How to develop PCK ability for prospective mathematics teachers? The case of lesson study-based field experience practice

Karim and A Danaryanti

Departement of Mathematics Education, ULM, Indonesia

karim_fkip@ulm.ac.id

Abstract. Prospective mathematics teacher students must have skills pedagogical content knowledge (PCK) adequate. They are expected to become professional teachers when entering the workforce. However, at this time, there are still stakeholders who doubt their PCK capabilities. For this reason, efforts are needed to prepare the PCK ability of prospective mathematics teacher students well. The aim of this study is to develop PCK for prospective mathematics teacher students through lesson study-based Field Experience Practice (FEP). This research uses action research method that involves lectures, teachers, and students. The research subjects were seven prospective mathematics teacher students who were participating in fieldwork practice partner schools in Banjarmasin. The research is conducted based on lesson study in 2 cycles. Each cycle consists of three stages of activity, namely planning (Plan), implementation (Do), and reflection (See). The data is collected through a study of learning plan, carry out, and reflection. The results of the research showed that during the planning and carrying out, there were developments in prospective mathematics teacher students' PCK ability from cycle I to cycle II. Through the lesson study-based FEP, prospective mathematics teacher students can learn, gain knowledge, and build PCK knowledge from lecturers, teachers, and friends who participate in open lesson activities. The implication of this research is the need to revitalize the implementation of FEP for prospective mathematics teachers, namely by integrating lesson study in FEP activities.

Keywords: PCK, FEP, lesson study

1. Introduction

In Indonesia, institutions that specifically produce prospective teachers are known as the Institute of Teachers’ Education. During the education, the students are provided with learning material, teaching practice, and other knowledge. This prospective teacher education is known as preservice education.

One of the activities of pre-service education is the implementation of a Field Experience Practice (FEP). FEP is a series of activities that involve teaching practice and educational tasks outside of guided and integrated teaching. What the author wants to achieve is a prospective teacher who has knowledge, skills, values, as well as attitudes are needed for the profession as a teacher, competent and appropriate to use them in organizing education and teaching [1], [2].

Professional teachers are the teachers who not only understanding about content knowledge and pedagogical knowledge but also understanding the integration between the two. Specific knowledge is integration between content knowledge, and pedagogical knowledge is known as Pedagogical Content Knowledge (PCK) [3], [4]. PCK is a way to represent and describe a subject so that others can
understand it easily [5], [6], PCK consists of three components, namely (1) Knowledge of Content and Students, (2) Knowledge of Content and Teaching, and (3) Knowledge of Content and Curriculum [7], [8]. Therefore, in simple terms, PCK’s capabilities can be measured from two aspects, namely (1) the ability to make learning plans and (2) the ability to carry out the planning in front of the class. Prospective mathematics teachers must have adequate PCK so they will become professional teachers later. In general, the ability of PCK prospective mathematics teacher students can be developed through learning media courses, computer-aided learning, evaluation of learning outcomes, learning planning, and microlearning. However, these five courses are considered inadequate because students do not have the experience to carry out in the real class [9]. One way to develop their PCK is through FEP.

Implementation of FEP in the Faculty of Teacher Training and Education of Lambung Mangkurat University, the prospective teachers are in school for three months at partner schools. A tutor and supervisor will guide them. Based on the experience over the past five years in guiding the students, the main problem encountered was not carrying out joint reflections involving students, teachers, and lecturers after students finished implementing classroom learning practice. This fact is very influential in the development of student’s PCK. For this reason, improvements are needed so that the implementation of FEP can truly foster prospective mathematics teacher students in developing their competencies.

One alternative improvement is activating collaboration between prospective mathematics teacher students who are currently FEP in partner schools with teachers and lecturers. Collaboration between students, teachers, and lecturers are packed in the form of lesson study. This is consistent with [10], [11] opinion which state lesson study is one of the ways of professional development of teachers, an effective way that can improve the quality of learning.

Lesson Study is a systematic process used by teachers in Japan to test the effectiveness of teaching to improve the quality and results of learning. This lesson study is carried out in three stages, namely, planning, implementation, and continuous reflection [12]. The systematic process in FEP activity is intended to collaborate with prospective mathematics teacher students to develop learning plans, make observations, reflect and revise cycles of learning plans periodically and continuously.

