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Learning Design of Triangle Concept Using Palembang Culture for VII Grade Students

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Abstract

The triangle is still a topic worth discussing because many pupils still want assistance in comprehending the notion of triangles as a whole. The research aims to produce a triangular concept learning design using the Palembang cultural context for VII grade students with augmented reality technology. The research subjects comprised 19 students from Class VII of Al-Azhar 33 Islamic Middle School in Palembang. The method used is design research, divided into preparing for the experiment, and design experiment, divided into two cycles, namely pilot experiments and teaching experiments, and finally, retrospective analysis. The data in this research was collected by observation, interview, documentation, and test. The instruments used in this research are video and field notes for observation and interview, LAS for documentation, and post-test for test. The data analysis technique is descriptive qualitative. The final result of this study is Local Instruction Theory (LIT) which contains the learning process in 4 activities, namely describing the triangles of the Musi 6 Bridge, identifying the properties of triangles based on side lengths, identifying the properties of triangles based on the size of the angles and solving problems related to the properties of triangles based on the length of the sides and the size of the angles. The results show that the cultural defined context can be used as a reference point in triangle material in class VII SMP.

Keywords: triangle; design research; local instruction theory; ethnomathematics

I. Introduction

Geometry is a branch of mathematics that students are familiar with, such as lines, planes, and space because they are often encountered in everyday life (Özerem, 2012; Sholihah & Afriansyah, 2018). Triangle is a flat shape taught to students since elementary school. Triangle shapes are familiar to students because there are many examples of these shapes in students' daily lives. However, in reality, junior high school students need help learning triangles, a common mistake is to show the number of angles in a triangle (Suryani et al., 2020).

One of the subjects of mathematics taught in class VII of junior high school is the subject of triangular angles; studying the angles of triangles is very important because it relates to other materials in mathematics, especially in geometry (Irsaf, 2015; Suherman, 2011). According to (Hidayah & Fitriani, 2021; Hidayat et al., 2019), there are still many students who experience difficulties with triangle material; these difficulties include understanding triangular concepts and analyzing context problems related to triangles; many factors, including a lack of

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understanding of the material, cause the difficulties faced by students.

The National Assessment of Educational Progress (NAEP) is a nationally representative and ongoing assessment of what students in the United States know and can do in a variety of subjects, including reading, mathematics, science, writing, history, geography, and other fields (Naep, 2012; Solem & Stoltman, 2020). The results of the National Assessment of Educational Progress (NAEP), the nation's leading indicator of what American students know and can do, suggest that students need a better understanding of the formulas (Naep, 2012; Solem & Stoltman, 2020; Witmer et al., 2023). There needs to be a design or learning design that can help students understand and solve problems encountered in the learning process.

Learning Design is a process that is carried out systematically to solve learning problems, improve the quality of learning, or achieve certain learning objectives, which consist of a series of activities for designing learning materials/products, developing and evaluating designs to produce effective and efficient designs (Agustiani & Putri, 2021; Scott et al., 2007). The current era, along with the dynamic pace of science and technology development, demands everyone to pursue these developments, including the world of education (Hardianto, 2005; Jupri et al., 2015; Valencia & Guevara, 2020). With the development of the times and the development of science and technology and this curriculum, teachers must have learning media that are in line. In some research, instructional media can help students understand fractions from informal to formal level (Agustiani & Putri, 2021; Jannah & Prahmana, 2019; Zabeta et al., 2015). Many science and technology-based learning media can be used by teachers in the learning process, including print media, audio-visual technology media, computer-based technology media, and Android-based media that can also be used. This media will later help teachers explain difficult and uninteresting learning for students (Anwar et al., 2019; Astuti et al., 2019). So that it will become interesting with the use of this technology and will be able to achieve the expected core competencies, where one of the expected learning can be applied with teaching aids in the form of this technology later, namely math learning.

Responding to the importance of triangular material, which is part of students' real world, and based on findings of learning difficulties experienced by students in understanding triangular material, it is necessary to develop a learning design rich in context and student learning activities. Besides that, by carrying out various activities in different contexts, students can interpret the material being taught, and being actively involved in the learning process can help students improve their abilities to solve mathematical problems.

