Nineth Grade Students Mistakes when Solving Congruence and Similarity Problem

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Abstract. This research aims to know the difficulty level and the difficulties faced by students on congruent and similar problems. The test is taken from students’ mid-semester exam in March 2021. Students’ learning condition is under the coronavirus pandemic. This research uses a mix-method to process its data which are the qualitative and quantitative methods. The quantitative method is used to analyze the difficulty level and the qualitative method will explain the difficulties faced by students when solving congruent and similar problems. There are 9 questions given in this research that consists of 8 visual problems and one combined problem. The difficulties of the problems are four questions with easy difficulty and five questions with medium difficulty. The sample of this research is 61 9th grade students from SPMN 47, Bandung, Indonesia. The data is taken by using the google platform. The second data will be taken from teachers’ interview results following the analysis of students’ difficulties when solving congruent and similarity problems. The test result average is 64.77 and teachers’ interview result shows that the poor test result is because teachers are not prepared with the teaching condition during the coronavirus pandemic. A recommendation for teachers is that they can improve their ability by integrating technology in mathematics.

1. Introduction
Geometricaly has a strong relationship with daily life and is often used to solve our daily problems[1], [2]. Geometry can also improve abstract thinking ability and change abstract shapes into concrete shapes [3]. Geometry plays an important role in improving students’ mathematical ability and strongly relates to high-order thinking skills [4]. Congruence and similarity are one of the geometry theories and it trains students’ spatial, mathematical connection, and mathematical proving ability.

A congruent figure is a figure that has the same shape and size [5]. A congruent triangle is a triangle that has the same shape and size. If we can show that a figure is congruent, we know that the sides, angles, and area are the same [6]. There are five theorems incongruent and similarity, and it can be seen in table 1.

This paper has two main aims: to analyze the difficulty level of congruent and similarity problems for 9th-grade students in Bandung, Indonesia, and to investigate 9th-grade students’ ability and difficulties when solving congruent and similarity problems. There has been no research that analyzes
students’ ability and difficulties on congruent and similarity, but congruent and similarity are important geometry concepts for students. This research’s result can serve as an evaluation for teachers when making lesson plans, help students to improve their mathematical ability, and minimize students’ errors on congruent and similarity.

Table 1. Congruent and Similarity Theorem [7]

| Theorem | Figures | Explanation |
|---------|---------|-------------|
| 1       | ![SSS](image) | All three pairs of corresponding sides are equal. |
| 2       | ![ASA](image) | Two pairs of corresponding angles and the corresponding sides between them are equal |
| 3       | ![RHS](image) | The pair of hypotenuses and another pair of corresponding sides are equal in two right triangles |
| 4       | ![SAS](image) | Two pairs of corresponding sides and the corresponding angles between them are equal |
| 5       | ![AAS](image) | Two pairs of corresponding angles and one pair of corresponding sides (not between the angles) are equal |
2. Method
This research uses a descriptive qualitative to investigate students’ ability on congruent and similarity. Sample students are taken from SMPN 47 Bandung, Indonesia in March 2021. Teachers gave 9 questions on congruent sub-topic to 9th-grade students. The mid-semester questions can be seen in table 2. These Figures taken from erlangga publisher mathematics textbook[8]. When this research was done, students are still using online learning methods, which is why this research might be affected by the problems that occur during the coronavirus pandemic in Indonesia. There are 61 9th-grade students in this research of which 34 are male students and 26 of them are female students.

Table 2. Mid-semester questions on Congruent and Similarity

| No | Question |
|----|----------|
| 1  | Which figure below shows a pair of congruent figures? |
|    | ![Figure 1](image1.png) |
|    | (i) ![Figure 2](image2.png) |
|    | (ii) ![Figure 3](image3.png) |
|    | (iii) ![Figure 4](image4.png) |
|    | (iv) ![Figure 5](image5.png) |
| 2  | Study the figure below |
|    | ![Figure 6](image6.png) |
|    | It is known that $\triangle PQR \cong \triangle KLM$ and $\angle PQR = 30^\circ$, what is the length of KL? |
| 3  | Study the figure below |
|    | ![Figure 7](image7.png) |
|    | The trapezium above is a congruent figure. AD = 12 cm, DC = 13 cm, dan EF = 22 cm find the length of EH |
| 4  | How many congruent triangles are present in the figure below? |
5. Which criteria can prove that the figure below is a congruent triangle figure?

![Figure](image1.png)

6. Trapezium ABCD is congruent to trapezium RSPQ. What is the length of x+y?

![Figure](image2.png)

7. Study the figure below.

What is the length of EF?

![Figure](image3.png)

8. Study the figure below.

What is the length of KL?

![Figure](image4.png)

9. In the figure below, a cane PQ has a length of 4 meters and the length of its shadow is 15 meters. If the tree’s shadow length is 30 meters, how tall is the tree?

![Figure](image5.png)
Teachers gave nine questions on congruence and similarity using the google platform and students are required to finish answering in 45 minutes. When students solve the question, they are required to open their zoom meeting so that the exam is supervised to avoid students cheating. After researchers collected students’ answers, they analyzed their answers and concluded the students’ ability on congruent and similarity.

