

Pre-Service Teachers' Knowledge of Pedagogy in Mathematics Learning on The Topic of Special Angles in High School

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ABSTRAK

This research is a case study that adopted a qualitative approach. It took place in the tenth-grade classes of MAN Palopo. The study's objective was to investigate pre-service teachers' knowledge of pedagogy during mathematics teaching and learning on the topic of unique angles in Trigonometry. The participants recruited showed distinct tendencies in every aspect observed. Participants had the skill in representing the problems through visual and verbal representation. Besides, they also tackle the problem of students' misconceptions by explaining the procedures. The participants used to encourage students to express the reasons for the use of methods. Lastly, knowledge of how to teach a concept facilitated by good class management could minimize misconceptions and enable meaningful learning for students.

INTRODUCTION

Mathematics learning in Indonesia has experienced various changes in its paradigm. The shifts reduce teachers' dominance in the classroom and increase students' role in constructing knowledge. The change enables the mathematics content to be more meaningful. As a learner, have we understood and experienced meaningful learning? Of course, the answers vary based on capacity and capability to know students' potential and needs. Meaningful mathematics' learning can be viewed as an effort to view the learner as a human who is dynamic and have the potential to develop themselves continuously.

We agree that mathematics learning in the past is significantly different compared to the present. As a teacher and pre-service teachers, we have to be aware of these dynamics and contribute to its process. Traditional learning is not a failure and is not a mistake in learning methods. However, it was only effective in the past. The learning does not suit the development of current pedagogical science nowadays. Preliminary observations in a High School in Palopo (MAN Palopo) revealed that there had been a steady change in mathematics' learning orientation. The teacher has tried to adapt to the habit of the current ways of teaching. They include mastery of a concept, teaching methods based on student-centered learning, and selecting authentic evaluation techniques or methods.

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The change in MAN Palopo affects pre-service mathematics' teachers readiness who will conduct teaching practices in the school. For the pre-service teachers, teaching activities in schools, also known as an internship, greatly impact their capacity as pre-service teachers, whether in pedagogical skills, content mastery, and social skills. Empirical experience during the internship reflects that teaching is not easy. They learn from simple things to complicated ones. One of the most fundamental things to do for them is to combine learning theory obtained in the college and experience during their teaching activities in the classroom. The term "pre-service teachers" is appropriated because the perspectives and mathematics' learning orientation is affected by the current pre-service teachers' capacity. The teachers also have tried numerous adaptations and transformations in their teaching styles and are suited to the digital era. Therefore, a change has to be made from the young generation as early provisions regarding useful pedagogical and teaching psychology.

Pedagogical content knowledge (PCK) is an effective solution to tackle the problem in teaching and learning. According to Ma'rufi, dkk (2020) explained that PCK today's' education paradigm has a vital role in promoting learning quality. Dimensions of PCK consist of knowledge of the subject matter, curriculum knowledge, knowledge of pedagogy, and knowledge about students. All of the dimensions are necessary for the teachers. The teachers have to contemplate their quality and capacity as learning organizers, and it has to be carried out sustainably to enhance their professionalism.

One kind of knowledge in PCK is knowledge of pedagogy. In mathematics, the knowledge consists of teachers' understanding of learning principles in delivering mathematics content, organizing the content, comprehension about students' thinking, and assessing students' knowledge. According to H. Kilic (2011) knowledge of pedagogy involves planning and organizing lessons and learning strategies. The knowledge is strongly related to how the teachers plan and organize the learning, including the lesson plan, representations used, the selection of tasks and examples, teaching methods, and assessment techniques (Ma'rufi, 2016; Ma'rufi, et al, 2017). Experience in teaching greatly impact teachers' PCK. Thus, investigating the prospective mathematics teachers PCK, including knowledge of pedagogy, is necessary since early (L. F. Y. Haryono, 2019; J. König, et al, 2015; J. E. Lee, 2017) .

