UNDERSTANDING THE CONCEPT OF ANGLE MEASUREMENT USING MEASUREMENT UNIT

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Abstract

Design research aims to help students' understanding of the concept of angle measurement by using measurement units. This study, using PMRI approach that produces two series of activities that support students to understand the concept of measurement in determining the angle of the angle. Implementation of these activities are designed through three stages: preliminary design, design of experiments and retrospective analysis. The resulting activity includes two activities, ie activities of students by comparing two different angles aims to determine the unit of measurement and using measurement unit for measuring large angles. The study involved 6bstudents in the experimental teaching at SDN 182 Palembang. The results showed that both activities have been carried out in stages, from the informal to the formal stages which help the students to understand the concept of measurement in determining the angle of the angle. From these results, it looks way answers the students understand the concepts used in the measurement of different angles. Students compare two different angles between large angle with a small angle to obtain a measurement unit and a large angle through a small angle as the unit of measurement. Students also conduct measurements using the size of the unit by way of laying several units large units that meet the measured angle.

Keywords: *angle measurements, measurement units, design research*

INTRODUCTION

Angle measurement is a difficult material to students. Mitchelmore and White (1998); and Munier and Merle (2009), said that many students believe that to know the large size of the angle depends on the length of its sides and students also have difficulties when determining or trying to understand about the size of the angle 0^o, 180^o and 360^o (Keiser, 2004; Bustang, Zulkardi, Darmawijoyo, Dolk, & van Eerde, 2013). Strutchens, Martin, and Kenney (in Van de Walle, 2008) also reported that students have deficiencies in understanding the concept of angle measurement. It can be seen in the implementation of learning mathematics in elementary school, teachers predominantly use the lecture method and giving the task, causing more learning are unidirectional and boring (Rahayu, 2013). In addition, the angle measurement turns out most students still have difficulty using a measuring instrument such as a ruler and protractor, for example, some students are not always right and not accurate in measuring angles and some are not appropriate to make the beam line (Freudenthal, 1983; Moore, 2012; Brydges, 2013; Maemunah, 2013).

These results caused an investigation to determine how learning activities can support the students in developing knowledge about the concept of angle measurement and the

ability of students to understand the concept of angle measurement. The purpose of this research is to design and try out a set of instructional sequence in which students can understand the concept of angle measurement. Thus, this study focuses on answering the following research questions:
How the activity measurement unit can support students' understanding of the concept of angle measurement?

To answer this research question, design research approach is chosen for this study. This approach allows us to design a learning activity that aims to help the students understand the concept of angle measurement.

THEORETICAL FRAMEWORK

Angle Measurement

Briefly, Matos (1990) has provided a summary of the history and the history of the angle in trigonometry, which highlights the development of measuring angles. History tells us that most of the growth occurred in the context of the size of the angle measuring arc. For example, Babylon measure circular motion of celestial bodies using 360 whole celestial bodies (Matos, 1990). It supports researchers to use the context of the solar system as a starting point in learning angle measurement. Where students have been studying the solar system in science lessons, so that the solar system is associated in mathematics to materials angle measurement. The use of the context of the solar system as a scientific context directly related to mathematics. In accordance expressed by Zulkardi and Putri (2006), the context can be interpreted by a situation or phenomenon/ natural events related to mathematical concepts being studied.

The angle measurement is one of the branches of mathematics fields which studies about geometry. Basically, angle measurement can be done in a similar way to measure other attributes, such as length or breadth (Van de Walle, 2008; Moore, 2012). As long and broad base of measurement lies in the understanding of concepts such as the same partition and unit iteration to understand the angle and size (Clements & Stephan, 2004; Clements & Sarama, 2009; Moore, 2012). It was disclosed by Clements and Sarama (2009) that the angle measurement method is based on the division of the circle.

METHOD

The design research consisted of three phases; preparing the experiment, doing experiment design, and implementing a retrospective analysis (Gravemeijer & Cobb, 2006). We chose this approach to design research for at least two reasons. The first is that this study is not only interested whether at understanding the concept of angle measurement by using the context of the solar system can support student learning about the concept of angle measurement, but also an understanding on how learning might occur. This research was conducted in class VI of SDN 182 in Palembang which involved 32 students and one of their sixth grade teachers. It is planned to have 2 HLT implementation cycle, namely the pilot experiment, and the experiment teaching. The

first cycle aims to try HLT early and gain insight on how to adjust and improve the HLT early to get a better design for the second cycle. Therefore, the following data were collected: video registration of all two meetings, students write research work and field notes.

