Analysis of pedagogical content knowledge on students of science education as pre-service teachers in Madura secondary school

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Abstract. Pedagogical content knowledge is defined as the ability of teachers for giving comprehensively true concepts to students which is provided through effective teaching and learning environments for all students. This capability has to be fulfilled by pre-service teachers in order they can create effective learning process as they planned and expected. This study aimed at describing the pedagogical content knowledge of students of science education as pre-service teachers in Madura secondary school. This qualitative descriptive research involved 110 students from three classes as subjects. Data were collected through interview, questionnaire, and test then analyzed qualitatively descriptively using the triangulation technique. Findings indicated that the lowest aspects of pedagogical content knowledge on the study subjects were about the teaching skill and comprehension about students’ needs. In addition, misconceptions were also found during the learning activity. It was also found that they have not implemented various learning methods to enhance students’ motivation. It can be assumed that students have not mastered the capabilities of being a teacher, so that their pedagogical content knowledge still reached moderate level. To sum up, the pedagogical content knowledge on students of science education as pre-service teachers in Madura secondary school still need to be enhanced respectively.

1. Introduction
As teaching is such a challenge and big task for teachers then many teachers have to find their initial views of teaching. Through this process, whereby a growing understanding of teaching begins to emerge largely as a result of learning through experience, a new appreciation of one’s skills and abilities compels some to move beyond the simple delivery of information.

Law number 14 in 2005 about educator stated teacher should attain four competencies, i.e., pedagogy, personality, professional, and social [1]. These competencies have to be enhanced continually in order teachers are capable of contributing to developing the quality of education. The enhancement quality of education can be considered by many factors, especially the quality of educators. Therefore, teachers have to fulfill all the competencies.

A transmissive view of teaching in contrast to perceiving teaching is a process of developing learning by building a deeper understanding of content. Teaching procedures and strategies are selected for particular reasons that are important to shaping learning in ways that are meaningful and valuable to the learner. Then, there are major differences in the implications for teachers, and teaching, when a transmission model is contrasted to the complex model of teaching for understanding, through which expertise in pedagogy is genuinely viewed as skill-fully managing and enhancing the relationship between teaching and learning [2].

Nowadays, teachers need to enhance the skill since technology and education quality improves better and faster day by day. If their skill is not increased, it can be assumed that teachers cannot conduct a good-quality learning process. Teacher quality is an important factor in determining gains in
student achievement, even after accounting for prior student learning and family background characteristics. Predictors of teacher quality have typically included factors such as class size, certification, type of qualification, degrees earned, or years of experience [3].

Another, less studied stated that indicator of teacher quality is the pedagogical knowledge of teachers. Pedagogical knowledge refers to the specialized knowledge of teachers for creating an effective teaching and learning environments for all students. As a practice, pedagogy describes the relational values, the personal engagement, the pedagogical climate, the total life-worlds and especially the normativity of life with children at school, at home, and in the community [3]. And as an academic discipline, pedagogy problematizes the conditions of the appropriateness of educational practices and aims to provide a knowledge base for professionals. Central to the idea of pedagogy is the normativity of distinguishing between what is appropriate and what is less appropriate for children and what are appropriate ways of teaching and assisting youths [4].

As we know, teaching is a knowledge-rich profession with teachers as “learning specialists.” As professionals in their field, teachers can be expected to process and evaluate new knowledge relevant for their core professional practice and to regularly update their knowledge base to improve their practice and to meet new teaching demands. Teacher quality itself is an important factor in determining gains in student achievement. The main motive for investigating teacher knowledge is to improve student outcomes. On the other hand, to improve teacher quality, it is crucial to understand what teacher professionalism involves. Thus, this study focuses on teacher’s skill especially related on the pedagogical content knowledge in which it studied the level of this skill on the students of Science Education Department as the pre-service teachers in Madura Secondary School.

2. Method

This study was quantitative descriptive research. It involved 110 students from three classes in Science Education Department at University of Trunojoyo Madura from class A, B, and C in the academic year of 2018 as the subjects of the research. Students were taught Ethnoscience during one semester, and the pedagogical content knowledge on students was observed and evaluated by researchers.

