answered using the concepts of opposite angles and algebra. However, students need to correct the concepts of integer arithmetic operations, especially negative integers, so that it affects the final answer or conclusion made by students.

In order to explore the findings, the researcher conducted an interview with S8 with the following results:

P : Question number 5, what is asked is the result of x plus y, well how do you do it?

S8 : The thinking is that this angle is 90 degrees, from a right angle. Anyway, I don't know where the 90 came from, because the figure looks like a right angle, but it's not, it's a bit sharp.

P : But have you ever gotten a question like this before?

S8 : No, I haven't, the problem is that usually there is a direct magnitude, not like x and y in this question.

P : Where did you think 90 degrees came from?

S8 : Right-angled. Anyway, this and this are entered into the result so it's 90. The bottom one is also the same, so it's 90. Then I got the result of 70 degrees. So the result of x + y creates an acute angle, because it is less than 90

Based on the interview results, it can be seen that students do not have a strong foundation in determining the values of the x and y variables. Students do use their knowledge of the types of angles and compare them with the figure in the problem, but students themselves doubt their opinion. In addition, students also assume that this type of problem is the first time they have done it. This means that students experience conceptsual ontogenic obstacles in algebraic concepts. Algebra concepts is taught to students when students have just re-experienced face-to-face learning, so the learning process could be more optimal because there is habituation from the transition between online and offline learning. Additionally, students felt that the algebra concepts taught then were too many and took a lot of time. So that students are overwhelmed in learning algebra concepts. Obstacles in algebra can occur due to incorrect use of the concepts of algebraic addition or subtraction, student inaccuracy in calculating variable values, as well as difficulty in connecting the values of two different variables through substitution (Khatimah et al., 2017; Siagian et al., 2017). As for students' understanding of algebra, that is incorrect, namely the concepts of "moving segments". According to Laja (2020), teachers and students should use steps justified in mathematics based on proper solution rules so that students can think mathematically and correctly, even though other ways are faster and can be used as alternatives.

The interview was also conducted to S9 with the following results:

P : Now to number 5, what are your thoughts?

S9 : The angle is opposite, then when I watched the video that was given to me, it said to use a linear equation of one variable, so I didn't think of anything else, so I just used this.

P : But what is the question asking about?

S9 : The sum of x and y

P : But can you find it?

S9 : I don't know, I don't really understand.

P : Then what does this mean about the equation, what is your thinking?

S9 : This is the same size, this angle is equal to this, so this is moved to the left, the min and plus are changed, so it's like this, and then the same is divided, so it's like this.

P : But before in class have you ever met a problem like this?

S9 : No, not yet, most of them are like this, but each angle has a number, but not like this.

Based on the results of the interview, it can be seen that although students doubt their knowledge, their arguments have a strong basis. The process is also correct and in accordance with what is asked in the question. However, because the student made mistakes in integer calculation operations, the student could not reach the expected conclusion in the problem.

The interview conducted with the teacher showed the following results:

P : If I may ask, why do you think students can experience learning obstacles in angle concepts?

G : Maybe the basics are also lacking, such as addition-subtraction of whole numbers, it is still difficult. Multiplication is also lacking, some students still need a long time to count, they cannot answer immediately.

The interview results with the teacher show that students experience obstacles in angle concepts. This is because students' mastery of prerequisite concepts is still lacking, especially in multiplication and integer operations. This means that students experience conceptsual ontogeny obstacles. This obstacle relates to prerequisite concepts, and students need to read more for previous learning experiences (Suryadi, 2019). Students need a long time to perform multiplication operations, which will interfere with the learning process. Nurhidayah and Maya (2021) explained that students who do not understand the concepts in mathematics will have difficulty understanding the next concepts, so it is important for students to master the prerequisite concepts in mathematics. Moreover, students also experience obstacles in integer operations, especially negative integers. These obstacles can occur if students cannot operate integer operations and order negative integers (Malau et al., 2021; Zuhriawan et al., 2023). This can cause errors in calculations and affect the results obtained by students.