The results of pre-test and post-test were collected both in pilot experiments and experiments teaching. This paper focuses on the results of 6 students who participated in the pilot trial.

RESULT AND DISCUSSION

First of all, we prepare the results of the pretest to give the impression for the starting point of the students' learning process. For the analysis, we observe a video lesson registration to investigate what teachers and students are in the experimental teaching and how activities can support student learning. Then we chose some important fragments and we compare the HLT determined for certain activities with the real student's activities during the experiment teaching. We also analyzed the students' written work.

Pre-test

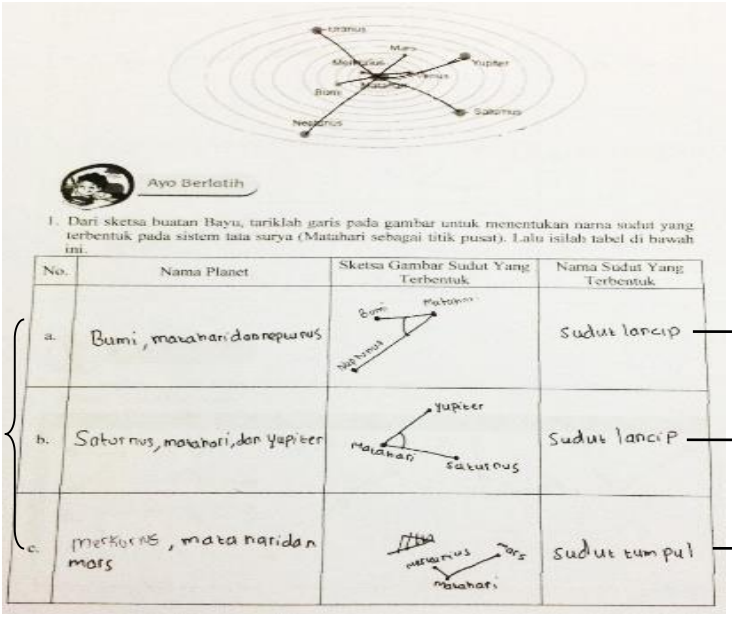
The pre-test was analyzed to investigate the current relevant knowledge and to determine the starting point of the students about the angle concepts. Because the focus of this study was on two meetings, we only analyzed at five in the pre-test problems related to two meetings. In the first issue, required students to provide knowledge about the types of angles as prior knowledge to measure angles. Most of the students were able to finish it, but there are still some students who have only completed half of the problem is given. The results showed that most of the students have understood the name of the angle through a corner of the image. Pre-test also showed that most of the students have been able to sort the angle based on the shape size of the smallest corner to corner to the largest and most students have already understood and had know a great corner by describing the proposed sketch corner. In the fourth and fifth issues, most of the students have not been able to resolve the problem to determine the angle proposed by the unit of measurement. These findings indicate that students have difficulties associated with the concept of angle measurement.

Meeting 1

Teachers provide a worksheet that consists of 6 issues of measurement units which was obtained through the solar system context. These problems were forming an angle which the solar system formed from sketch to obtain units of measurement. We hypothesize that by working together, students can develop their knowledge to understand the units of measurement through the comparison of the angles formed by the sketch of the solar system.

The first problem

1. From the artificial wind sketch, draw a line on the image to connect the sun with two other planets so it forms an angle (the Sun as the center point).



Earth, Sun, and Neptune → acute angle

Saturn, Sun, and Jupiter → acute angle

Mercury, sun, and mars → obtuse angle

Let's discuss. From Bayu-made sketch, draw a line on the image to determine the name of the angle formed at the solar system (the sun as the center point). then fill in the table below.
Column 1. Number, Column 2. Name of the planet, Column 3. Sketch drawing angles formed, and Column 4. Name the angle formed

Figure 1. The results of the students' answers in the form

Based on Figure 1, the student can make the angle formed by the sketch drawing of the solar system. Of the angle formed, students can determine the name of the corner as their initial understanding to know the units of measurement.