The pedagogical content knowledge level on students was evaluated using a questionnaire and interview consisting of several questions related to the indicators of pedagogical content knowledge. The questionnaire arranged in this study used a Likert scale since it is used to measure the perception and argument of participants related to some social phenomenon. Furthermore, the questionnaire and interview consisted of question about the knowledge of the content materials, utilization of learning media, implementation of learning strategy, the way to understand student’s characters and background, and the knowledge of how to manage the classroom.

Findings were analyzed using quantitative descriptive method and data triangulation technique. Data were calculated and tabulated in the table, then the total score was concluded based on the category in Table 1 [12]. However, the indicators of pedagogical content knowledge evaluated in this study can be seen briefly in Table 2.

| Score          | Category      |
|----------------|---------------|
| Below 1.3      | Low           |
| 1.31 – 1.5     | Moderate High |
| 1.51 - Above   |               |

Table 1. Criteria of pedagogical content knowledge level.
### Table 2. Indicators of pedagogical content knowledge.

| No | Aspect                                      | Indicator                                                                 |
|----|---------------------------------------------|---------------------------------------------------------------------------|
| 1  | Knowledge about students and their characteristics | a) Identification of students’ learning characteristic                     |
|    |                                             | b) Ensure that students get the same chances in the learning process      |
|    |                                             | c) Manage the class situation to give the same learning chances in all students |
|    |                                             | d) Identify the causes of a bad habit                                    |
|    |                                             | e) Assist the students’ abilities                                        |
|    |                                             | f) Focus on the students’ physical weakness during the learning process  |
| 2  | Knowledge about learning materials and principles | a) Analyze learning materials to determine the difficulties               |
|    |                                             | b) Ensure the comprehension level of students on such topics              |
|    |                                             | c) Explain the factors of the learning process                            |
|    |                                             | d) Use many techniques to motivate the students’ learning                 |
|    |                                             | e) Plan the learning process related to each other by focusing on the learning and process |
|    |                                             | f) Focus on the students’ responses toward the learning process objectives |
| 3  | Knowledge about curricula development       | a) Capable of arranging the syllabus related to the curricula             |
|    |                                             | b) Arrange the learning plans related to syllabus                         |
|    |                                             | c) Follow the orders of learning materials and focus on the learning aims |
|    |                                             | d) Choose the relevant learning materials with the situations             |
| 4  | Knowledge about learning strategies         | a) Conduct the learning process related to the plans                     |
|    |                                             | b) Conduct the learning activities to assist the students’ learning process |
|    |                                             | c) Communicate the new information related to the level of students’ abilities |
|    |                                             | d) Consider the students’ mistakes as the parts of the learning process   |
|    |                                             | e) Conduct the learning activities related to curricula and connect it with daily life |
|    |                                             | f) Conduct various learning activities                                   |
|    |                                             | g) Manage class effectively                                              |
| 5  | Knowledge about students’ skill development | a) Analyze learning achievements                                          |
|    |                                             | b) Support students to learn based on the learning styles                |
|    |                                             | c) Enhance the students’ critical and creative thinking skill            |
|    |                                             | d) Assist every student during the learning process                      |
|    |                                             | e) Identify the potency and difficulty of every student                  |
|    |                                             | f) Give learning chances to students based on their learning styles      |
|    |                                             | g) Interact with students and support them to comprehend the topic more  |
3. Results and discussion
The result obtained in this study indicate that the pedagogical content knowledge on students in class A, B, and C have not reached on the high level yet, showed by the average of 1.35 in class A; 1.44 in class B, and 1.31 in class C (Table 3). Furthermore, it also can be seen that the highest level of students’ pedagogical content knowledge was in class B showing 1.44 on average.

| No | Aspect | Indicator | Indicator |
|----|--------|-----------|-----------|
| 6  | Knowledge about communication with students | a) Use various questions to know the student's participation and comprehension | a) Arrange the assessment related to learning aims |
|    |        | b) Give attention to students’ questions and responses | b) Evaluate the learning process using several techniques |
|    |        | c) Respond to students well related to curricula | c) Analyze the assessment to identify the standard competence |
|    |        | d) Give learning activities that are capable of developing the cooperative skill between every student | d) Utilize the students’ response toward the learning process and do reflection |
|    |        | e) Listen to all students’ questions and answers | e) Utilize the evaluation result as the plan on the next activities |
|    |        | f) Pay attention toward students and respond to them | |

| 7  | Knowledge about assessment and evaluation | a) Arranged the assessment related to learning aims | |
|    |       | b) Evaluate the learning process using several techniques | |
|    |       | c) Analyze the assessment to identify the standard competence | |
|    |       | d) Utilize the students’ response toward the learning process and do reflection | |
|    |       | e) Utilize the evaluation result as the plan on the next activities | |

