

First-year mathematics student teachers' pedagogical content knowledge

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Abstract

The competencies teachers should master are the pedagogical skill and subject mastery. The combination of these is also known as pedagogical content knowledge (PCK). Through PCK, teachers could match the subject materials taught with students' characteristics, teaching methodology and learning media, or with other pedagogical components. This research aims to describe first-year mathematics student teachers' PCK through analysing three students as the subjects. The subjects were selected based on their microteaching test result which was included as the second round of student enrolment process at Al Hikmah Teacher Institute. Data was collected through observation and interview. The result of this research showed that all three subjects had sufficient PCK. PCK components which were not mastered by the subjects were curriculum knowledge, delivering subject materials in uncomplicated language, and class management. However, all three subjects were able to choose and take the advantages of the media and they were also able to conduct observation. This result is hoped to serve as the mapping of students' PCK and as the base in quality improvement programs at Al Hikmah Teacher Institute.

1. Introduction

Mathematics has abstract study objects so the mathematics teachers must have the ability to represent/simplify the abstract object by involving concrete objects that are around students. Therefore, an effective mathematics teacher is a teacher who has the ability to deliver a material with a particular learning design and pay attention to the background knowledge of students and other supporting aspects so that learning objectives can be achieved. In line with the above, The Ministry of National Education Policy Attachment No. 16 Year 2007 stated four compulsory competencies that teachers should have in order to be said qualified both in mastering the subject content and in teaching. Shulman [3] stated that the combination of these two competencies is called Pedagogical Content Knowledge (PCK).

Through PCK, teachers can combine subject contents with students' characteristics, educational aims, learning media, instructional principles and other pedagogical components. The concept of PCK at STKIP is in line with the vision of STKIP Al Hikmah Surabaya. That is, to produce Muslim educators with good morals and has competitive teaching competence. Therefore, all student teachers in this institution, including the mathematics student teachers, need to have a sophisticated combination of teaching competency and subject content mastery. Therefore, the educational process of student teachers at STKIP Al Hikmah not only conveys the content knowledge but also pedagogical knowledge as well as the experience of interacting with students in the class within a certain period of time. The first experience that is provided to first-year mathematics student teachers' is teaching peers. Student teachers are trained to deliver

material by paying attention to the selection of the right diction, variations in voice intonation and body gestures, making connections between materials, forms of evaluation given to check understanding, and so forth. In general, the provisions given to students are in line with the PCK components developed by several experts. For this reason, the application of the PCK concept at STKIP Al Hikmah is urgently needed to develop mathematics student teachers' competency.

With regard to PCK components, some experts are trying to develop PCK components besides Shulman such as Grossman, Tamir, Magnusson [2] and others. Furthermore, Hu [1] revealed that the model developed by Grossman focused on teaching English literature, while Tamir and Magnusson focused on teaching science. However, the PCK component developed by Magnusson was not only implemented in science but also in mathematics. This indicates that the terminology for PCK components is sometimes general so that it can be implemented in other fields. Thus, in the study using PCK components developed by Magnusson. Much research has been done on PCK but the focus of the subject is teachers in various fields of study the results of the research have a good impact [4]. While the subjects in this study were student teachers' so that through this research could contribute to teacher competence including PCK to graduates of the STKIP Al Hikmah.

2. Research Method

This type of research is descriptive qualitative. This research aims to describe the first-year mathematics student teachers' PCK on the function material. There were three subjects in this research. The subjects were selected using a purposive sampling technique and chosen based on the microteaching test result, that was tested in the second round of STKIP Al Hikmah student enrollment process. The instrument used was an observation sheet and assisted with video recording. The observation sheet was adapted from Magnussons' [1] and contains five PCK components which can be seen in the following table.

Table 1. Magnussons' PCK Model

Code	Component	Competencies
C1	Orientations Toward Teaching Mathematics	Knowledge and beliefs serve as a "conceptual map" that guides daily objective, the content of student assignments, the use of textbooks and other curricular materials, and the evaluation of student learning.
		Knowledge of the purpose of using certain learning methods/ techniques for a material
C2	Knowledge of Mathematics Curriculum	<i>Knowledge of the goals and objectives for students:</i> the articulation of those guidelines across topic addressed during the school year, the vertical curriculum in their subject (what student have learned in previous and later years), and national documents that outline framework for guiding decision-making with respect to mathematics curriculum and instruction.
		<i>Knowledge of specific curricular program:</i> programs and materials that are relevant to teaching a particular domain and general learning goals of the curriculum as well as the activities and materials to be used in meeting those goals.

Code	Component	Competencies
C3	Knowledge of Students' Understanding of Mathematics	<p><i>Knowledge of requirements for learning:</i> prerequisite knowledge for learning specific mathematics, understanding of variations in students' approaches to learning, and knowledge of the abilities and skills that students need including different learning styles.</p> <p><i>Knowledge of areas of student difficulty:</i> about each type of difficulty, for example the concepts very abstract or student do not know how to think and find solutions. Knowledge about the errors that students commonly make and a misconception.</p>
C4	Knowledge of Instructional Strategy	<p><i>Knowledge of subject-specific strategies:</i> models/ approaches/ strategies that can be implemented in mathematics learning.</p> <p><i>Knowledge of specific strategies</i> includes topic-specific representation refers to knowledge about ways to represent specific concepts or principles in order to facilitate student learning and topic-specific activities refers to knowledge of the activities that can be used to help students comprehend specific concepts or relationships.</p>
C5	Knowledge of Assessment in Mathematics	<p>Knowledge of dimensions of mathematics learning to assess.</p> <p>Knowledge of methods of assessment.</p>

3. Result and Discussion

The results of research were obtained from analysis observation sheet data of mathematics student teachers' PCK.