The second problem

2. Sort the corner that has been formed from the solar system from the smallest to the biggest corner of the world.

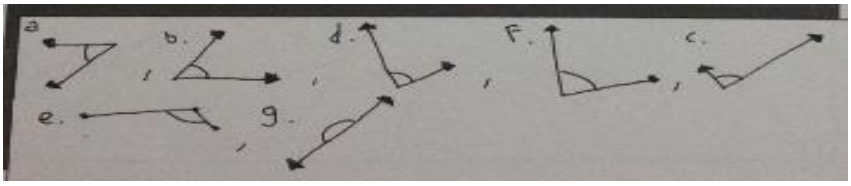
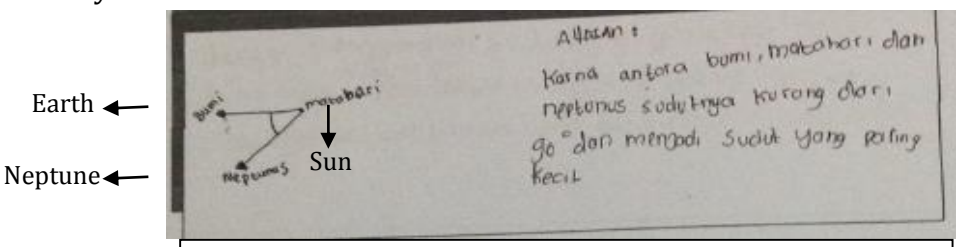


Figure 2. The results of the students' answers in a sort corner

Based on Figure 2, students can sort the angle formed from a sketch drawing of the solar system. They can sort the angle based on the smallest to the largest angle size.

The third problem

3. Determine the smallest angle of the corner sort results by sketching a picture of the solar system.



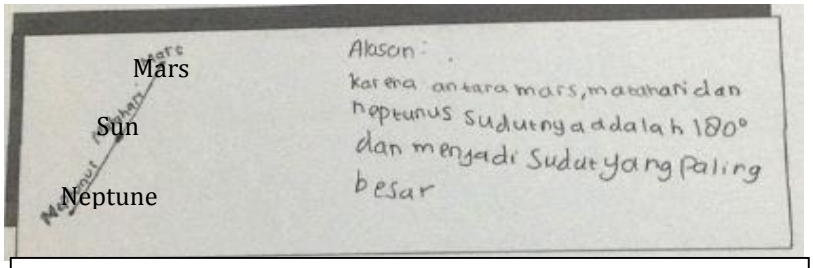
Reason: because the earth, the sun, and Neptune angle less than 90 degrees and became the smallest angle.

Figure 3. The results of the students' answers in determining the smallest angle

Based on Figure 3, students can determine the smallest angle formed by the sketch drawing of the solar system. They can determine the smallest angle based on the size of the angle obtained from the sort angle.

The fourth problem

4. Determine the angle of the yield from the corner sort through sketch drawing of the solar system.



Reason: because between Mars and the sun and Neptune angle is 180 degrees and become the greatest angle.

Figure 4. The results of the students' answers in determining the largest angle

Based on Figure 4, students can determine the largest angle formed by the sketch drawing of the solar system. They can determine the smallest angle based on the size of the angle obtained from the sort angle.

The fifth problem

5. Comparing the two angles obtained to measure angles.

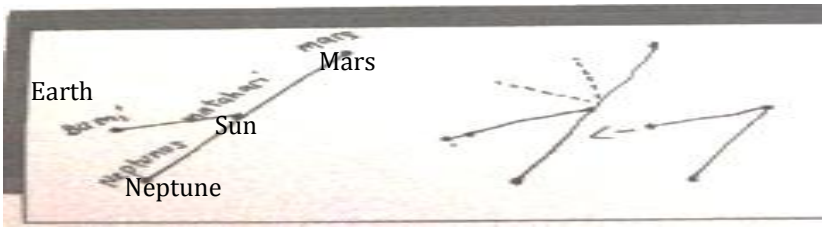
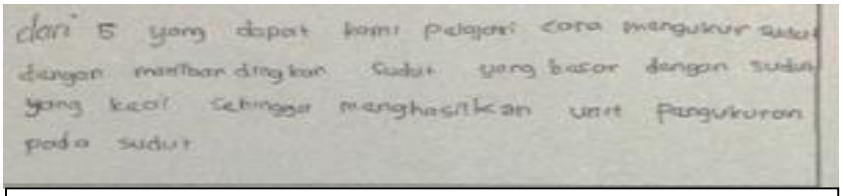


Figure 5. Results of comparing the students' responses in the corner

The figure 5 shows the results of comparing the students' responses in the angle formed between the small and the large angle so that there are multiple units produced by a large angle to the small angle. So large corner 4 times smaller angle.