Design Research in Topics Triangle In recent years, Design Research in triangular materials has been carried out. Design research conducted by Anwar &; Rofiki resulted in a learning trajectory with 3 activities to draw triangles manually (Anwar & Rofiki, 2018). Another research using Origami to conduct learning activities topics Triangle, one possibility for a setting that can encourage students to take an active part in the learning process is the environment of Origami (Elisyah et al., 2023). In addition, Suryani &; Rofiki researched triangular defense using the Geogebra application (Suryani et al., 2020). Geogebra in learning geometry eases students to comprehend geometry and helps students concretize abstract concepts often found in mathematics (Celen, 2020; Tamam & Dasari, 2021). From these studies, researchers consider it important to utilize applications in triangular learning by designing a series of learning activities (Learning instruction) based on the Geogebra application. In other words, researchers consider it important to utilize applications based on specific learning designs. In this article, the focus discussion is about designing learning instruction theory (LIT) of the topic Triangle using Geogebra.

II. Research Method

This study uses Design Research. This study uses a cyclic (repetitive) process from a learning experiment in the form of a diagram illustrating the idea of the experiment.

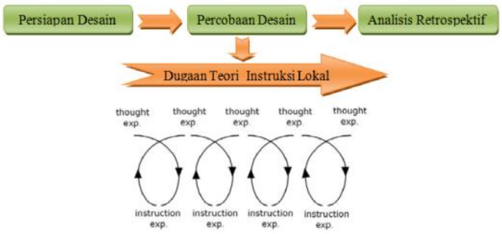

Figure 1. Design research phase
(Akker et al., 2006; Cobb & Gravemeijer, 2021)

The research was conducted at Al-Azhar Islamic Middle School 33 Palembang City, with the research subjects being students of class VII B with a total of 19 students. The procedure carried out in this study went through three stages: preparing for the experiment, designing the experiment, and retrospective analysis (Cobb & Gravemeijer, 2021).

1. Preparing for the experiment

At this stage, a literature review is carried out by studying literature such as journals, articles, and books related to the triangle concept material. During this literature study, the researcher also designed a research instrument. Research instruments, conjectures of students' thinking and strategies, and developing contexts using Palembang Culture were then developed with the Palembang Musi 6 Bridge building functioning as the beginning of the Hypothetical Learning Trajectory (HLT), which will be designed and validated by expert review. A hypothetical learning trajectory is a theoretical paradigm for designing mathematical training; it comprises three parts: a learning goal, a collection of learning tasks, and a hypothesized learning process (M. Simon, 2020; M. A. Simon & Tzur, 2004).