Then problem number 6 is related to the modified angle concepts to relate to the triangle angle concepts and one variable algebraic operation. Students are asked to determine the measure of an angle of a triangle with one of the longer sides, with several known angles in the form of one variable algebra. The following are the results of student answers:

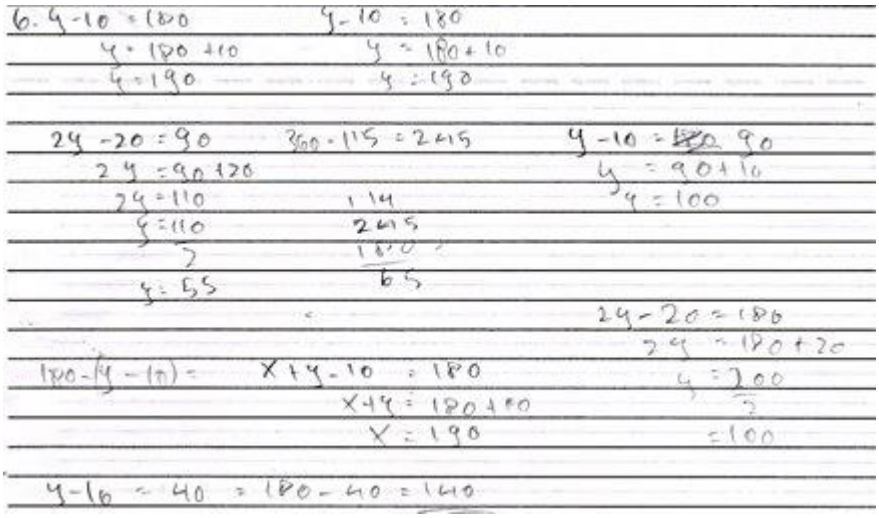

Figure 6. Student Answers to Question Number 6

Figure 6 shows how student 10 (S10) answered with various possibilities, so that the solution process he did could not be seen clearly. At first glance students appear to involve algebraic concepts, but there is no reason or argumentation underlying their understanding. Students also did not appear to connect the solution process with triangle concepts.

In order to deepen the findings, the researcher conducted an interview with S10 with the following results:

P : For number 6, what is your thought?

S10 : So I tried several formulas, but obviously that one is correct. so what was asked was the ACD angle, that's why I thought of calculating first from the ACB angle, then the ACD angle minus ACB equals 180, but it was wrong.

P : Where did you write it first?

S10 : From here, then I tried it wrong, finally I was sure of this one.

P : Where is 40 from?

S10 : This is from the ACB, fortunately I use the protractor. That's why it can be directly subtracted

Based on the interview results, students have been able to map their understanding so that what is known and asked is clear. However, students use a protractor to find the required angle instead of connecting it with triangle concepts. Although students understand angles, the selection of students' problem-solving methods is less precise and not in accordance with the instructions in the problem. So, it seems that students experience conceptsual ontogenic obstacles in triangle concepts. In their research, Sumiati and Agustini (2020) show that students have difficulty solving problems on triangle concepts due to a wrong view of mathematics, lack of curiosity, and lack of student understanding skills. Students also experience ontogenic and

epistemological obstacles in the triangle (Hidayat et al., 2019; Lutfi et al., 2021), and this can affect students' understanding in angles.

CONCLUSION

Based on the analysis that has been done, it is found that students experience learning obstacles in angle concepts. The learning obstacles experienced by students, such as: a) instrumental ontogenic obstacles, caused by students not being accustomed to facing difficult problems; b) conceptsual ontogenic obstacles, caused by low mastery of pre-math concepts, in the form of multiplication operations, integer operations, algebra, and triangles; c) psychological ontogenic obstacles, caused by low student interest in learning; d) epistemological obstacles, caused by low mastery of angle concepts, in the form of angle measurement concepts and types of angles. This research has limitations, so the research can be continued to overcome the learning barriers experienced by students. Didactical design research (DDR) can be conducted as a follow-up.