The sixth problem

6. Give the conclusion of the measurement unit that can be used in determining the angle.



Of 5 we could learn, we can measure angles by comparing the large angle with the small one. The result is a unit of measurement of the angle.

Figure 6. The results of the students' answers in the conclusions

The figure 6 shows the results of the students' answers in a giving conclusion, namely how to measure angles by comparing the largest angle with the smallest angle, so it produced a unit of measurements; the unit of measurement used is the smallest angle.

From the description of this activity, it can be seen the extent to which students' understanding of the units of measurement. Students already know the unit of measurement is obtained through comparison of the two angles in different size.

Meeting 2

At this second meeting, the teacher encouraged students to do the measuring angle activity by using a unit of equal measure angles. The problem was solved by the students in a worksheet. It helps students to understand the angle measurement, as follows:

1. Students use paper media. The goal is to obtain a unit of measure equal angles by folding the paper in accordance with the number of planets in the solar system. The number of planets in the solar system as a benchmark to get the unit of measure used to measure the angle. The results obtained were 8 units of measure angles.

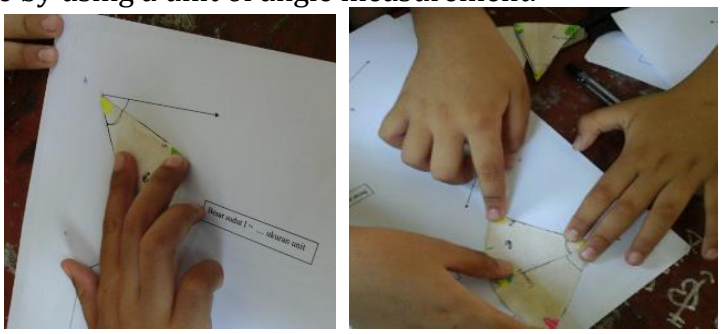
(a) **(b)** **(c)**

Figure 7. Students' Activity To Acquire the same size Measurement Unit

Figure a. shows the strategy of the students in finding kosep measurement. students make measurement unit by folding paper as large circular. Figure b. shows the results section unit obtained from the crease that there are eight parts of the unit. Figure c

shows of students' activities to clarify the results of the crease by giving each crease line on the form.

2. Measure the angle by using a unit of angle measurement.



(a) **(b)**

Figure a. shows the students' strategies for measuring the angle by placing the unit in the form of measurement unit to determine the angular size of the angle. Figure b. shows how to measure students in arranging a large number of units in accordance with the measured angle.

Figure 8. Student's Activity In Current Measuring Units of Measure Angle

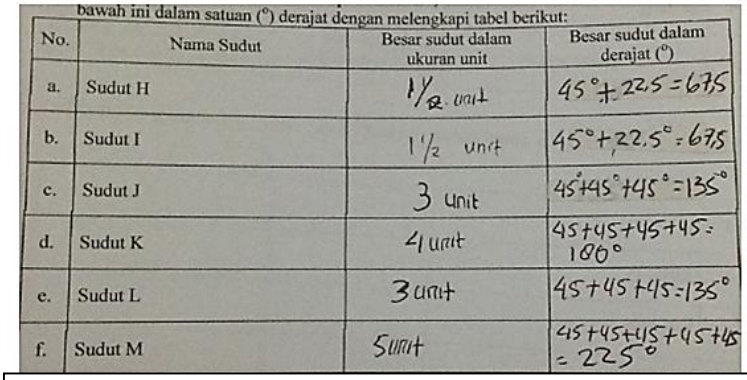
Based on Figure 8 shows the student has been able to measure angles by using measurement units.

3. Determine the angle by using a great big size one unit of measure angle. All students can measure the angle measured in the corner. But when measuring large-sized corner half unit of measure angle, students got difficulties. The following conversation dialogue conducted by researchers with a group of students about the size of half a unit in degrees.

Fragment 1: About the size of half a unit in degrees

1	Alya	: "**Mis, it's a great angle corners H one and a half units.** So if it will be 70 degrees, isn't it?".
2	Researcher	: "why will it be 70 degrees?, the angle of H is one and a half units. **So how many degrees of one unit?**".
3	Rama	: "**45 degrees Mis**".
4	Researcher	: "**If a half of unit**, so how many degrees?".
5	Adelia	: "If half the unit means half of 45 degrees. **45 degrees Divided by 2. The result is 22.5 degrees**".
6	Rama	: "so the size of a 45-degree angle H plus 22.5 at with **67.5 degrees**".

