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Prospective mathematics teachers' understanding of pedagogical knowledge: what and where it came from

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Abstract. Pedagogical Knowledge (PK) is one of teachers' knowledge that important in teaching and learning process. Prospective mathematics teachers' development in the PK is the key to its successful implementation. This research aims to describe prospective mathematics teachers' understanding about PK and their opinions about university mathematics education courses that contribute. The research was a qualitative research using phenomenological approach. Data were collected through in-depth interview followed by focus group discussion (FGD) that involved 6 final-years mathematics education students and 5 professional teacher program students in Yogyakarta State University, both have done micro-teaching practice. The data were analysed by means of Cresswell's step. The result of the study showed that prospective mathematics teachers have been able to explain PK and has mentioned the elements of PK. However, they had various opinions about which courses contribute to the development of their own PK. But, the implementation of these lectures still needs to be improved, such as advice from the prospective mathematics teacher, which is to expand teaching practices and update information about the system that applies in the school.

1. Introduction

The teaching and learning process demands the readiness of prospective mathematics teachers in mastering various kind of knowledge. Pedagogical Knowledge (PK) is one of these knowledge. Shulman [1] said that a teacher must have seven basic components are subject matter knowledge, general pedagogy knowledge, pedagogical content knowledge, knowledge of curriculum, knowledge of learning and its characteristics, knowledge of teaching strategy, and knowledge of learning context. One of these components is the main focus in this research, namely pedagogy knowledge (PK). Furthermore, the government, through Indonesian law number 14 about teacher and lecturer [2], states that a teacher must have four competencies as a learning agent in primary, secondary, high school and early childhood education. These four competencies are professional, pedagogic, personality and social competencies. Actually, this research focuses on the pedagogical knowledge (PK).

Shulman explained that PK is the teacher's knowledge in choosing the best teaching strategy to be applied in classroom which is develop through his teaching experience. Enfield [3] said that PK is how teacher master strategies that can help students learn about science problems. Hawkins [4] used different terms to mention PK that is knowledge of teaching (KT). Hawkins explained that it was a teacher's knowledge of teaching practice. PK implementation may include planning of lesson and preparation of resources to develop student's conceptual. To practice planning lesson we need integrate classroom



management [5], teaching strategies [6], implementation and assessment strategy [7]. Based on König et al. [8] some elements of PK include:

- Knowledge of classroom management means maintaining clear direction in lesson, teaching at a steady pace, handling classroom event, maximising the quantity of instructional time.
- Knowledge of teaching methods means knowing when and how apply each method, having a command of various teaching methods.
- Knowledge of classroom assessment means knowledge of different frames of reference impact students' motivation, knowledge of different forms and purposes of formative and summative assessment.
- Structure means lesson planning and evaluation, structuring of learning objectives and lesson process.
- Adaptivity means dealing with heterogeneous learning groups in class.

Retnawati [9] found that the teacher should improve the learning process in order to make student find their own strategy in learning. So that student get the best understanding of the subject matter and final exam results. Recalling the important of PK according to implement the teaching and learning process, the education university should be able to facilitate its mathematics education students in the developing PK through the courses given. So that, mathematics prospective teachers are expected to be able to understand and develop PK. Shúilleabháin [10] said that teachers' planning and implementing learning was good when their PK is high. Bhowmik, Banerjee & Banerjee [11] have found that teachers' PK influences the effectiveness of student learning. Teachers' PK helps them make decisions about curriculum design and teaching strategies. Before the mathematics education students develop PK, they must first know what it is. Moreover, according to Buchholtz's research [12] education students in the final year of the university gave advice on the lectures in order to obtain a higher PK. Based on the description above, it is necessary to find out the prospective mathematics teacher's understanding about PK and their opinion about the relevant courses that contribute.

2. Research Method

2.1. Research type

The research was a qualitative research using phenomenological approach. This research aims to describe prospective mathematics teacher's understanding about PK and their opinions about the courses that contribute.