REFERENCES

Amany, D. A. L., & Puteri, A. A. I. (2023). Analysis of The Relationship Between Student Interest and Written Communication in Solving Realistic Mathematics Problems. *Delta-Phi: Jurnal Pendidikan Matematika*, *1*(1), 31–42.

Annisa, A. M., Suryadi, D., & Rosjanuardi, R. (2018). *Design Development of Determinant Lines Concepts and Angles on Math Learning for Junior High School*. *160*, 1–9.

Azmidar, A., Darhim, D., & Dahlan, J. A. (2017). Enhancing Students' Interest through Mathematics Learning. *Journal of Physics: Conference Series*, *895*(1).

Barabash, M. (2017). Angle concepts: a high school and tertiary longitudinal perspective to minimize obstacles. *Teaching Mathematics and Its Applications: International Journal of the IMA*, *36*(1), 31–35.

Biber, Ç., Tuna, A., & Korkmaz, S. (2013). The Mistakes and The Misconceptsions of The Eighth Grade Students on The Subject of Angles. *European Journal of Science and Mathematics Education*, *1*(2), 50–59.

Brousseau, G. (2002). Epistemological Obstacles, Problems, and Didactical Engineering. In V. W. Nicolas Balacheff, Martin Cooper, Rosamund Sutherland (Ed.), *Theory of Didactical Situations in Mathematics* (1st ed., Vol. 19). Springer Dordrecht.

Butuner, S. Ö. (2021). The Concepts of Angle in Turkish and Singaporean Primary School Mathematics Textbooks: Dynamic or Static? *International Online Journal of Primary Education*, *10*(1), 89–105.

Bütüner, S. Ö., & Filiz, M. (2017). International Journal of Mathematical Education in Exploring high-achieving sixth grade students ' erroneous answers and misconceptsions on the angle concepts. *International Journal of Mathematical Education in Science and Technology*, *48*(4), 533–554.

Crompton, H. (2015). Understanding angle and angle measure: A design-based research study using context aware ubiquitous learning. *International Journal for Technology in Mathematics Education*, *22*(1), 19–30.

Devichi, C., & Munier, V. (2013). About the concepts of angle in elementary school: Misconceptsions and teaching sequences. *The Journal of Mathematical Behavior*, *32*(1), 1–19.

Fajriah, N. (2015). Kriteria berpikir geometris siswa Sekolah Menengah Pertama (SMP) dalam menyelesaikan masalah geometri. *Math Didactic: Jurnal Pendidikan Matematika*, *1*(2), 110–115.

Faradisa, M. (2019). Penggunaan Aplikasi Geogebra pada Pembelajaran Matematika Materi Poligon dan Sudut Sebagai Sarana Meningkatkan Kemampuan Siswa. *Jurnal Equation: Teori Dan Penelitian Pendidikan Matematika*, *1*(2), 166–172.

Farida, N. (2015). Analisis Kesalahan Siswa SMP Kelas VIII dalam Menyelesaikan Masalah Soal Cerita Matematika. *Aksioma: Journal of Mathematics Education*, *4*(2), 42–52.

Fitri, A., & Abadi, A. M. (2021). Kesulitan siswa SMA dalam menyelesaikan soal matematika pada materi peluang. *Jurnal Riset Pendidikan Matematika*, *8*(1), 96–105.

Hidayat, C. R., Rosjanuardi, R., & Juandi, D. (2019). Epistemological obstacle on the topic of triangle and quadrilateral. *Journal of Physics: Conference Series*, *1157*(4).

Jatisunda, M. G., Suryadi, D., & Prabawanto, S. (2021). Development of competencies for teaching geometry through an analysis learning obstacle. *Journal of Physics: Conference Series*, *1806*(1).

Khatimah, K., Sa'dijah, C., & Susanto, H. (2017). Pemberian scaffolding untuk mengatasi hambatan berpikir siswa dalam memecahkan masalah aljabar. *Jurnal Kajian Pembelajaran Matematika VOLUME*, *1*(1), 36–45.