Research on the topic of PCK is already prevalent, even in Indonesia. Various study also addressed this topic. For example, there was a study by I. C. Nissa (2018) which described the development of approaches and instrument to examine PCK. There was also one that develop this knowledge through microteaching lesson study (W. Murtafiah & M. Lukitasari, 2019) or even one that investigate its relationships with students' learning motivation (M. Alifah, 2019). However, a study exploring and specifying knowledge of pedagogy is a rarity, especially one that addressed the topic of unique angles. The most related one was a study by K. Subramaniam (2014) which investigate knowledge of pedagogy, but on the topic of estimation of length measurements. Therefore, a study investigating pre-service mathematics teachers' knowledge of pedagogy on topic of unique angles is necessary. Based on the explanation regarding knowledge of pedagogy, the focus of the study are;

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- a. How do the pre-service teachers organize a lesson plan about unique angles?
- b. How do the pre-service teachers implement learning strategies on the topic of unique angles?
- c. How do pre-service teachers assess students' learning outcomes?

METHOD

This research is a case study that adopted a qualitative approach. The study's focus is to investigate pre-service mathematics teachers' knowledge of pedagogy during the teaching of unique angles. Observation is one of the data collection techniques in this study. The participants were two pre-service teachers from a mathematics education bachelor program who were currently in their internship in the tenth-grade of MAN Palopo. The observer conducts observations three times, starting from February 2020.

The study's data are statements or arguments based on observation results or field notes. The study's primary instrument is the researcher, who also collects, organizes, analyzes, and interprets the data. The researcher was also supported by the field notes, observation sheets of students' and teachers' activities, and learning transcripts. The data were obtained by recording all learning activities since the introduction phase. Next, data validation was carried out through triangulation.

The researcher compared and matched the data of every instrument used to look for consistencies. Consistent data is valid data used for the next step, which is data analysis. The data analysis methods used adopted the technique from (M. B. Miles, 2014) (Data Collection, Data Condensation, Data Display, Data Verification) to obtain patterned data through interactive and continuous ways. The steps of the analysis were:

- a. Collecting data through observation sheets, field notes, learning transcripts, and recorded video.
- b. Data condensation is an activity based on selecting, focusing, abstracting, and transforming raw data. The researcher creates a summary consisted of points, processes, and arguments that suit the research objectives. The data validation technique used was an extended observation.
- c. Data display includes classifying and identifying data by writing organized and categorized data collections to produce valid data.
- d. Interpreting data includes the discussion of valid data to produce research findings based on the predetermined research objectives.

RESULT AND DISCUSSION

The following Table 1 presents the results of the three observations conducted on pre-service mathematics' teachers during their teaching activities.

Table 1. Observation results of pre-service mathematics teachers' knowledge of pedagogy.

Observation I	Observation II	Observation III
The participants used questions as learning strategies that can build students' knowledge.	The participants employed questioning as learning strategies to build students' knowledge.	The questioning was used as a learning strategy that could build students' knowledge.
The questioning strategy used emphasized the process of delivering material verbally from a teacher to groups of students. The objective was to maximize students' concept comprehension.	The participants presented the questions or problems in various forms, including figures. It helped the students to construct ideas.	Questions or problems used were presented in various forms, including figures. It helped the students to build ideas.
The participants divided students into several groups to work collaboratively, divide works, and build trust.	The pre-service mathematics teachers divided students into some groups to enable cooperation, shared responsibilities. It also built trust among the students.	The participants divided students into some groups to enable cooperation, shared responsibilities. It also built trust among the students.
The presence of students' worksheets facilitated the collaborative process. It builds a sense of individual responsibilities. Therefore, students could actively participate in the learning process.	Students' worksheet facilitated the collaborative process to build individual responsibilities to participate in the learning process actively.	The participants used apperception to provide meaningful knowledge for students. The pre-service teachers also provide students' worksheets to promote individual responsibilities to participate in the learning process actively.