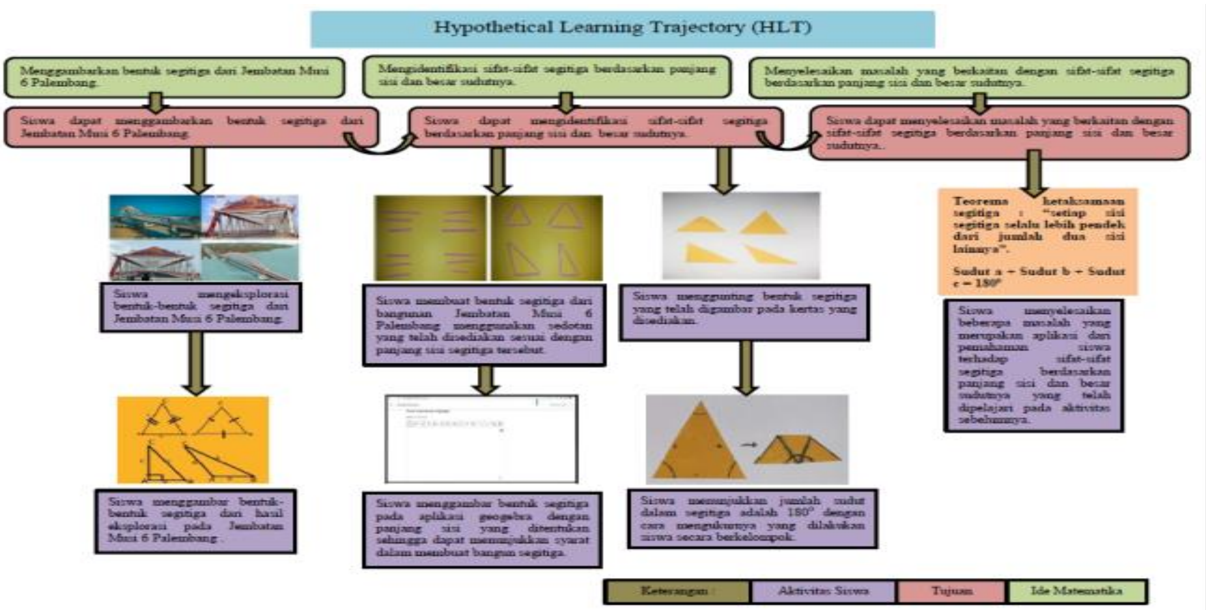

Figure 2. HLT after expert review

Learning indicators selected by researchers based on the basic competency to be achieved, students can describe the triangular shape of the Palembang Musi 6 Bridge, and students can identify the properties of triangles based on the length of the sides and the size of the angles. Students can solve problems related to the properties of triangles based on the length of the sides and the size of the angles.

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The use of the Palembang cultural context, in this case, the Palembang Musi 6 Bridge, apart from helping to attract students' understanding of the triangle concept, is also expected to make students familiar with what Palembang culture is and be able to maintain and preserve it.

2. Design experiment

In the second stage, a teaching experiment was carried out. According to (Akker et al., 2006), the teaching experiment aims to test and improve the Hypothetical Learning Trajectory (HLT) conjecture developed in the early stages and to develop an understanding of how it works. This teaching research aims to collect data to answer the research questions. So, at this stage, the activities made in the early stages are carried out through two cycles. The first cycle was carried out as a pilot experiment; the aim was to adjust both the content and sequence of activities that had been developed and improve them to get a better HLT design for the next cycle. Furthermore, the next cycle, namely teaching experiments, is carried out as an actual teaching process where the sequence of activities is carried out in the classroom. At this stage, it prioritizes data collection regarding the implementation of HLT and data from student responses in each sequence of activities carried out as material for compiling local instructional theory.

3. Retrospective analysis

Retrospective analysis is studying the entire data set to contribute to developing a local instructional theory and (improvement of) the interpretative framework (Cobb & Gravemeijer, 2021; McKenney et al., 2006). At this stage, HLT is used as a guideline and reference point in analyzing all data collected during the teaching experiments at the experiment design stage. This HLT is compared with the actual theory and student learning processes in the classroom. The analysis was described in terms of both occurrences that supported and refuted the conjecture. The findings of this analysis served as the responses to the research questions. The major result is not primarily a working design but rather the rationales for how it works (Bustang et al., 2013; Cobb & Gravemeijer, 2021). This conclusion and analysis are used to answer the research problem formulation.

III. Results and Discussion

The ongoing learning process consists of several learning activities before carrying out activities which are called initial ability tests to determine students' understanding abilities. The following activities have been carried out in the learning process.

a. Activity 1

Figure 3. Students pay attention to the building of the Musi 6 Palembang Bridge

This activity aims to make students able to describe the triangular shape of the context used, namely the Musi 6 Palembang Bridge. Students are asked to scan the barcode provided on the activity sheet. Then students observe augmented reality which displays a video of the building of the Musi 6 Palembang Bridge to explore the flat triangular shapes on the bridge so that students can describe what triangular shapes are on the Musi 6 Palembang Bridge.

Based on the results of student work, all groups completed Activity 1 well. In the first question, students are asked to name what buildings are in the augmented reality video, and the second question, students are asked to mention what flat shapes are in the building. All groups can answer the question correctly.

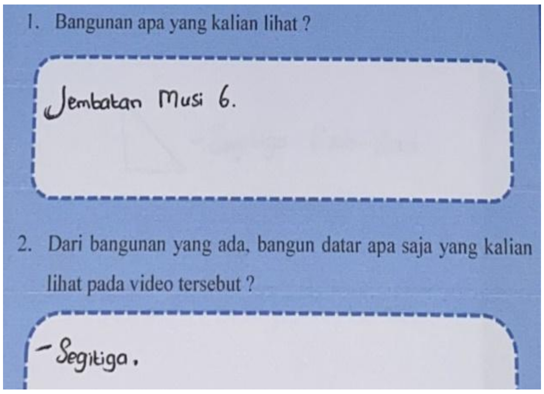
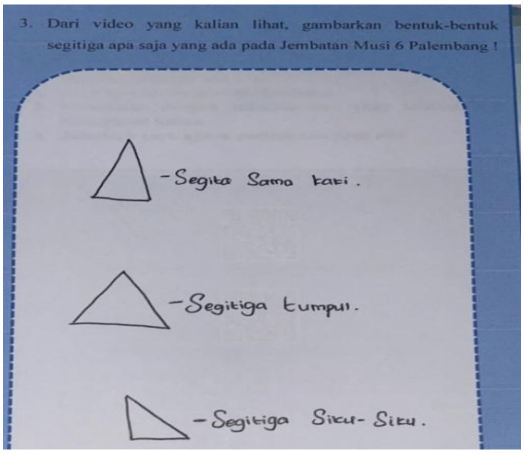