Previous researches related to PCK has been carried out by [13]-[16]. They conclude that lesson study can improve the PCK of prospective science teachers and physics teacher. The difference between this research and previous research is (1) specifically examining the PCK ability of prospective mathematics teacher students, and (2) integrating lesson study in FEP activities.

Based on the explanation above, it is necessary to research for developing PCK for prospective mathematics teacher students through FEP activities, which is packed in the form of lesson study. The research aim is to develop PCK for prospective mathematics teacher students through lesson study-based FEP. This research uses the Classroom Action Research Method within 2 cycles. Each cycle consists of three stages of activities, namely planning (Plan), implementation (Do), and reflection (See). The implication of this research is the need to revitalize the implementation of FEP for prospective mathematics teachers, namely by integrating lesson study in FEP activities.

2. Method
The research method used is Class Action Research. The places for conducting research are Junior High School 5 Banjarmasin and Junior High School 32 Banjarmasin. There are seven students who are the subject of this research. The research subjects are coded to simplify identification. (1) The first digit S shows the subject. (2) The second digit shows the school. (3) The third digit shows the sequence number of the research subject at a particular school. For example SA1, it means the subject is in Junior High School 5 Banjarmasin with the sequence number of one.

This research uses a lesson study based on 2 cycles. Each cycle consists of three stages of activities, namely planning (Plan), implementation (Do), and reflection (See). Data is collected through a study of learning plan, carry out, and reflection. There are two aspects of prospective mathematics teacher students’ PCK that are observed, namely the ability to make learning plans and the ability to carry out aspects. There are several indicators of students’ ability to make lesson plans, namely consists of
formulating learning objectives, learning materials, learning strategies, learning media, choosing learning resources, evaluating, and planning remedial activities. While the indicators for the aspects of the ability to carry out are opening lessons, mastering the subject, learning strategies/approaches, process assessment, and closing learning.

The research instrument was used to measure the ability of prospective mathematics teacher students’ PCK to use instruments made by the Development Team for Testing Teacher Performance [17]. There are 10 observers in this research, consist of two teachers, two lecturers, and six students. Each observer will assess the ability to make learning plans and the ability to carry out in the class. Data from observations by each observer will be averaged. Furthermore, the average results are interpreted in the form of categorization by Table 1. In addition to data on the ability to make plans and carry out them, data also are collected on the results of learning reflection. This learning reflection data is used as input material to improve the next cycle of the learning process. The success indicator of this research is that five out of seven research subjects experience an increase in the PCK ability category, both the ability to make a learning plan and the ability to carry out.

| No. | PCK Ability | Category                   |
|-----|-------------|----------------------------|
| 1.  | < 40.0      | Grade 1 (Very incapable)   |
| 2.  | 40.0 – 59.9 | Grade 2 (Incapable)        |
| 3.  | 60.0 – 79.9 | Grade 3 (Capable)          |
| 4.  | 80.0 – 100.0| Grade 4 (Very Capable)     |

3. Result and Discussion

The student’s PCK ability consists of two aspects, namely (1) the ability to make a learning plan, and (2) the ability to carry out. To see the development of the prospective mathematics teacher students’ PCK abilities, PCK capability data in cycle I and cycle II are categorized using criteria Table 1.

Students’ PCK abilities for aspects of making learning plans in the first cycle and second cycle are explained in Figure 1.

![Figure 1. Ability to make learning plans](image)

Figure 1 shows two students were in the grade 2 category (SA2 and SA3) in the first cycle, and after making improvements, the second cycle developed into grade 3 (SA3) and grade 4 (SA2). Furthermore, in the first cycle, five students were in the grade 3 category, and after making improvements, the second cycle developed into grade 4 (SA1, SB5, SB6, SB7). These results indicate that the research met the required indicators. Figure 2 explains Students’ PCK abilities for aspects of carrying out.
Figure 2. Ability to carry out

Figure 2 shows three students were in the grade 2 category (SA2, SA3, SA4) in the first cycle, and after making improvements, in the second cycle developed into grade 3 category (SA3, SA4) and grade 4 (SA2). Furthermore, in the first cycle, four students were in the grade 3 category, and after making improvements, the second cycle developed into grade 4 category (SA1, SB5, SB6, SB7). These results indicate that the research met the required indicators.