Table 1 presents how the participants prepare and implement learning strategies. The participants implement cooperative learning to promote teamwork and interaction among students. Through this instruction, there are at least three learning objectives: academic learning outcomes, acceptance toward difference and diversity, and social skills development. Cooperative learning can support effective communication among learners (W. Umar, 2012). Mathematical communication is essential for students to

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formulate the concept and mathematical strategies, and it also serves as success capital toward the approach in mathematical exploration and investigation. Communication also helps the students to obtain information, share ideas and findings, assess and improve ideas to convince other people.

In the implementation of cooperative learning, the participant emphasized social interaction as a mechanism to support students' cognitive development. Similar findings was also reported by M. Muhtarom, et al (2019) which said that one of the focus in the teacher's learning implementation is social interaction. Through apperception, the participant could grab students' attention to learning situations and activities. Of course, to achieve such goals, creativity, innovation, and high imagination is necessary for the teachers to create brilliant ideas that can inspire and motivate students.

Table 1 shows that the participants select teaching methods based on the concepts and the students' characteristics. They employed questioning strategies by explaining the material. Question and answer methods, group counseling, and peer tutoring follow the characteristics of students and concepts taught. Moreover, it also could enhance students' activities and interaction among learners. In every lesson, the participants divide the students into several heterogeneous study groups based on skills and cognitive absorption to enable peer learning. Besides, by working cooperatively, the students could discuss and exchange ideas in solving the problems given. Knowledge of pedagogy (KP), according to H. Kilic (2011), is knowledge of planning and organizing the lesson as well as teaching methods. Pre-service teachers who have a good understanding of pedagogy have a list of many teaching activities. KP in this study includes planning and organizing learning, implementing learning strategies. The former is the teachers' idea of all students' and teachers' activities, especially ones related to competency building. This aspect should encourage the teachers to be more prepared in carrying out learning activities with careful planning.

The participants explained that every problem was based on its level of difficulties and the questions' objectives regarding questions used. For instance, question examples will be addressed during the whole-class discussion because it aims to help students comprehend the material. As for the exercises, the students should complete them in groups due to their goals, enabling students' interaction and complementing students' understanding. Individual tasks were also given to examine the learning process's achievement and change the student learning process's achievement data analysis. The participants planned the learning methods according to students' characteristics and the material. The methods used were expository, discussion, group counseling, and peer tutoring. Assessment of process allowed the teachers to identify the cause of misconceptions earlier. R. Even & D. Tirosh (1995) said that an awareness of students' misconception in understanding structures and contents taught and their relation h other mathematical ideas, various models, analogies, and representations used to promote students' comprehension. This findings was quite different from a study by Z. Aksu (2019) which reported that the pre-service mathematics teachers' skill in identifying students' sources of mistakes was not in the desired level.

The participants described that the learning process's assessment was carried out by observing students' activities during the learning process and the intensity of students who question, answer, and present their work in the classroom. This assessment objective was to motivate other students to be active in the learning process. Thus, every student who asks, answer, or present their work would be noted, and the pre-service teachers will consider this to give the final score on the topic of unique angles. The score obtained from the assessment will be added to daily quiz scores and is called daily test scores. The participants also said that to assess students' learning outcomes according to their competencies, a test in an essay was also employed. With this technique, students' understanding could be easily understood. As teachers, the participant can examine students' level of comprehension based on students' problem-solving.

The learning process is inseparable from the phenomena or events that the students experience in their environment. Therefore, before beginning a new topic, the teachers should relate it with students' previous knowledge or experience as a stepping stone to deliver the material. This strategy enables an effective learning process. Moreover, E. Renold (2002) said that effective teachers connected students' knowledge with new information and relied on knowledge of the subject matter to create effective learning and a good explanation.

The teacher also presented the meaning of cooperative learning through documentary film screening. Its objective was to increase students' motivation. This fact asserts that the participant could design learning that students need. These findings were in line with M. Ma'rufi & M. Ilyas (2017) opinion, who said that the teachers choose which examples to begin and which examples to bring the students into the learning content. The teachers evaluated the advantages and disadvantages of using representation to deliver particular concepts and identify different procedures or methods to select the one that could be implemented. The positive impact of the screening was that students could understand the benefit of teamwork. Some of them include teaching students to trust their teachers, promoting thinking skills, helping the students look for information from other sources, and learning from and with peers; encouraging students to express their ideas verbally, and compare ideas with their friends.