Orientation Toward Teaching Mathematics

The first component of PCK according to Magnusson refers to two competencies that can be seen in table 1. Based on the observation, one of three subject that is S1 are able to arrange the learning objective but after the interview, S1 did not know how to arrange learning objectives that are based on basic competencies. Besides that, S1 does not have knowledge and learn more about basic competencies. The results of the interviews showed that the three subjects did not master the material transformation of linear functions properly. This has an impact on the selection of appropriate textbooks and the form of assignments given. The data shows that the three subjects do not yet have the knowledge and beliefs serve as a "conceptual map" contained in the first competency in the first PCK component.

In general, there is no explanation regarding the learning methods/ techniques used. the three subjects appear to use several different delivery methods so that the material can be conveyed. Thus the second competency has not been fulfilled by the three research subjects.

Knowledge of Mathematics Curriculum

No subjects have knowledge of the mathematics curriculum. The impact is that no subjects have been able to determine the prerequisite material and the relation of the linear function transformation material with other material. In addition, the material is considered new material.

This is possible for the three subject schools not yet implementing K13 so there are several different materials. Based on these data, it can be said that the three subjects do not yet know about the applicable national mathematics curriculum documents and have not met the first competency in the second component of PCK. Due to the limited knowledge related to the goals and objectives for students, the knowledge has not been fulfilled. Thus, the second component of PCK has not yet been fulfilled.

Knowledge of Students' Understanding of Mathematics

As stated earlier, the three subjects had never studied linear function transformation material so that they had difficulty in finding references and resubmitting the material in plain language. Although the three subjects also did not have sufficient knowledge about the learning methods/techniques that were appropriate to the material, but in its implementation, it appeared that variations in the delivery of the material as a way of understanding peers. This indicates the growth of the soul and belief of the teacher, namely making various efforts to understand students. So it can be said that the three subjects fulfill one of the three competencies in the third component of PCK.

In general, the three subjects have not been able to determine the part that is considered difficult for students. Observation data shows that S1 knows the level of difficulty and types of errors that students commonly make. However, unconsciously S1 also made a mistake in explaining the steps to draw graphics. While the other subjects have not been able to demonstrate this knowledge. Based on the data description, it can be concluding that were fulfilled in the third component of PCK.

Knowledge of Instructional Strategy

The fourth component of PCK refers to two competencies refers to models/ approaches/ strategies that can be implemented in mathematics learning and ways to represent specific concepts or principles. As previously explained the three subjects do not yet have knowledge of particular model/approaches/strategies so that all subjects using the same method of delivering material and then giving examples. Nevertheless, there are differences in the way between S1, S2, and S3 to help colleagues in understanding linear function transformation material. First, S1 uses mind mapping, then S1 uses two techniques in drawing graphics, which are drawn on the board and using geogebra. While the other two subjects only describe the function graph on the board. S2 uses colorful boardmarkers while S3 only uses black boardmarkers. In general, one competency in the third component can be fulfilled by all three subjects even with different qualities.

Knowledge of Assessment in Mathematics

The last PCK component refers to knowledge of dimensions of mathematics to learning assess and methods of assessment. Based on the two competencies, all subjects only knew one assessment method, written test. written test questions have been prepared well it's just that due to time constraints the written test has not been carried out. While the subject's knowledge of dimensions of mathematics learning to assess is still limited to the cognitive dimension, it does not include affective and psychomotor dimensions. So, the three subjects only fulfill one competency in the fifth component.

A description of the competencies of each PCK component fulfilled by the three subjects can be presented in the following chart.

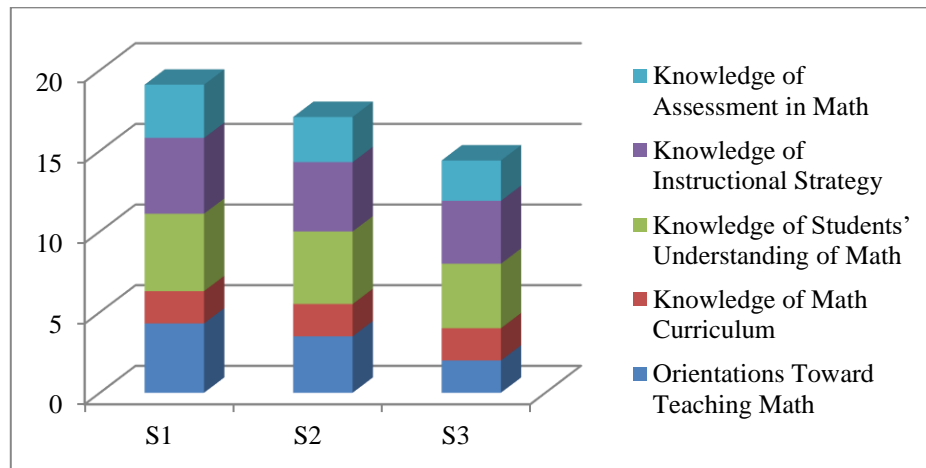


Figure 1. Composition of PCK Component

4. Conclusion

Based on the research result, it can be concluded that the all research subjects have not been able to have five PCK components developed by Magnusson. However, one subject is S1 fulfills four components while S2 and S3 fulfill three components. The components fulfilled by the three subjects are not yet intact because there are several competencies in each component that have not been fulfilled. However, the results can be used as a basis for consideration/ strategy to improve mathematics student teachers' pedagogical content knowledge going forward.

References

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