Komala, E., Suryadi, D., & Dasari, D. (2020). Learning Obstacle Related to the Ability of High School Student Representation to the Trigonometry Concepts. *The 2nd International Conference and Innovation Exhibiti on Global Education (ICEGE)*, 43–49.

Laja, Y. P. W. (2020). Sebuah Studi Fenomenologi Mengenai Aturan Pindah Ruas Dalam Menyelesaikan Persamaan Linear Matematika. *Mandalika Mathematics and Educations Journal*, *2*(1), 10–20.

Lestari, I. (2015). Pengaruh Waktu Belajar dan Minat Belajar terhadap Hasil Belajar Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *3*(2), 115–125.

Lopes, A. P. C. (2022). Aspects of attitudes towards mathematics in modeling activities: Usefulness, interest, and social roles of mathematics. *International Electronic Journal of Mathematics Education*, *17*(4), em0711.

Lutfi, M. K., Juandi, D., & Jupri, A. (2021). Students' ontogenic obstacle on the topic of triangle and quadrilateral. *Journal of Physics: Conference Series*, *1806*(1).

Makgopela, P. M. (2010). *The Teachers' Perceptions in Making Connections between Mathematics and Everyday Life Experiences*. North West University Mafikeng Campus.

Malau, S., Sugilar, & Yumiati. (2021). Analisis Hambatan Belajar Operasi Bilangan Bulat (Studi Kasus Pada Kelas VII SMP Katolik ST Paulus Palangka Raya). *Jurnal Pendidikan*, *22*(2), 116–129.

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2015). *TIMSS 2015 International Results in Mathematics*. Chesnut Hills, MA:TIMSS & PIRLS International Study Center, Boston College.

Musthofa, P. R., & Sujadi, I. (2020). The students' perception of the teacher's apperception and its influence on students' initial knowledge. *Journal of Physics: Conference Series*, *1465*(1).

Nurhidayah, D. F., & Maya, R. (2021). Penggunaan kriteria watson untuk menganalisis kesalahan siswa dalam menyelesaikan soal materi garis dan sudut. *Jurnal Pembelajaran Matematika Inovatif*, *4*(6), 1473–1480.

Nurhudha, R. A., Riyadi, R., & Subanti, S. (2022). Analysis of Mathematical Connection Abilities in the Seventh Grade Students of SMP Muhammadiyah Pakem in Solving Line and Angle Question. *Proceedings of the Soedirman International Conference on Mathematics and Applied Sciences (SICOMAS 2021)*, *5*(Sicomas 2021), 50–53.

Nursafitri, A. D., & Anriani, N. (2023). The Effect of Learning Science, Technology, Engineering, and Mathematics (STEM) on the Ability to Understand the Concepts Concepts of Lines and Angles. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, *7*(1), 45–56.

Ozen Unal, D., & Urun, O. (2021). Sixth Grade Students' Some Difficulties and Misconceptsions on Angle Concepts. *Journal of Qualitative Research in Education*, *27*, 125–154.

Özerem, A. (2012). Misconceptsions In Geometry And Suggested Solutions For Seventh Grade Students. *Procedia - Social and Behavioral Sciences*, *55*, 720–729.

Pachemska, T. A., Gunova, V., & Lazarova, L. K. (2016). Visualization of the Geometry Problems in Primary Math Education (Needs and Challenges). *Istrazivanje Matematickog Obrazovanja*, *8*(15), 33–37.

Perbowo, K. S., & Anjarwati, R. (2017). Analysis of Students' Learning Obstacles on Learning Invers Function Concepts. *Infinity Journal of Mathematics Education*, *6*(2), 169–176.

Piu, A., Fregola, C., & Santoro, A. (2021). Using a simulation game to make learning about angles meaningful. an exploratory study in primary school. *European Journal of Science and Mathematics Education*, *4*(4), 490–500.