Table 3. The score of students’ pedagogical content knowledge.

| Class | 1 | 2  | 3  | 4  | 5  | 6  | 7  | Average | Category |
|-------|---|----|----|----|----|----|----|---------|----------|
| A     | 1.3| 1.4| 1.4| 1.3| 1.4| 1.3| 1.4| 1.35    | Moderate |
| B     | 1.4| 1.5| 1.4| 1.4| 1.5| 1.4| 1.5| 1.44    | Moderate |
| C     | 1.3| 1.3| 1.3| 1.3| 1.4| 1.3| 1.3| 1.31    | Low      |

Findings indicated that students in class A reached low score in indicator 1, 4, and 6. Meanwhile the rest is on moderate score. However, students in class B reached better score, showing that indicator 1, 3, 4, and 6 got moderate score meanwhile the other indicators on high score. Furthermore, students in class C reached low score in all indicators except indicator 5, which was moderate score. The results showed that the score of students’ Pedagogical Content Knowledge still need to be enhanced.

According to the findings obtained in this study, it can be concluded that the pedagogical content knowledge of students in class A, B, and C have not reached on a high level yet. It is shown that the average of 1.35 on class A; 1.44 in class B, and 1.31 on class C (Table 3). Furthermore, it also can be seen that the highest level of students’ pedagogical content knowledge was in class B showing 1.44 on average. Literature highlights many features that characterize expert teachers, which include extensive pedagogical content knowledge, better problem-solving strategies, better adaptation for diverse learners, better decision making, better perception of classroom events, greater sensitivity to context, and greater respect for students [5].

Several studies stress the importance of the knowledge teachers hold, highlighting that in addition to assimilating academic knowledge, student teachers also need to incorporate knowledge derived
from experiential and practical experiences in the classroom [6, 7]. Research also shows that variations in opportunities to learn in teacher preparation are related to differences in student achievement.

This study also indicated that student factors are part of, and interdependent with, the teaching-learning process. A teacher’s knowledge goes beyond a mere knowledge of content and classroom management, and should also include knowledge of learners and learning [8].

The pedagogical knowledge base of teachers includes all the required cognitive knowledge for creating effective teaching and learning environments. Most studies use the distinction between declarative (knowing that) and procedural knowledge (knowing how) from cognitive psychology as a theoretical basis. This approach is relevant as it focuses on understanding how knowledge is related to behavior, or in other words, the quality of teaching performance [9, 10].

It is assumed that teachers must fulfill general pedagogical knowledge (principles and strategies of classroom management and organization that are cross-curricular) and pedagogical content knowledge (the knowledge which integrates the content knowledge of a specific subject and the pedagogical knowledge for teaching that particular subject).

Investigating the knowledge of teachers as learning specialists involves understanding how this knowledge functions in the teaching-learning process; more specifically, how teachers apply their knowledge in making decisions, for example, about lesson design or making on-the-spot judgments in the classroom [10, 11].

It is explained how teacher knowledge is used in decision-making seems to be suggesting that in order to make informed pedagogical decisions, teachers must be able to analyse and evaluate specific learning episodes, in combination with contextual and situational factors, and to be able to connect all this information to their specialist knowledge of the teaching-learning process to guide subsequent teaching actions. Thus, making good pedagogical decisions increases the quality of the pedagogical knowledge held by the teacher. All in all, students as pre-service teachers have to fulfill their skill especially pedagogical content knowledge skill in implementing plants for every learning activity in the order they can improve the quality of education.

4. Conclusions
According to the findings obtained in this study, it can be concluded that the pedagogical content knowledge on students of science education as pre-service teachers in Madura secondary school still need to be enhanced respectively since it still reached on a low and moderate level. However, this conclusion is only based on students’ pedagogical content knowledge data that were collected only during one lecture. Therefore, further research need to be implemented during more than one lecture continually in order student’s pedagogical content knowledge can increase respectively.

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