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Understanding of Prospective Physics Teachers Students Toward Pedagogical Content Knowledge on Optical Geometry Materials

E Erwin^{1,2,*} and NY Rustaman¹

¹Program Studi Pendidikan Ilmu Pendidikan Alam, Sekolah Pascasarjana Universitas Pendidikan Indonesia, Jl. Dr.Setiabudi No. 229, Bandung 40154, Indonesia.

² Sekolah Tinggi Keguruan dan Ilmu Pendidikan Nurul Huda, Kabupaten Ogan Komering Ulu Timur, Provinsi Sumatera Selatan

*erwinpohan74@student.upi.edu

Abstract. This article discusses about Pedagogical content knowledge (PCK) profile of prospective physics teachers on optical geometry materials. Data collected using interview and questionnaire, and the data were analyzed descriptively. The results showed that PCK is an unfamiliar term to students. The extreme findings in this study is the lack of understanding of PCK by prospective physics teachers relating to the importance of recognizing the characteristics of students and how to manage questions from students, which teacher has to directly answer questions from students, and how to respond to the students' incorrect answer, mostly prospective physics teachers assume that in case of the students answer incorrectly, the students should be directly blamed. Prospective physics teachers have not yet integrated the pedagogical knowledge with the content knowledge in their possess learning it he optical geometry material.

1. Introduction

PCK is a combination of two competencies, namely pedagogical knowledge (pedagogic competence) and content knowledge (content competence). PCK for teacher is very important due to create meaningful learning. content knowledge includes knowledge of concepts, theories, ideas, framework of thinking, method of verification and evidence, while pedagogical knowledge relates with the ways and processes of teaching which include knowledge of classroom management, tasks, effective lesson planning, and student learning and assessment [1]. Initially, education of teacher emphasized more of teacher's knowledge of subject matter [1,2] However, over the past decade, education of teacher has begun to emphasize on the effectiveness of general pedagogical methods which include the use of questions, and the design of an assignment and the curriculum, also the assessment of student's independent performance on each subject matter [2, 3]. The experts now recognize that both knowledge of subject matter and pedagogical knowledge are crucial in a good teaching and in enhancing students' understanding [2]. A good teacher should be able to be an expert of the content (subject matter) and master the science of teaching (pedagogy).

In accordance with the National Education Regulation of the Republic of Indonesia number 16 of 2007 about Academic Qualification Standards and Teacher Competencies, it is stated that the teacher's

pedagogy competence includes seven competencies and in this study, PCK components are: Mastering the characteristics of learners, Mastering the learning theory and principle of educational learning, Curriculum development, Educational learning activities, Development of learners' potentials, Communication with learners, and Assessment and evaluation. The pedagogical competence in which is applied in teaching special subject matter will actualize the ability of PCK [4]. Inculcating PCK to teachers is most likely to be done while they are taking the education for prospective teacher. The teacher education institution (Teacher Training Institute), which is an institution that produces educators (teachers), should provide the PCK acquaintance to prospective teacher before they are graduated from Teacher Training Institute. To facilitate the development of prospective teachers' PCK, educational models prospective teachers need to be gradual and structured early gives experience to prospective teachers to interact and gain experience in schools [5]. As a form of Teacher Training Institute responsibility to the prospective teacher related to the ability of their PCK, and the institute ought to assess the ability of prospective teachers' PCK until being declared as a competent prospective teacher.

Several studies on how to assess PCK have been done using a variety of instruments, including: Essay open ended test [6], Content Representation (CoRe) [7], Observation [8, 9, 10], Interview [8, 9, 10, 11, 12]. But there have not been research that reveals about the understanding of PCK prospective physics teacher on optical geometry material, then based on background described, this article will discuss about how the PCK profile of prospective physics teacher on optical of geometry materials.

2. Method

In The research was conducted at one of the High School of Teacher Training and Education in South Sumatera Province, involved 30 respondents, specifically prospective physics teachers who had followed the pedagogy and Field Experiment Program I and II, so it was assumed to have a sufficient understanding of PCK. Respondents were asked to provide information on how they understood the importance of PCK. The instruments used for data collection were questionnaires and interview guidelines.

Questionnaire consisted of 45 items of statements on optical geometry materials, with a choice of answers strongly agree, agree, disagree, and strongly disagree. Scoring method used Likert scale of 4 points. A score of 4 was given on the option strongly agree for a positive statement and strongly disagree for a negative statement. Score 3 was given on the option of agreeing to a positive statement and not agreeing to a negative statement. Score 2 was given on the option of disagreeing for a positive statement and agreeing to a negative statement. As well as score 1 was given on the option strongly disagree for a positive statement and strongly agree for a negative statement.

Data analysis was done descriptively by presenting the findings from the research. Data derived from the questionnaire were verified and calculated on average PCK score of prospective teacher and presented in percentage form.

3. Result and Discussion

3.1. College profile of research location

Students of Physics Education study program at High School of Teacher Training and Education who became research object mostly came from farmer family, so many students used their time to work part time as farm labours or helped their parents farming.