The observers provided suggestions for improvements when reflecting on the implementation of learning. Summary of reflection results for the first cycle, and the second cycle are presented in Table 2 and Table 3, respectively.

**Table 2. The first cycle reflection result**

| Subject | Observers’ Suggestions |
|---------|------------------------|
| SA1     | Give the students direction first before group discussions are held. |
|         | Reduce teachers' dominance in the learning process. |
|         | Improve class management and time management. |
| SA2     | Pay attention to body gestures and voice intonation. |
|         | Improve classroom management and reduce teacher dominance. |
|         | Improve the learning process so that active learning will be stimulated. |
|         | Reinforce students' answers. |
|         | The idea of drawing learning conclusions must come from students. |
| SA3     | Apperception and motivation given are inadequate. |
|         | Reinforce the subject and classroom management. |
|         | Give scaffolding, not answer. |
|         | Modify the questions in the student worksheet with the questions at evaluation time. |
|         | Reduce teacher dominance in learning and improve time management. |
| SA4     | Apperception and motivation given are inadequate. |
|         | Improve class management and time management. |
|         | Give examples must be from concrete to abstract. |
|         | Use a bow to draw circles on the board. |
|         | All students must be involved in drawing a conclusion. |
| SB5     | Give attractive motivation to students. |
|         | The teachers don't just stick to one group. |
|         | Improve class management. |
| SB6     | Give an adequate apperception. |
|         | Deliver learning objectives in the opening section. |
|         | Use a bow to draw circles on the board. |
|         | Reinforce students' answers. |
| SB7     | The teacher must prepare students physically and mentally. |
Subject | Observers’ Suggestions
--- | ---
 | • Give motivation as well as possible.
 | • Give scaffolding, not answer.
 | • The teachers need to provide strategies, so students pay attention to the presentation.

Table 2 shows the students still need guidance in carrying out in front of the class. In general, the students need to improve how to open lessons, carry out core activities, and close lessons, body gestures, voice intonation, classroom management, and time management.

**Table 3. The second cycle reflection result**

| Subject | Observers’ Suggestions |
| --- | --- |
| SA1 | • In general, the learning process was running well.  
 | • Apperception and motivation still need improvement.  
 | • Prepare another group to answer the questions, so not only the groups who already answered were active. |
| SA2 | • Pay attention, the purpose of the lesson forgot to be given.  
 | • Improve the gesture because it can affect the mood of the class.  
 | • The role of a teacher as a leader of students needs to be improved. |
| SA3 | • The teacher did not prepare students well.  
 | • The teacher lacks mastery in subjects.  
 | • Make active students as motivation for other students. |
| SA4 | • Apperception and motivation were good, only less optimal.  
 | • Discussions were not that optimal because the class is noisy.  
 | • Pay attention to the body gesture; don't smile too much. |
| SB5 | • Apperception given is inadequate.  
 | • Give scaffolding, not answer.  
 | • Reinforce the concept that has been taught. |
| SB6 | • The scope of the material needs to be given before entering the core activities.  
 | • When making conclusions, conclusion ideas must begin from students.  
 | • Give explanations and reinforcement of different student answers. |
| SB7 | • Apperception given is inadequate.  
 | • Activity one on the student worksheet is not communicated.  
 | • The conclusions made must start from students, not teachers. |

Table 3 shows the students had received improvement suggestions during the first cycle of reflection, but during the second cycle of learning, there were still students who made the same mistakes.

Based on the results of reflection, the study continued until the second cycle. The research indicators were achieved after the implementation of the second cycle. The results achieved after the implementation of the second cycle, both the ability to make learning plans aspects and the ability to carry out aspects, two students were capable (SA3, SA4), and five students were very capable (SA1, SA2, SB5, SB6, SB7). There were still students who made the same mistakes. The results of this study are consistent with the results of the research [18], which states that prospective mathematics teacher students must practice a lot in using strategies/models/learning approaches so that the same mistake does not recur.

