The Roster context in angle learning for Primary School pre-service teachers

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Abstract. This study aims to develop angle learning through Pendidikan Matematika Realistik Indonesia (PMRI) approaches for primary school pre-service teachers. The method used was design research consists of three stages: preliminary, teaching experiment, and retrospective analysis. The study was conducted six primary school pre-service teacher (PGSD). Data were collected by observation, interviews, video recording, photos and filed notes. The roster context was used as a starting point in developing the learning. The results of the study were in the form of a learning trajectory on student activities when finding the type of angle and determine the magnitude of angle on octagram.

1. Introduction
In the era of globalization, improving the quality and competence of teachers is something that must be done. One effort that can be done is to improve the quality of pre-service teachers. The reality shows that pre-service teachers are still lacking of pedagogic competence and learning methods [1]. For this reason, a treatment is needed so that pre-service teacher can have an understanding related to the pedagogical abilities and learning methods. The learning process engaging in pre-service teacher must be well managed. The researchers are trying to implement an approach that can help pre-service teachers develop pedagogical abilities. The approach was named Pendidikan Matematika Realistik Indonesia (PMRI).

PMRI is an approach adapted from Realistic Mathematics Education (RME) which has been developed in Indonesia since 2001 [2]. PMRI views mathematics as a human activity and mathematics must be related to the real world [3]. In PMRI, the teacher must develop interactive teaching and provide opportunities for students to actively participate in their own learning processes [4]. Students must be given the opportunity to rediscover mathematics under the guidance of adults [5] and the process of finding them begins by exploring various real-world problems and situations [6]. PMRI in Indonesia has been widely used to increase students' interest in mathematics and improve students' mathematics learning outcomes [7].

One of the geometric subject, measuring angle of two ray, become topics chosen by the researchers because on this topic, most students still have difficulty in understanding them. Some literature mentions the difficulties, including the existence of several different definitions of angles [8]. Some of these different definitions start from various views about the angle itself [9]. Most students also assume that the magnitude of angle depends on the length of the angle [8][10]. In addition, there are
also students who are confused to recognize right angles in different orientations [11], students still cannot ascertain whether these angles are right angles or not. In Indonesia, this angle concept was first introduced at the primary school level. Thus, this understanding of the concept of angles at the primary school level is most likely to be carried to a higher level, even to college. For this reason, students who became the subjects of this study were primary school pre-service teacher or Pendidikan Guru Sekolah Dasar (PGSD).

The use of objects related to the real world in the learning process is expected to increase the understanding of mathematical concepts [12], including the concept of angles. Some research on angle topics that use real objects were Michelmore and White [9] using wheels, doors and scissors. Fhyn [13] used climbing activities, Munie et al [14] conducted a research in finding angles by conducting experiments at the playground. Bustang et al. [15] used visual field activities and spatial representatives while Crompton [16] used dynamic geometry environments.

In PMRI, real object or something real in the minds of students is known as context, which serves for the starting point in learning. Context makes mathematical concepts more meaningful and easier to understand [17,18]. This context can be used as a starting point for students in the learning process [19]. In this study, the context used is roster [20]. Roster or some people call it a vent, a natural air vent or perforated wall insulation which is widely used in mosque buildings. The roster motif that the researcher choose as the starting point was an octagonal star (octagram) roster motif. Therefore, this study aims to find out the learning trajectory about angular topic with the context of roster in the primary school pre-service teacher.

2. Method
The study used design research method to develop local instruction theories for the teaching of pre-service teacher on angular topics. To get these local instruction theories, there are three phases that must be done, namely preliminary design, teaching experiment and retrospective analysis [21,22]. The study was conducted on six primary school pre-service teachers at Sriwijaya University. The student consists of two students with two high achievers, two mid achievers and two low achievers. Data were collected using various data sources that can illustrate the mastery of the concept of angular topics, namely through observation, video recording, photos, interviews and field notes. These data were analyzed using hypothetical learning trajectory as a guide.

3. Result and discussion
Before doing the learning, the researchers gave a pretest to students to find out the initial abilities. Then learning began by inviting students to recall the angular concepts that had been studied before, both when they were in school or when they were in college. The concept of angle is related to the definition of angles and the kinds of angles (acute angles, right angles and obtuse angles). Then the researchers divided students into several groups, distributed activity sheets and asked them to hold discussions. Students were asked to identify and determine the number of right angles, acute angles and obtuse angles in the roster context. Afterward, students were asked to determine the magnitude of acute angle and obtuse angle based on their understanding of the angle contained in the octagram.

The results showed that in the end the students were able to solve the problems given by the lecturers with guidance and were able to solve the problems given at the time of posttest. The results of the pretest and posttest shows a positive improvement in learning. At the time of the pretest, there were still many students who had not been able to solve the given questions. Some students just answered without reason that can be accounted for. However, in the posttest, students are able to answer questions by giving an explanation of the answers.