The location of the college was located at in a village about 30 km from the district capital, and was $\pm$ 200 km from the capital city of South Sumatera Province, Palembang. The regency was an ex-transmigration area whose inhabitants were almost 80% were transmigration community from ethnic Javanese. People's livelihood was generally rice farmer, paddy field spread in this regency was technical irrigation rice field.

The college students generally were students who did not pass the entrance examination public universities, although there were some who did choose that college as the main goal for some reason.

For example, because of that college was under control of a boarding school, so the Islamic nuances more felt compared with other colleges nearby. Another reason was because that college was located near the location of student residence and for students from outside the region, there was dorm boarding school available for students' residence.

Input of students at that college was not as good as the input of students at college which hold very strict selection and tight competition, but the college made its special standard, with respect to the ability to read Al-Quran for graduate candidates, in which student who was Muslim wouldn't be allowed to take final examination or thesis court, if the student had not passed the Al-Quran literacy test, and his graduation was proved by the certificate of pass reading Al-Quran issued by high school based on the recommendation of lecturers who were appointed as the testers and mentors of reading Al-Quran

3.2. Profile of Pedagogical Content Knowledge (PCK) prospective physics teachers

3.2.1. Comprehension the concept of Pedagogical Content Knowledge (PCK)

Based on the result of interviews, prospective physics teachers had their own perceptions about the concept of pedagogical knowledge (PK). most of the prospective physics teachers who were interviewed (7 out of 10) did not understand the pedagogical understanding well, even though they had heard the term from the lecturers who taught the subjects of education, they commonly thought pedagogy was teaching. Even when all students had not fully understood the notion of pedagogy, the understanding of prospective physics teachers was only limited to how to manage the class during learning activities, not comprehensively comprehending about pedagogy which included 7 competencies. According to the regulation of education and culture minister number 16 of 2007 [4], that is: Mastering the characteristics of students, mastering learning theories and principles of educational learning, development of curriculum, educational learning activities, development of learners' potential, communication with learners, and assessment and evaluation.

Student understanding about content knowledge (CK) which in Minister of National Education number 16 of 2007 was named by the term of professional competence also still very minimal [4]. All of the prospective physics teachers stated that CK was only about understanding the content of subject that would be taught to the students.

Students claimed that the CK was the ability of the teacher to understand the material regardless of the depth, breadth, and how to package the subject material that would be taught to the students, so the learning could be effective and meaningful. Subject material was presented to students depended only on the teacher's curriculum or handbooks.

PCK was an unfamiliar term for students who were interviewed. It was revealed from their statement as a respond to the question; "I just heard the term –pedagogical content knowledge-, which usually I had heard only pedagogical term.". All the interviewed students gave a statement with a same meaning, based on the statement, neither understand the definition or concept of PCK, nor even did they hear the term before.

The term of PCK during lectures had never been introduced by lecturers, and after making confirmation with lecturers who taught the subjects on physics education, they absolutely never had introduced the term to the students. The reason why lecturers had not introduced the term was because they themselves also did not understand the term of PCK, even it was the first time of hearing the term.

3.2.2. Prospective physics teachers feedback on the importance of pedagogical content knowledge (PCK)

At the first time of the interview as stated preceding, it was revealed that prospective physics teachers were still unfamiliar with the term of PCK. Based on the interview guidelines, if the they were not familiar with the term, then the PCK definition: "Pedagogical content knowledge was a special combination between pedagogy and content or a mixture of content and pedagogy to form a

knowledge of how a topic, problem, or issue was organized, represented according to the learner's ability" plus a simpler language explanation indicating that the PCK was used specifically on a particular material does not apply equally to all material. The interviewer's explanation did not impact the respondent, but only provided a theoretical understanding of PCK, so that the respondent understood what the term meant and could give any knowledge based feedback about PCK. After the respondent understood the meaning or definition of PCK, then respondents were asked for their responses about whether or not the PCK was provided for the prospective physics teachers.

Based on interviews with prospective physics teachers indicating that an understanding of PCK was considered to be very important. PCK provided provision for prospective teachers to understand how to package a subject matter combined with pedagogical knowledge to teach a subject to produce a meaningful learning for students. This was as revealed by one the students who stated that:

"I just heard the term PCK. I once read that a learning model could not be used on all materials, because a learning model was used on materials that matched with the characteristics of the material. If PCK was used only on certain materials, it meant what I had read and that was important for students."

The average score and percentage of scores based on the potential physicist PCK component were presented in the following Figure 3.1 and 3.2.

Figure 3.1. The average score based on PCK components

Figure 3.2. Percentage score based on PCK components

PCK components as shown in the figure 3.1 and 3.2 above were: I is mastering the characteristic of learners, II is mastering the learning theories and principles of educational learning, III is curriculum development, IV is educational learning activities, V is development of learners' potential, VI is communication with learners, and VII is assessment and evaluation.

Based on the picture 3.1 and 3.2 above, it turns out PCK component most understood by physics teacher candidate is on the component of potential development of learners, while the lowest understanding is the component of establishing communication with learners. The response of respondents who were interviewed as a while showed similarity of opinions, PCK was an important knowledge to be given to prospective physics teachers, as the ability to be able to carry out better learning. During lectures, students were provided with pedagogical knowledge which includes: Introduction to educational sciences, study and learning, educational psychology, fundamentals of teaching process I & II, curriculum review, learning evaluation, and field experiment program I & II.