The results prove that through lesson study-based FEP could develop prospective mathematics teacher students’ PCK. This happened because, through the collaboration of students, lecturers, and teachers, prospective mathematics teachers have a broad opportunity to learn and gain experience to build pedagogical knowledge. The results of this study are supported by the opinions of [11] and the results of research [15], [19], [20], which states that lesson study can develop teacher professionalism.

The results achieved are related with the results of the research [13], [14], [16] which states that the use of lesson study in real teaching practices shows an increase in the ability of prospective teachers in
making learning plans, focusing more on PCK development, and ideas on how to teach the subjects. Reflections on the learning outcomes in the lesson study provided an opportunity for prospective mathematics teacher students to openly accept criticism and feedback from lecturers, teachers, and students who participate in open lesson activities. Open lesson activities will increase the eagerness of prospective mathematics teacher students, both physically and mentally, to develop their PCK abilities. This is consistent with the results of the research [13], which shows that the experience of implementing learning will affect the PCK of prospective teachers.

4. Conclusion
The results and discussion above conclude the lesson study-based FEP can be used as a method to develop prospective mathematics teacher students’ PCK. Through the lesson study-based FEP, prospective mathematics teacher students can learn, gain knowledge, and build PCK knowledge from lecturers, teachers, and friends who participate in open lesson activities. The weakness of this study is the limited number of samples. However, the results obtained can be used as a basis for making policy. The implication of this research is the need to revitalize the implementation of FEP for prospective mathematics teachers, namely by integrating lesson study in FEP activities.

References
[1] BNSP 2011 Antisipasi Terhadap Pergeseran Paradigma Pendidikan Tinggi Abad XXI. Laporan Survei (Jakarta: Badan Standar Nasional Pendidikan).
[2] Tim UPPL 2012 Petunjuk Teknis Pelaksanaan Praktik Pengalaman Lapangan (Banjarmasin: UPT UPPL Universitas Lambung Mangkurat).
[3] Schulman L 1986a Educ. Res. 15 4
[4] Lee E and Luft J A 2008 Int. J. Sci. Educ. 30 1343
[5] Loughran J, Berry A and Mulhall P 2012 Understanding and Developing Science Teacher’s Pedagogical Content Knowledge (2nd ed.) (Rotterdam: Sense Publisher).
[6] Schulman L 1986b Harv. Educ. Rev. 57 1
[7] Ball D L, Thames M H and Phelps G 2008 J. Teach. Educ. 59 389
[8] Jing-Jing H U 2014 Int. J. Educ. Res. 2 411
[9] TIM 2017 Kurikulum Program Studi Pendidikan Matematika, Berdasarkan KKNI Dokumen Program Studi FKIP Universitas Lambung Mangkurat.
[10] Mulyana S 2007 Lesson Study LPMP Jawa Barat.
[11] Zubaidah S 2010 Lesson Study Sebagai Salah Satu Model Pengembangan Profesionalisme Guru Pendidikan dan Pelatihan Nasional Tanggal 22 April 2010 di Universitas Brawijaya Malang https://www.researchgate.net/publication/318040478_LESSON_STUDYSEBAGAI_SALAH_SATU_MODEL_PENGEMBANGAN_PROFESIO NALIS-MEGURU_1.
[12] Fernandez C, Yoshida M, Chokshi S and Cannon J 2001 An Overview of LessonStudy, ppt. online lsrg@columbia.edu,www.tc.edu/lessonstudy.
[13] Karal I S and Alev N 2016 Teach. Dev. 20 162
[14] Yulianti L 2017 Momentum Phys. Educ. J. 1 16
[15] Ma’rufi and Ilyas M 2017 J. Pedagog. 2 106
[16] Akerson V L, Pongsanon K, Rogers M A P, Carter I, and Galindo I 2017 Int. J. Sci. Math. Educ. 15 293
[17] Ristekdikti 2017 PANDUAN TEKNIS IV: Instrumen Penilaian Uji Kinerja UKMPPG (Jakarta: Dirjen Pembelajaran dan Kemahasiswaan).
[18] Siswono T Y E, Hartono S, Kohar A W, Karim K and Lastiningsih N 2019 TEM J. 8 677
[19] Saw T F, Chap L S and Cheng C M 2017 Malaysian J. Learn. Instr. Special Issues 145
[20] Ayebo A and Assuah C 2017 Malaysian J. Learn. Instr. 14 169