2.2. Research participant

The research participants were 11 prospective mathematics teachers that involved 6 students of final-years mathematics education and 5 students of mathematics professional teacher program in Yogyakarta State University. Mathematics professional teacher program is a university education program for graduate mathematics education students. They were purposively selected. All participants have done micro-teaching. Data were collected when the professional teacher program students implemented teaching practice for a week while the final-years mathematics education students haven't started yet.

2.3. Instrument and procedure

The researchers begin with FGD and then followed up with an in-depth interview so that data were collected in detailed information. FGD and interview topics consist of two sub-themes: 1) Prospective mathematics teacher's understanding about PK and its components, 2) courses in university that contribute to obtaining PK. Researcher ask the first sub-theme question individually. So the participants did not know the answer each other. For the second sub-theme, the researcher create five main questions involve what courses are relevant to knowledge of classroom management, knowledge of teaching methods, knowledge of classroom assessment, structure, and adaptivity. Questions about sub-theme 1

are asked first to participants. After the researcher explained about the meaning and components of PK to participants, the questions of sub-theme 2 were given.

2.4. Data analysis

Data from FGD and interviews were analysed using Creswell's steps [13] involved: organizing and preparing data, reading overall data, encoding data in order to define the theme and to create description, defining the inter-theme relationship, and interpreting the theme or the description.

3. Research Result

The results of data analysis are categorized in term of prospective mathematics teachers' understanding about PK and their opinion about the courses that contribute.

3.1. Prospective mathematics teacher's understanding

There are kind of prospective mathematics teacher's responses about what is the meaning of PK. Some of the responses given were misguided with the understanding of PK. PK is a knowledge but some of the respondents said that PK was skill or ability. This is according to the responses below.

"PK is an educational skill, intellectual and social ability."

"PK is the teachers' ability to teach."

"PK is the teaching ability of a teacher."

"PK is ability of the teacher to understand students, do learning plan and others."

However, most respondents explained the meaning of PK as a knowledge. This refers to following opinion.

"PK is knowledge about how to teach at elementary and secondary school."

"PK is knowledge about how to teach and manage students."

"PK is knowledge that can be used as a basis for teaching."

"PK is knowledge of teaching and knowing class."

"PK is the knowledge that the teacher must have in teaching in class."

Some respondents interpreted PK as a knowledge by mentioning several elements, such as:

"PK is teachers' knowledge in managing the class, understanding students' character, managing time, and maintaining relationship with students and teachers."

"PK is the teachers' knowledge related to the management of teaching or learning strategies."

Furthermore, the percentage of 11 the prospective mathematics teacher's opinion about elements of PK would be presented in Table 1.

Table 1: The Percentage of prospective mathematics teacher's understanding about PK

Elements of PK	Percentage of appropriate response
Knowledge of classroom management	90.90
Knowledge of teaching methods	100
Knowledge of classroom assessment	72.72
Structure	63.63
Adaptivity	72.72

Table 1 show that all respondents stated that knowledge of teaching methods is one element of PK. While there were only 7 respondents (63.63%) who mentioned that adaptivity is one of the PK elements. In addition, there were 4 respondents who successfully mentioned the five elements of PK. data shows that knowledge of classroom management and knowledge of teaching methods are elements of PK most mentioned by participants. In addition, there was one participant who mentioned one element outside the five elements above, namely knowledge of the subject matter. However, researcher have clarified that knowledge of the subject matter is include in content knowledge (CK). Their responses indicate that most of the respondents have understood the meaning and elements of PK.

3.2. University courses

Result gives information about prospective mathematics teachers' perceptions about university courses they have obtained that support mastering PK. Table 2 contains the appropriate courses to develop PK according to prospective mathematics teachers' perceptions.