Figure 4. Group 5 student answers activity 1 questions 1 and 2

In the third question, all groups of students were asked to describe any triangular shapes on the Musi 6 Palembang Bridge; in this question, all groups could describe the triangular shapes from the results of paying attention to augmented reality in activity 1.



Group 5 Student answers activity 1 problem 3

b. Activity 2

In activity 2, students are introduced to how to make a triangle based on the side lengths. The purpose of this second activity is for students to identify the properties of a triangle based on the length of its sides. Students try to make triangular shapes from the Musi 6 Palembang Bridge using straws provided by the researcher,


Figure 6. Students make triangles using straw

In this activity, four groups of students were able to follow it properly and correctly, one group still needed to be corrected in making a triangle based on the side lengths, and group 5 still needed clarification in making a triangle shape based on the side lengths.

The following is the conversation that took place between the teacher and Group 5 in the learning process:

L1 Teacher: "Why do you think these three straws can be made into triangles? (the teacher points to the straws students use, namely those with side lengths of 5, 7, and 12 cm)."

L2 Student: "*Karno sedotan ini biso dibuat jadi bentuk segitiga*."
(Because the three existing straws can form a triangle).

L3 Teacher: "Okay, now let us see if all the sides meet at each end?"

L4 Student: "*idak bu*."
(No, ma'am)

L5 Teacher: "What if you say that the triangle is formed from three sides that unite or meet at each end of the side."

L6 Student: " *Kalau cakitu berarti sedotan ini dak biso dibentuk jadi segitiga, karno ujung sedotannyo dak biso ketemu sampe ujung ketigo-tigonyo*"
(Then, the straws cannot be formed into a triangle because the ends of the triangles do not meet at each end.)

L7 Teacher: "*Jadi apa jawabannya sekarang?*"

(So, what are your answers now?)

L8 Student: "*Kami sepakat dengan kawan-kawan yang laen men sedotan yang panjangnyo 5,7 dan 12 cm ini dak biso dibentuk jadi segitiga*."
(We agree with our other friends that straws with lengths of 5.7 and 12 cm cannot be formed into triangles)

After a conversation between the teacher and the students, it can be seen that the students have overcome their confusion in making triangles based on the length of the sides using straws. Students' understanding can be seen from students' answers at L6 and L8, and group 5 students agree with the answers from the other four groups.

Then in the next activity, students scan the barcode on activity sheet 2; students pay attention to augmented reality which displays worksheets on GeoGebra Students complete all activities on GeoGebra to answer questions on student activity sheets.

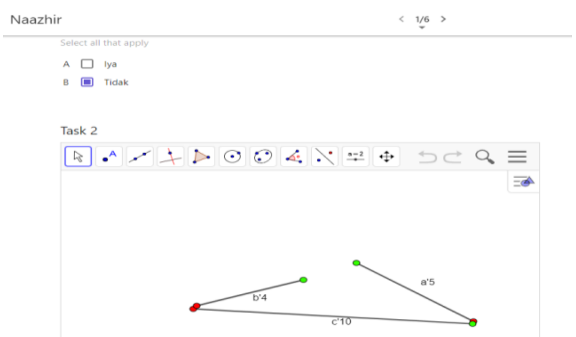


Figure 7. Students make triangles using GeoGebra

In the first question, students were asked to make a triangle from three straws with different lengths, 4 cm, 3 cm, and 9 cm. All of the group students answered that they could make an appropriate triangle. See Figure 8 below.