Besides pedagogical knowledge, the students were also equipped with knowledge of physical content, but both components were provided separately, according the concept of Pedagogical Content Knowledge, meanwhile, according to Shulman learning of a particular material is done by

amalgamation between pedagogical knowledge and content content, so that learning becomes more meaningful. Knowledge of Pedagogical content knowledge (PCK) prospective physics teachers [1].

The result showed that the average understanding of students about PCK on optical geometry material was generally quite good, which obtained the average questionnaire score 89.76 of a maximum score 120 or the percentage of 74.80%. PCK of prospective physics teachers which revealed in the study was divided into 7 competencies, according to the regulation of the national education minister number 16 of 2007 [4], the average score of understanding of PCK by prospective physics teachers on the competence; Mastering the characteristics of the learners is 95.50 or 79.58%, mastering learning theories and principles of educational learning is 80.17 or 66.81%, curriculum development is 90.00 or 75.00%, educational learning activities is 83.69 or 69.74%, development of potential learners is 99.00 or 82.50%, Communication with learners is 81.00 or 67.50%, assessment and evaluation is 92.00 or 76.67%.

The surprising findings were maintained based on a questionnaire on six items; *first*, item number 4, which reads; ‘in the course of learning materials of optical geometry, the teacher must understand the students’ habits in his environment’ only got the percentage score of 56.67%, it indicated that the prospective teacher had not understood the introduction of the characteristic of learners as a whole, whereas the introduction of the characteristics of learners on aspects of learners’ habits or culture was important to provide appropriate treatment to student related to optical geometry material. *Second*, Item number 13, which reads; ‘in the course of implementing the learning of optical geometry materials, the student’s questions should be answered by teacher immediately’ only got the percentage score of 46.67%, this showed the understanding of PCK prospective physics teachers for strategies to answer students’ questions on the material of optical geometry materials was not sufficient, students considered a good way to manage learner questions was directly answered the questions. *Third*, Item number 15, which reads; ‘the reason for using experimental method in optical geometry learning was because the curriculum demand’ got percentage 58.33%. *Fourth*, Item number 16, which reads; ‘the reason for using experimental method in optical geometry learning was that the method used by teachers to be varied’ got percentage 48.83%. *Fifth*, Item number 17, which reads; ‘the reason to use experimental method on optical geometry learning was order to student practice’ earned a percentage of 47.50%. The three items of questions number 15,16, and 17 related to the reason of using the method of learning used was the experimental method on optical geometry materials. Students had not understood well the reason for the use of experimental methods that were closely related to inquiry. Instead, prospective physics teachers understood the use of experimental methods only because the curriculum demands, so the methods used in learning vary and so students practice. that was not a fundamental reason for the use of experimental methods in the learning of optical geometry. The reasons for using experimental methods in optical geometry learning which should be understood by the prospective teacher, based on pedagogy or psychological function were; experiments developed causal and functional thinking and creativity, experiments could develop the ability to work in teams, experiments motivated, increased variation, and aroused interest, experiment gave experience learning, and etudents were actively involved. Meanwhile, based on functions relating to the subject or epistemology the use of experimental methods on optical geometry materials were; the experiments supported the study of scientific research methods, experiments were established methods of acquiring knowledge in physics (generating hypotheses and working with them), experiments made a concrete visual physical facts, experiments made physical facts or relationships reasonable or explained it, experiments supported the formation of concepts, and experiments could cause cognitive conflicts. Whereas, based on built practical functions, the use of experimental methods on optical geometry materials were; students practiced how to handle data and done data analysis, students practiced to dealing with differences orrelationships with them, and haptic or developing psychomotor aspects [6], and *Sixth*, Item number 32, which reads; “if a student gave incorrect answers when learning optical geometry, teacher should immediately blamed him/her, so the student would know that he/she was wrong” only got the percentage score of 55.83%, it indicated the lack of understanding of prospective physics teachers to do educational learning process related in building student knowledge. The

student's incorrect answer should not be directly adjudged, but the teacher should guide the student to find the correct answer, so that the student's understanding was built by constructing his/her own knowledge and through his/her own process of thinking and understanding.

4. Conclusion

The understanding of prospective physics teachers about PCK on optical geometry material is quite good, but needs to be improved so that the understanding of PCK more deeply. Nevertheless, the terms in PCK are still not well understood by student prospective teachers. The understanding of Prospective physics teachers is very low on some component of PCK that is: *first*, the lack of understanding of PCK about the importance of knowing the characteristics of students relating to the students' habits, or cultural environment that the students consider unimportant in carrying out optical geometry. *Second* how to manage student questions that teachers directly answer. *Third*, the reason to use of experimental methods on the learning of optical geometry, students assume because of the demands of the curriculum only, in order for the method to vary, and to have students practice. *The last*, respond to the students' incorrect answers, where most students understand that if the learners are incorrect to answer the question, then the student must be blamed immediately.

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