For more details, here are the results of the learning process using the context of the roster which is divided into three stages, namely preliminary design, teaching experiment and retrospective analysis.
Preliminary design
At this stage, the activity carried out by the researchers were to review some of the literature related to angles and discussed with the lecturer from primary school pre-service teacher who would act as models. The researchers also discussed with the validators about the topic and subject of the study. Angular topics have already been given, but there are still many students who do not understand well, especially determining the magnitude of angle on a regular shape. The researchers determined roster as the starting point and formulate the hypothetical learning trajectory which contains allegations of how the learning process occurs as a result of thought experiment. Based on the results of the discussion, the researcher then formulated the hypothetical learning trajectory (HLT) that can be seen in Figure 1:

![Figure 1. The hypothetical learning trajectory of learning angle in roster context](image)

A series of angular topic learning activities was designed based on learning trajectory and how students think about their problems could be predicted.

The design experiment
At this stage, the researcher tested the learning plan that had been discussed with the validators based on the hypothetical learning trajectory that had been designed. This stage also to developed an understanding of how the design in angle learning worked. Researchers tested that hypothetical learning trajectory on six students of primary school pre-service teachers. The heart of design research lies in the cyclic process of the process of remaking the design and testing learning activities and other aspects of design. During this teaching experiment activity, researchers analyzed the actual process of students participation and learning about angle. The results of the experiment then revised at the hypothetical learning trajectory for next experimental stage.

Activity 1 carried out the students to pay attention to the roster image given by the researchers in each group. The researchers asked students to identify the angles in the roster. The following is conversation between the students and the lecturer:

Lecturer : Is there an angle in the image of the roster?.
Student : Yes, in the roster picture there are right angles, acute angles and obtuse angles.
Lecturer : How do you know that?
Student 1 : I can find out there is a right angle because there is a square built there. From what I know, that square has four right angles.
Student 2 : For the acute angle, there is at the angle of the inner part of the octagonal star, because the magnitude is less than 90º. While the obtuse angle, at the outer corner of the roster, the magnitude is more than 90º.
Lecturer : Good ... can you determine the number of right angles in the roster?

Figure 2 is one of the answer from student.
From the picture above, there are 40 right angles. From the picture it can be seen that there are 8 rectangular holes. From what we know, each square has 4 right angles. Then from the 8 holes multiplied by 4 so that there are 32 right angles. Whereas the outer corner of the square has 8 right angles so that 40 right angles are obtained.

**Figure 2. Student’s answer**

From the Figure 2, it can be seen that the student can answer the problem, but not a fully correct answer. The lecturer then directed students to be able to find other right angles in the roster.

Then, the lecturer continued the question:
Lecturer : Can you also determine the magnitude of the acute angle and the obtuse angle?

Here's the students’ answer in Figure 3.

**Figure 3. Students’ answer**

See in Figure 3, it can be seen that students have been able to estimate the magnitude of the acute angle, but only by guessing it. The students also cannot write down the magnitude of angle correctly. The lecturer after that directed the students by asking students to look back at the roster and to
determine the form of the roster. The lecturer directed students to recognize the roster as an octagram shape and find the magnitude of the acute angle and obtuse angle of the roster.

Figure 4. Roster is an octagram

Figure 4 shows that roster (a) with the octagonal motif above consists of two different presentation of an octagonal star, namely (b) an octagram that constructed as two square and (c) a regular octagram. An octagram is an eight angle polygon. Then, the lecturer guided the student to find the magnitude of inner angle in octagram (b) is 90º and the magnitude of the inner angle in octagram (c) is 45º. Thus the magnitude of the acute angle and obtuse angle found in the roster are 45º and (90º + 45º ) = 135º respectively.

To develop student creativity, the lecturer asked the students to describe other roster shapes which also contained right angles, acute angles and obtuse angles [20]. One of the results include in figure 5.

Figure 5. Students’answer

See in Figure 5. The student have been able to make another motif of the roster that also includes the three types of angles. This means that the student has been able to develop their knowledge in another forms.
The retrospective analysis

The researchers conducted an analysis at this stage using hypothetical learning trajectory as a guide. During analyzing expected learning, assumptions about student learning compared to actual learning observed during learning. The activity of identifying the angle found in the roster was evaluated according to the designed hypothetical learning trajectory.

The result showed that all of the students have been able to properly show right angles, acute angles and obtuse angles of the roster. However, some students have not been able to provide right explanations and reasons for where they know it. Then, in the activity of determining the magnitude of angle, some students also solved the problem by guessing and have not been able to recognize the object as an octagonal star or an octagram. Students have not been able to show reasons and explanations related to the answers given. The researcher revised the hypothetical learning trajectory and conducted learning in the next cycle. At the end of learning, the lecturer gave a posttest. The posttest showed better results with the ability of students to answer problems and be able to explain and give reasons for the answers.

4. Conclusion

An octagram in the roster can help students to recall the concept of angles that have been studied before. Some students can recognize right angle in roster even that right angle in different orientation. That roster context also helps students to determine the magnitude of acute angle and obtuse angle.

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