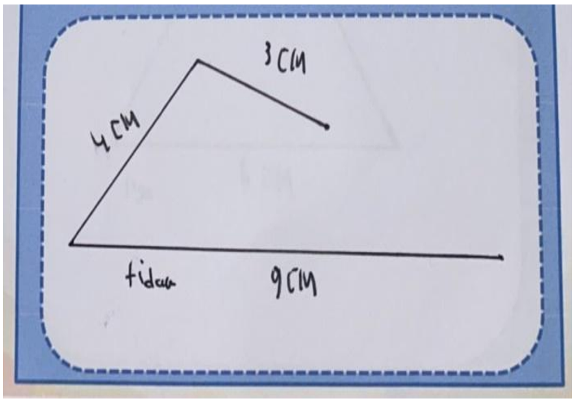


Figure 8. Group 1 student answers activity 2 problem 1

In the second question, "From problem two, there are three straws with different lengths, straws a = 6 cm, straws b = 6 cm, and straws c = 6 cm. Can we make a triangle from straws of different sizes?" Draw on the following sheet!" all groups also answered correctly to this second question, i.e., all groups answered "Yes."

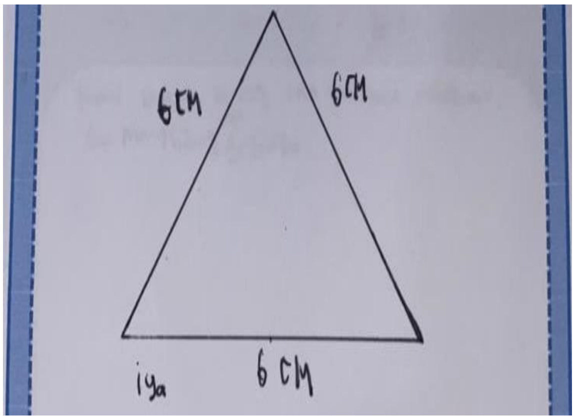


Figure 9. Group 1 student answers activity 2 question 2

The picture above exemplifies the answer to the second question in Activity 2. It can be seen that the group of students answered the questions correctly. Other groups also answered with the same answer as the picture above. From Activity 2, the implementation of this activity can run quite well in the learning process students can already know the properties of triangles based on the lengths of their sides.

c. Activity 3

In activity 3, students are asked to scan the barcode on the student activity sheet; then, students work on the activities on the Geogebra worksheet available in augmented reality. This third activity aims for students to identify triangles' properties based on their angles' size. Students complete all activities on GeoGebra so that students can answer the questions on the activity sheet.

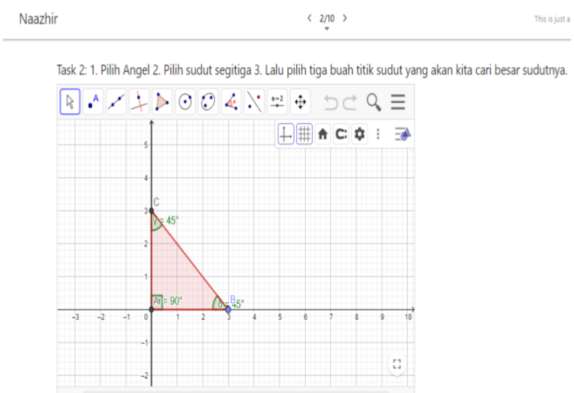


Figure 10. Students determine the size of the angles of a triangle using GeoGebra

After solving the problems in augmented reality, students make a triangle to calculate the number of triangle angles using a protractor so students can find out how many angles a triangle has. Each group can carry out this activity well so students can know that the sum of the angles of a triangle is 180^0.

Figure 11. Students calculate the number of angles using a protractor

To ensure students' understanding, interviews were conducted with students, and the following conversations occurred between the teacher and students during the learning activity process:

L1 Teacher: "How do you know that the sum of the angles of a triangle is 180^0?"

L2 Student: "*Dengan caro ngitung ketigo sudut segitiga makek mistar busur, terus dijumlahkan dan dapat kito ketahui jumlah sudutnyo 180^0*"
(By calculating the three angles in the Triangle using a protractor. It can be seen that the total number of angles in a triangle is 180^0).

To increase students' understanding of the large number of angles of a triangle apart from being seen from students' answers at L2, students are given questions on the student activity sheet. Of the 5 existing groups, four of them answered correctly to the first question, "If it is known that the apex angle of the triangular framework is 40^0, then how big are each of the other two angles?" among them, there were 4 groups that answered the question correctly, namely 70^0. Meanwhile, one other group, namely Group 5, did not answer the question correctly, and they needed to calculate the triangular angles of the problem correctly.