The fragment 1 illustrates how researchers direct students to determine the angle of angle measurement unit (the size of the unit) to a large degree by using a single measure angles. The students' answer gained can be seen in Figure 9.



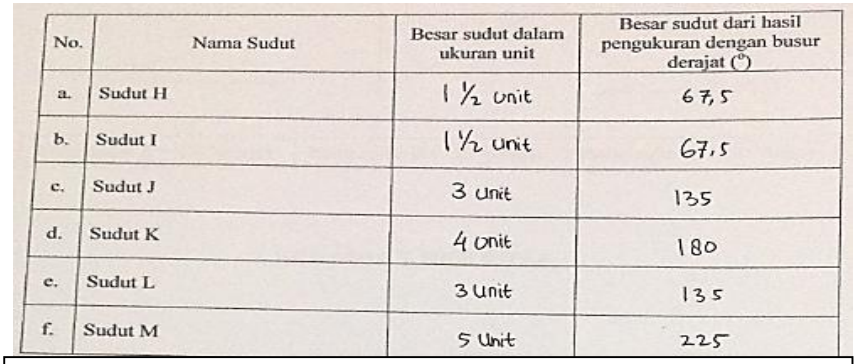
bawah ini dalam satuan (°) derajat dengan melengkapi tabel berikut:

No.	Nama Sudut	Besar sudut dalam ukuran unit	Besar sudut dalam derajat (°)
a.	Sudut H	1½ unit	45° + 22,5 = 67,5
b.	Sudut I	1½ unit	45° + 22,5° = 67,5
c.	Sudut J	3 unit	45+45°+45° = 135°
d.	Sudut K	4 unit	45+45+45+45 = 180°
e.	Sudut L	3 unit	45+45+45 = 135°
f.	Sudut M	5 unit	45+45+45+45+45 = 225°

Column 1. Number. Column 2. Corner Name (a. Angle H, b. Angle I, c. Angle J, d. Angle K, e. Angle L, f. Angle M). Column 3. The large corner unit in size. column 4. Large angle in degrees.

Figure 9. An answer of a student to measure the angle of angle measurement unit to measure the degree

4. The students take measurements use a protractor to determine the angle. The purpose of this activity is to determine student's understanding about the angle in degrees, students' skills in using a protractor and thoroughness of students in reading the numbers on the protractor.



No.	Nama Sudut	Besar sudut dalam ukuran unit	Besar sudut dari hasil pengukuran dengan busur derajat (°)
a.	Sudut H	1 ½ unit	67,5
b.	Sudut I	1 ½ unit	67,5
c.	Sudut J	3 unit	135
d.	Sudut K	4 unit	180
e.	Sudut L	3 unit	135
f.	Sudut M	5 unit	225

Column 1. Number. Column 2. Corner Name (a. Angle H, b. Angle I, c. Angle J, d. Angle K, e. Angle L, f. Angle M). Column 3. The large corner unit in size. column 4. Large angle of measurement results with a protractor.

Figure 10. Results of the answers the students by using a protractor

From Figure 10 shows the results of the students' answers by using a protractor to determine the angle. These results are in accordance with the measurements they have done with the use of measurement units.

The results of this activity series, the students have understood the angle measurement by using measurement units. So it can be concluded that both the activity that has been done to help the students to understand the concept of angle measurement to determine the angle.

Post-test

Post-test was administered to assess students' understanding of the concept of angle measurement that they could learn during the lesson. Because this study focuses only on

the two meetings, we then analyzed and compared to the results of the first five issues in the pre-test and post-test with regard to the two meetings. By comparing the results of the student's post-test with the pre-test, we can gain insight into the development of students' learning and understanding of the concept of angle measurement and also in problem solving strategies on the corner. The results of post-test analysis also can enrich teaching experimental analysis supports the conclusion.

CONCLUSION

Two activities that we analyzed and discussed, confirms that by allowing students to compare the two different angles of the sketch drawing of the solar system, they can understand the concept of angle measurement to obtain measurement units. The students also perform angle measurement using a unit of measure angles to determine the angle measured. Afterwards, the students were led to measure angles with large corner unit size and use a protractor to determine the angle. Through two activities that have been carried out, it can be concluded that these activities have helped students to understand the concept of angle measurement. Teachers or other researchers can use this learning design to support the learning process of measuring angles in the sixth grade. The activity can be repeated using the same context, just use that context can be performed by using posters, simulation and role playing. A fun and non boring learning atmosphere will be created.

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