The process of comparing ideas in learning communities is the beginning of reasoning skills development. The reasoning is a mental process that logically aims to obtain correct answers. Research findings by N. Ainun (2015) explained that activities in cooperative learning demand students' reasoning. Students should predict the responses and the process to obtain the solution, make conjectures, conclude, give a reason behind the solution's correctness, and think of the most appropriate and logical methods to conclude a statement. The learning strategies used facilitated the material presented so that learning objectives could be achieved.

Questioning strategies employed by the participants emphasized delivering the material verbally from a teacher to groups of learners. The objective was to optimize and maximize students' mastery of the concept. Similar findings were also shown by D.

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Haryani (2011), which stated that the strategy could be viewed as a thing that shapes students' mathematical mindset. It also trains and familiarizes the students to think activities, including critical thinking. Through questioning, students were taught to make a rational decision whether to believe or do something. Students were asked to always contemplate with full consideration before accepting and doing something. Logical thinking is strongly affected by logic and reasoning, which become the main components of the mathematics learning process. Thus, students can start getting used to thinking critically through learning mathematics. It is expected that students can become critical thinkers by studying mathematics.

The process of answering questions is a part of thinking activities. It brings out students' courage in expressing ideas or presenting answers. The students' ideas result from mental activity (thinking) by organizing and combining some simple ideas into a complex one. This process is also known as accommodation. In mathematics, its goal is to build reasoning and problem-solving skills comprehensively. D. L. Nurina & H. Retnawati (2015) said that reasoning is strongly related to students' achievement, especially in mathematics. The reasoning is necessary to solve various problems in learning that always change and develop. The problems also demand higher thinking. It was evident when the participant asked questions in a planned manner to think creatively and critically in the learning process and outcomes. Through this skill, the participant could create a meaningful learning environment that enables students to employ their initial knowledge to construct new ideas for a new topic.

In her study, R.Y. Gazali (2016) explained that if students connect or relate information or material to their current understanding, a learning process that creates meaning occurred. Nonetheless, providing that the students do retention without relating the concept, learning is called rote learning. D.P. Ausubel (1998) said that numerous education experts thought learning by receiving and rote learning is the same because meaningful learning happens if they construct their knowledge independently. The participants provided meanings for students by explaining the relationship of the concepts of sine, cosine, and tangent on related angles and its use in problem-solving (word problems) that involves trigonometry.

CONCLUSION

Based on results and discussion, the pre-service teachers' knowledge of pedagogy showed various tendencies in every aspect observed. First of all, a participant had the skill to present the problems through visual and verbal representations. Secondly, both of the participants solved students' misconceptions by explaining procedures. Additionally, the pre-service teachers also encourage the learners to express the reasoning behind the methods they used and showed. Lastly, knowledge of teaching concepts facilitated by good class management can minimize students' misconceptions and provide a meaningful learning environment.

The pre-service teachers organize learning in two ways. First, they divide the students into several groups to work cooperatively, divide tasks, and build trust.

Secondly, the cooperative process is also facilitated by students' worksheets to promote individual responsibilities to participate in learning actively. The learning strategy used by pre-service teachers is mainly questioning. The teachers used it to build students' knowledge. It emphasized the process of delivering the content verbally from a teacher to groups of students. It also enables the students to master the learning content optimally. The questions or problems are presented in various forms, including verbal and other representations (illustration and word problems).

This study only investigated pre-service teachers' knowledge of pedagogy on the topic of unique angles. Other researchers interested in the topic of PCK, especially knowledge of pedagogy, can consider other mathematical topics or even with a larger size of participant. One also can consider investigating how teachers' knowledge of pedagogy development in general since their first year in mathematics education program. Last but not least, the findings of this study can serve as a reference for other pre-service mathematics teachers in delivering their mathematical content in the classroom.

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