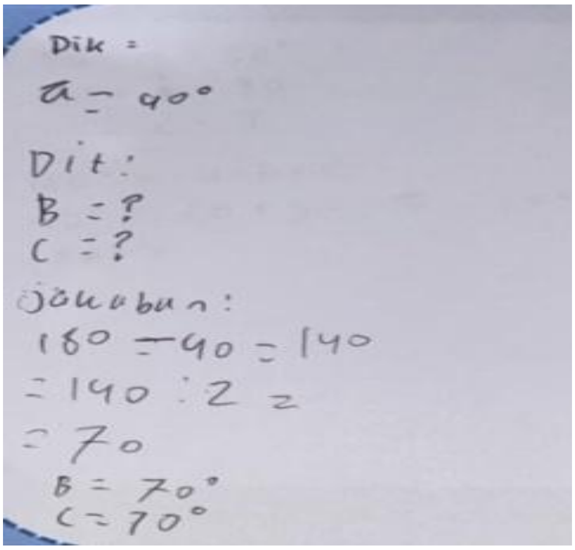


Figure 12. Group 2 student answers to activity 3 problem 1

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For the next question, "If one of the angles of a right triangle has a measure of 500, then how big is the other angle?" the same as the previous question, there were 4 groups who answered correctly, namely 400. Meanwhile, one group answered this question inaccurately, namely group 5; like the previous question, this group needed to be more careful in adding up the triangular angles in the problem. The rest of the students can understand the concept of the sum of the angles of a triangle well. Students can already conclude the results of the activities carried out in activity 3, as shown in Figure 14.

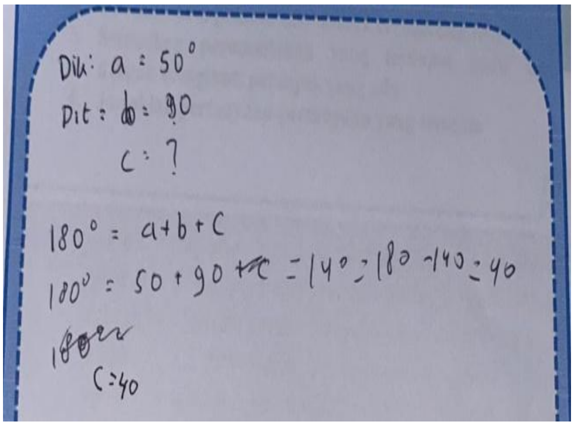

Figure 13. Group 2 student answers activity 3 problem 2

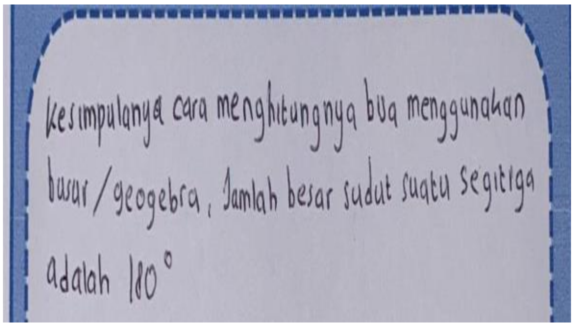

Figure 14. Group 2 student answers activity 3 problem 3

d. Activity 4

In activity 4, students are asked to solve the problems on the student activity sheet, which is an application of students' understanding of activities that have been carried out in previous activities. The purpose of this fourth activity is for students to be able to solve problems related to the properties of triangles based on the length of the sides and the size of the angles. Based on the five questions on the activity sheet, four groups were able to complete them, namely groups 1, 2, 4, and 5, while group 3 needed to complete this activity properly because the learning time had run out. As shown below, students have been able to solve the problems in this activity.