Table 2: List of mathematics teachers' perceptions about appropriate courses to develop PK

Elements of PK	Appropriate courses
Knowledge of classroom management	Micro-teaching
Knowledge of teaching methods	Mathematical learning strategy
	Mathematical learning method
Knowledge of classroom assessment	Assessment
Structure	Mathematical learning media
	Planning mathematics learning
	Evaluation of mathematics learning
	Curriculum analysis
Adaptivity	Psychology of learning mathematics
	Educational psychology

From the data above, we can find that the courses given at university appropriate with each element of PK. There are some differences of opinion between one respondent and another regarding the courses that matches each element of PK. For example, respondents have different opinions whether micro-teaching appropriate with knowledge of classroom management, knowledge of teaching methods, or adaptivity. In addition, some students argue that evaluation of mathematics learning courses are included in courses that support knowledge of classroom assessment and other respondents agree with element structure.

Not only giving opinions about appropriate courses with each element of PK, they also gave opinions regarding the implementation of the courses. The following are suggestions regarding the implementation of several lectures that support PK:

- "When lecturing, lecturers should provide update information on the implementation of learning in schools such as lesson plans, curriculum, and teacher assignments in addition to teaching."
- "Faculty should teach the attitude of flexibility in adapting the face of difference between the theory and practice of teaching in schools that are sometimes different."
- "Lectures are still dominated by theory, so when doing teaching practice is less confident. Lecturers should provide more opportunities for their students to practice teaching."
- "There needs to be a course or knowledge about dealing with unexpected events while teaching such as a class condition that is difficult to be conducive or addressing students who are under classmates in the ability to understand the material."
- "It is recommended that learning about the preparation of teaching instruments is always updated so that there are no significant differences with practice in school."

Students who give advice are those who give good answer on the sub-theme question 1. Their responses indicate that the implementation of lectures still needs to be improved again in terms of students' point of view. In addition, this response was mostly given by students of mathematics professional teacher programs who were doing field practice.

4. Discussion

According to the research results, it can be stated that most prospective math teacher students have known the meaning of PK. More detail; all participants (11 participants) mentioned that knowledge of

teaching methods was an element of PK, 10 participants (90.90%) said that classroom management knowledge was an element of PK, 8 participants (72.72%) mentioned that class assessment was an element of PK, 8 participants (72.72%) said that the structure is an element of PK, and 7 people mentioned that adaptivity is an element of PK. Although there are a few of them who are somewhat confused and take a few moments before answering the question. There are 2 participants who explain the meaning of PK by describing the elements, even though only a small part of its elements was mentioned. They mentioned teaching strategies and manage students/class as an explanation of PK, that are refers to knowledge of classroom management and knowledge of teaching methods. Some other explained PK correctly.

There are four students who are able to mention all the elements and some are able to mention most of the elements. In addition, there are some suggestions from students about the implementation of appropriate lectures with PK which is in line with the results of Buchholtz's research [12]. Respondents who give advice are those who were previously able to answer sub-theme questions 1. Suggestions given by participants include improving the quality of lecture implementation in classrooms by lecturers, and providing more opportunities for students to practice teaching in schools. This means that those who have understood the meaning of PK are aware that the PK they have needs to be maximized again so that they can do better teaching activities in the school, this is in line with research of Retnawati [9]. Some respondents who has done the practical teaching activities also give advice about the differences between teaching practices and theories obtained on lectures. Students found problems in teaching practice that make them confuse because their knowledge from lectures cannot help. But it is necessary to get familiar with the practice of teaching. They hope that the university suggest every lecturer to keep up to date the information about the ongoing education system in the school. It is intended that prospective mathematics teachers can obtain the latest information as well.

5. Conclusions

Eleven students of prospective mathematics teacher were all able to explain what was meant by PK. Most of them are able to mention almost all PK elements and courses at the university that support each of the PK elements. This is in line with the fact that the subjects given are appropriate with all PK elements. Even so, the university or lecturers still need to improve the implementation of each course in order to maximize in facilitating students of mathematics teacher to obtain PK. There are 3 outlines regarding the lecture implementation recommendations obtained through this study. First, the university should establishes good communication with many school institutions so that updates of the school system can be delivered to students of prospective mathematics teachers who will practice teaching. Second, lecturers need to teach flexibility or anticipation when they found problems in teaching practice. Third, students of prospective mathematics teachers hope they get more opportunities for teaching practice.

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