Students’ answers were processed to know the difficulty level of each question, students’ difficulty when answering each question, and analyze why students make mistakes when solving congruent and similar questions. In the final stage, researchers will interview teachers to evaluate the teaching-learning process on congruent and similarity.

Table 3 showed the criteria to interpret the question’s difficulty level. a good test is a test that is according to the students’ ability. Not too difficult but also not too easy. Tests consist of questions with medium difficulty levels and insert some questions with hard and easy difficulty levels.

Table 3. Question’s difficulty level criteria

| Difficulty Index | Difficulty category |
|------------------|---------------------|
| 0.70 < IK < 1.00  | Hard                |
| 0.30 < IK < 0.69  | Medium              |
| 0.00 < IK < 0.29  | Easy                |

3. Results and Discussion
The average test score of 61 9th grade students is 64.77, and it’s still below the average as the passing score is 70. From a total of 61 students, 30 students did not pass. From figure 1, we can see that question 4 and 5 has the lowest average score. Question 4 is a combination question to see if students have already mastered every concept about congruent shape and analyze students’ visual ability and their precision when answering the question. From question 4, researchers found the 2 biggest factors why students did not get the correct answer and the two factors were students were not thorough when answering the question and they did not master the concept of congruence and similarity so students don’t know characteristics of congruent figures.

Mathematics questions can be in visual, pure mathematics, verbal and combined form [9]. Students need to get used to solving various forms of mathematics questions this way they will not face difficulties when teachers change the question form. The analysis result on the difficulties faced by students can be seen in table 4. From this, we can see that question 4 and 5 is in the medium-difficult level. Teachers did not give a difficult level question because the learning condition is ineffective due to the coronavirus pandemic.

Table 4. Questions difficulty index

| Question number | Contextual features | Representation forms | Difficulty index | Interpretation |
|-----------------|---------------------|----------------------|------------------|----------------|
| 1               | Application         | Visual               | 0.21             | Easy           |
| 2               | Non-application     | Visual               | 0.30             | Medium         |
| 3               | Non-application     | Visual               | 0.28             | Easy           |
| 4               | Non-application     | Visual               | 0.46             | Medium         |
| 5               | Non-application     | Visual               | 0.48             | Medium         |
| 6               | Non-application     | Visual               | 0.23             | Easy           |
| 7               | Non-application     | Visual               | 0.33             | Medium         |
| 8               | Non-application     | Visual               | 0.36             | Medium         |
| 9               | Application         | Combined             | 0.18             | Easy           |
Based on the analysis result, researchers found out 5 factors that became students’ mistakes (Table 5). The biggest factor is that students did not master the basic concept of congruent. Researchers see that students did not master the congruent concept because teachers did not focus on discussing the meaning of congruent and similar figures. During the online class that uses google meetings, researchers see that teachers only use PowerPoint to explain the meaning of congruent shapes. This coronavirus pandemic has made learning not active as learning activity becomes a one-way communication. The bad internet connection has also made students unable to hear clearly when the teacher is explaining congruent shapes. De Porter’s research [10], [11] stated that students can apprehend information better when doing mathematics proving experiments. Researchers also stated that students’ learning interest will increase, making students absorb the information better. Teachers can make video-based learning media during the pandemic to help students review the lesson after class [12]–[14]. A video-based learning media has been proven to be able to improve student's learning achievement and mathematical ability [15], [16].

Table 5. Questions difficulty index

| No | Factors                                      | Number of students | Percentage |
|----|----------------------------------------------|--------------------|------------|
| 1  | Did not master the congruent concept         | 44                 | 72.13%     |
| 2  | Made mistake in calculation                  | 21                 | 34.42%     |
| 3  | Careless                                     | 14                 | 22.95%     |
| 4  | Not used to solving questions in visual form | 39                 | 63.93%     |
| 5  | Not used to solving questions in word problem form | 20     | 32.79%     |

From the analysis result in table 5 with the research done, students’ difficulties on congruent and similarity are that they did not master the basic concept of congruent [17]. There have been researches that proved that students are not used to various question forms. A recommendation for teachers in school is to focus on mastering the basic concept of congruent and similarity and give various questions forms so that students get used to the different questions forms.

From the interview with the teachers, they stated that school has a learning media that can be used to teach congruence and similarity however, it’s still online learning so they were unable to use the learning media. Teachers are also not ready with the online learning situation as the school's facilities and infrastructure still can’t support online learning during this pandemic. The coronavirus pandemic has made teachers realize the importance of mastering Technological Pedagogical Knowledge which is in line with previous research that TPACK is important in education [18], [19].
4. Conclusion
Based on the research result, we can conclude that 9th-grade students still have difficulties in solving congruent shape problems. Students have difficulties because they did not master the concept of congruent figures as teachers did not use learning media to help students understand the basic concept of congruent. Teachers also did not give practice questions with various forms to train students’ problem-solving skills. A recommendation for junior high school teachers is that they can use learning media to explain congruent concepts.

The drawback of this study is that it is done during the coronavirus pandemic, which means that teachers can’t use the usual learning media in school when teaching congruent and similar. Future research can develop a learning media that can help students to master congruent and similarity concepts during the coronavirus pandemic.

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