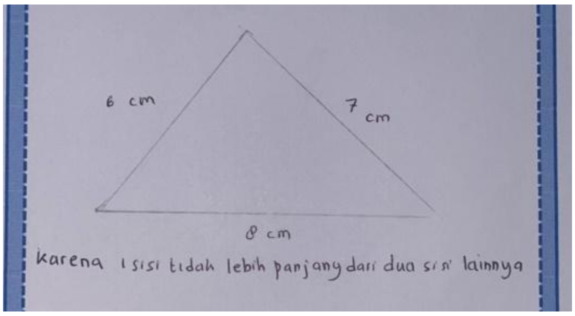

Figure 15. Group 2 student answers activity 4 problem 1

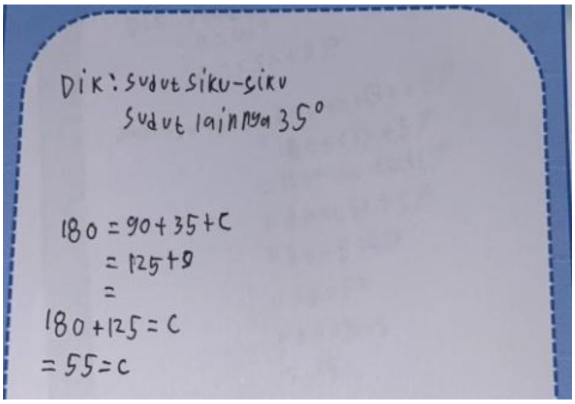

Figure 16. Group 5 student answers to activity 4 problem 3

Based on the answers obtained from the four groups, it can be seen that students have been able to answer the questions correctly; this can be seen in the image below so that students can understand the concept of a triangle based on the length of the sides and the size of the angles.

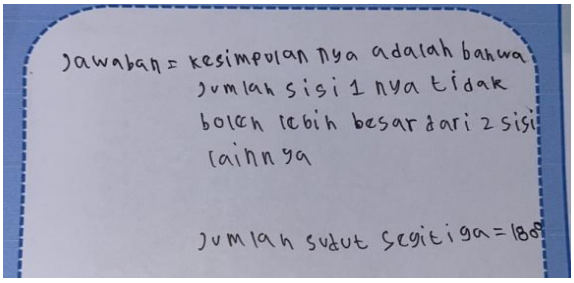

Figure 17. Group 5 student answers to activity 4 problem 5

Based on the learning outcomes that have been carried out, the four learning activities that have been designed can be carried out quite well. This can be seen from the results of observations during the learning process and can also be seen from the results of student work on the activity sheet. The conjecture of students' thinking in the field during the learning process follows the hypothetical learning trajectory design that the researcher designed. From these four activities, students can gradually understand the concept of triangles based on the length of the sides and the size of the angles.

Table 1. Compatibility of HLT RA 1 and ALT

Activity	HLT	ALT
Activity 1 Students pay attention to the AR of the Musi 6 Palembang Bridge building. Students explore the bridge and describe the triangular shape of the Palembang Musi 6 Bridge.	Strategy 1: Students explore the Musi 6 Palembang Bridge building; students can describe the triangular shape of the building. Strategy 2: Students do not explore the Musi 6 Palembang Bridge building; students cannot describe the shape of a triangle. The teacher explains to students that in this activity, students must first explore the Musi 6 Bridge. So that students can describe the triangular shapes found in the building.	All groups of students explore the Musi 6 Palembang Bridge building; students can describe the triangular shape in the Musi 6 Palembang Bridge building.
Activity 2 Students make a triangular shape using a straw. Students pay attention to AR; students make triangular shapes in the GeoGebra application that is in AR. Students answer the questions in the LAS; students can show the conditions for making a triangle based on the length of the side.	Strategy 1: Students make triangles using straws of different sizes. Students make triangular shapes in the GeoGebra application in AR; students can answer questions in LAS and can show conditions for making triangles based on side lengths. Strategy 2: Students need to be corrected in making triangles using straws of different sizes. Students could not draw a triangle because they mistakenly used the straws provided, so students could not answer the questions on the Student Activity Sheet. The teacher gives an understanding to students "that to make a triangle based on the length of its side, that is, one side of the triangle will not be greater than the sum of the other two sides."	Four groups of students can make triangles using straws of different sizes. One group mistakenly made a triangle using straws of different sizes. The teacher gives understanding to group 5 "that to make a triangle based on the length of the sides, that is, one side of the triangle will not be greater than the sum of the other two sides." Students can make triangular shapes in the GeoGebra application in AR, answer questions in LAS, and show conditions for making triangles based on side lengths.
Activity 3 Students pay attention to AR; students solve problems in the	Strategy 1: Students can solve problems in the GeoGebra application in AR.	Students can solve problems in the GeoGebra application in AR. Students make a flat triangle