Pudjono, M. (2015). Teori-teori kelupaan. *Buletin Psikologi*, *16*(2), 89–93.

Qomariyah, S. H. (2022). *Hambatan epistemologi siswa dalam menyelesaikan soal cerita*

materi segitiga. Universitas Islam Sultan Agung.

Rahmani, N. D. (2021). *Hambatan Belajar Siswa SMP Kelas VII pada Materi Garis dan Sudut dalam Pembelajaran Daring*. Universitas Pendidikan Indonesia.

Sarı, M. H., Tertemiz, N. I., & Demirci, N. (2021). A Study on 5th Grade Students' Achievement Levels and Misconceptsions in the Concepts of Angle. *International Journal of Progressive Education*, *17*(1), 338–356.

Setiadi, D. R., Suryadi, D., & Mulyana, E. (2017). Didactical Design Enrichment of Angle in Geometry. *Journal of Physics: Conference Series*, *895*(1).

Siagian, R. M. B., Halini, H., & Hamdani, H. (2017). Hambatan Koneksi Matematis Siswa Dalam Materi Operasi Hitung Ekspresi Aljabar Di Smp. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa (JPPK)*, *6*(12), 1–7.

Sidik, G. S., Suryadi, D., & Turmudi, T. (2021). Learning Obstacle on Addition and Subtraction of Primary School Students: Analysis of Algebraic Thinking. *Education Research International*.

Sirait, E. D. (2016). Pengaruh Minat Belajar Terhadap Prestasi Belajar Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *6*(1), 35–43.

Sumiati, A., & Agustini, Y. (2020). Analisis Kesulitan Menyelesaikan Soal Segi Empat dan Segitiga Siswa SMP Kelas VIII di Cianjur. *Jurnal Cendekia*, *04*(01), 321–330.

Suryadi, D. (2019). *Penelitian Desain Didaktis (DDR) dan Implementasinya*. Gapura Press.

Susilowati, N. (2017). *Analisis Hambatan Berpikir Kritis Siswa dalam Menyelesaikan Soal Materi Garis dan Sudut Berdasarkan Teori Bruner*. Universitas Islam Sultan Agung.

Tallman, M. A., & Frank, K. M. (2020). Angle measure, quantitative reasoning, and instructional coherence: an examination of the role of mathematical ways of thinking as a component of teachers' knowledge base. *Journal of Mathematics Teacher Education*, *23*(1), 69–95.

Umardiyah, F., & Handhayani, A. N. (2022). Development of Concepts Mapping as Optimizing Apperception of Learning for Social Arithmetic Concepts. *Application: Applied Science in Learning Research*, *2*(1), 14–18.

Utari, D. R., Wardana, M. Y. S., & Damayani, A. T. (2019). Analisis Kesulitan Belajar Matematika dalam Menyelesaikan Soal Cerita. *Jurnal Ilmiah Sekolah Dasar*, *3*(4), 534–540.

Yadrika, G., Amelia, S., Roza, Y., & Maimunah. (2019). Analisis Kesalahan Siswa SMP dalam Menyelesaikan Soalpada Materi Teorema Pythagoras dan Lingkaran. *JPPM (Jurnal Penelitian Dan Pembelajaran Matematika)*, *12*(2), 195–212.

Yan, K., Deng, H., & Huang, Z. (2020). Evaluation of Lesson Study on Lines and Angles. *Journal on Education*, *3*(01), 42–50.

Zahara, S. R. (2017). Perbedaan Prestasi Belajar Fisika antara Siswa yang Berasal dari SMP dan MTs pada Madrasah Aliyah Darussyari'ah Mesjid Raya Baiturrahman Banda Aceh. *Jurnal Dedikasi*, *1*(2), 116–123.

Zuhriawan, M. Q., Nasrulloh, M. F., Satiti, W. S., & Umardiyah, F. (2023). Trends in Class VI Students ' Thinking in Understanding Negative Integer Number Through Number Lines. *Application: Applied Science in Learning Research*, *2*(3), 121–126.