Activity	HLT	ALT
GeoGebra application in AR. Students construct triangles and calculate the sum of the angles using a protractor. Students answer the questions in LAS; students can show that the angles of a triangle are 180 degrees. .	Students make a flat triangle shape and then calculate the number of angles using a protractor. Students answer the questions in LAS; students can show that the angles of a triangle are 180 degrees. Strategy 2: Students do not measure the angles of the Triangle using the protractor provided. Students cannot determine the number of angles of a triangle. Students cannot show that the angle measure of a triangle is 180 degrees. The teacher gives questions that provoke students' understanding, such as "Can you determine the number of triangle angles if you do not measure them?". The teacher also explains to students that "to calculate the number of angles of a triangle, you have to measure it using a bow so you can find out if each triangle has a total angle of 180 degrees".	shape and then calculate the number of angles using a protractor. Students can show that the angle measure of a triangle is 180 degrees. Four groups of students were able to answer the problems in LAS, and one group had yet to be able to answer questions in LAS systematically.
Activity 4 Students in groups answered the problems in LAS, which were the application of students' understanding of the properties of triangles based on side lengths and angles, which had been studied in the previous activity.	Strategy 1: Students can answer the questions in LAS well and understand problems related to the properties of triangles based on side lengths and angles. Strategy 2: Students can solve the problems on the Student Activity Sheet, but there needs to be a correction in understanding the concept of the properties of a triangle based on the length of the sides and the size of the angles. Then the teacher will again remind students about the concept of the properties of a triangle based on the length of the sides and the size of the angles.	The four groups of students were able to answer the questions in the LAS well and understand problems related to the properties of triangles based on the side lengths and the size of the angles. One group of students could not solve the problems in this fourth activity because the learning time had run out.

Based on the table of suitability of HLT RA 1 and ALT above, it can be seen that the learning design that has been designed can be applied properly during the learning process in the classroom. students thinking strategies were obtained in solving the material properties of triangles based on side lengths and angles. This strategy is the impact of implementing HLT that has been designed and tested at the pilot experiment stage and then revised according to the learning that has occurred to be applied to teaching experiments that produce learning trajectories. As in previous studies that have been studied by researchers, namely research conducted by Fraisa and her team (2015) entitled "Sriwijaya Jakabaring Gelora Stadium in Triangle

Learning" there is the same goal of the resulting LIT but there are differences in the implementation of its activities

Where in the previous research conducted by Fraisa and her team (2015) only went through three stages of activity to achieve the objectives of the designed learning design while in research conducted by researchers using four stages of activity to achieve the objectives of the designed learning design.

In addition, the researcher also looked at how students responded to the use of augmented reality in this study, to be precise in the triangular concept material which also used the Palembang cultural context in the form of the Musi 6 Palembang Bridge on the student activity sheet. The augmented reality used by researchers contained in this student activity sheet is a simple augmented reality, where students can open it by scanning the barcode on the student activity sheet. As stated by Ismayani (2020) that the use of augmented reality in learning will make students more interested in the material being discussed and make it easier to understand the material. This can be seen in the use of AR technology in the learning design that the researchers designed.

IV. Conclusion

Based on the research results and discussion of the research process, a hypothetical learning trajectory (HLT) was produced using the context of the Musi 6 Palembang Bridge with augmented reality technology. The following is the final design consisting of 4 activities.

Activity 1 begins with students observing augmented reality; in AR activity 1, a video shows the Musi 6 Palembang Bridge context. After paying attention to the AR, students were asked to answer the questions on the activity sheet. This activity aims to make students able to describe the triangular shape of the context used, namely the Musi 6 Palembang Bridge.

In the second activity, students will make triangular shapes using straws of various sizes; after that, students are asked to pay attention to augmented reality and solve problems that exist in augmented reality. Namely, students make triangular shapes using the GeoGebra application. Then students were asked to answer the questions on the student activity sheet. The purpose of this second activity is for students to identify the properties of a triangle based on the length of its sides.

In the third activity, students will observe augmented reality and then solve problems in AR, namely determining the angles of triangles using the GeoGebra application. Then students were asked to determine the number of triangular angles using a protractor, after which students answered the questions on the student activity sheet. This third activity aims for students to identify triangles' properties based on their angles' size.

In this fourth activity, students are asked to answer all the questions related to a triangle's side lengths and angles on the activity sheet. The purpose of this fourth activity is for students to be able to solve problems related to the properties of triangles based on the length of the sides and the size of the angles.

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