The analysis of prospective science teachers' pedagogical content knowledge (PCK) on living organism physiology and anatomy course

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Abstract. This study intended to obtain information about the scope of *Pedagogical Content Knowledge* (PCK) on Living Organism Physiology and Anatomy Course. The sample of this research was all 71 students of Integrated Science Education program in the even semester, Universitas Negeri Semarang, who took the Living Organism Physiology and Anatomy course. The research sample was picked using the purposive sampling. The data collection was conducted employing the evaluation instruments consisting of test questions, student portfolio, and micro-teaching assessment. The research results indicated that about 89% of the students mastered the Content Knowledge. The components of Content Knowledge including method selection, material delivery, and classroom management were learned respectively by 81%, 85%, and 84% of the students. It concluded that the PCK on Living Organism Physiology and Anatomy influenced significantly in improving the quality of prospective science teachers.

1. Introduction

The Undergraduate Integrated Science Education program of Universitas Negeri Semarang has proven to generate creative and innovative either educators or facilitators with prominent conceptual knowledge, science procedural materials, as well as adequate IT skills to keep up with the latest scientific development. Prospective science teachers must earn thorough science concepts and transfer it to students. In equipping the prospective science teachers, courses in our program were arranged to raise graduates mastering: (1) the concepts, principles, laws, and theories of science to be applied in science learning; and (2) the philosophy of approaches, models, methods, and learning media to implement science learning both in junior high school and social environment. One of the must-mastered courses is the Living Organism Physiology and Anatomy. In addition to comprehending the course, prospective science teachers are expected to deliver the material suitably to avoid misconceptions. Therefore, a future teacher has to acquire the taught materials (content) and how to explain it (pedagogy) [1].

The Living Organism Physiology and Anatomy is a fundamental course a future science teacher must acquire. It covers formations, structures, and functions of an organism including animal and human. Referring to [2], the Living Organism Physiology and Anatomy course comprise a high level of difficulty; hence, appropriate strategies are required to visualize the physiological process. Such a difficulty level is caused by the necessity of prerequisite knowledge on the chemical process, tissue structure, organs, and enzymes. To overcome this issue, a learning innovation is required. An analysis of prospective science teachers' score in the Living Organism Physiology and Anatomy course was

carried out in Universitas Negeri Semarang, the academic year of 2017. There were 25 students in the total, in which five students achieved 'A' score, while 8 of them got 'AB'.

Referring to [3], Pedagogical Content Knowledge (PCK) is an essential professional knowledge dimension for future teachers. The PCK comprises two kinds of competencies; i.e. pedagogical knowledge and content knowledge. This is interpreted as a piece of theoretical knowledge and how to teach such theories to students. The aspects of PCK include ideas, illustrations, examples, explanation with a demonstration, and formulation of the subject matter [4]. [5] elucidated that PCK is a way or an idea of presenting materials (theories) to foster students' learning motivation. The development of teaching skill among prospective teachers based on experience would result in purposeful learning for students.

According to [6], the PCK covers a curriculum description of difficult materials which may cause misconceptions. A prospective teacher having favourable Pedagogical Content Knowledge (PCK) would be able to represent and determine an intelligible topic or a learning subject. Successful learning is achieved through strong analogies, illustrations, explanations, and demonstrations. One of the high analytical level science materials is about systems of an organism [7].

Knowledge about learning difficulties and misconceptions could promote teachers to designate appropriate strategies in delivering materials while the proper methods are obtained after a teacher comprehends the materials (content) well. As reported by [8], strengthening PCK would enhance learning effectiveness by combining the developed pedagogical knowledge and content knowledge to result in professional teachers.

By the time being, various kinds of PCK concepts have been developed. Researchers of education agree that PCK is knowledge and expertise earned through classroom experience [9, 10, 11]. A set of integrated knowledge, concepts, beliefs and values evolved by teachers during teaching-learning activities is found in PCK [12, 13, 14, 15, 16]. Experience determines the pedagogical maturity of future teachers since a novice teacher usually does not have favourable PCK compared to an experienced teacher [17].

The PCK teaching model proposed by [18] is a model identifying a connection between teachers' domain knowledge including (1) the knowledge of subject matter, either substantially or syntactically; (2) the general pedagogical knowledge; (3) the knowledge of material context and teaching sources, and (4) Pedagogical Content Knowledge. The Indonesian education system is identically related to learners' competence achievement, just as the core competencies or basic competencies in the 2013 curriculum. Teachers should also master the curriculum knowledge since it covers the learning objectives, targets, scope, and sequence of scientific concepts that would be taught.

There are two categories of curriculum knowledge; (1) the applicable curriculum objectives and learning objectives of each topic; and (2) specific curriculum program, sources, and materials. The PCK teaching model offered by [18] is the development of PCK model proposed by [19] and [20] in [21]. Learning materials at a particular level of class following the objectives is an orientation of teachers in learning. Teachers' orientation is a concept map in determining learning objectives, material implementation related to the curriculum, and evaluation of student learning outcome [22]

The components of PCK consist of Pedagogical Knowledge (PK) and Content Knowledge (CK). The Pedagogical Knowledge covers learning strategies generally adopted in a learning process. The PK applies learning through learning cycles and particular strategies on a certain topic. The PK represents a concept in diagrams, figures, tables, and graphs. Students are fostered to actively participate in carrying out investigations, experiments, demonstrations, and simulations of problem. Meanwhile, the Content knowledge comprises students' understanding of concepts and potential learning burdensome and misconceptions which they might experience during learning. The PCK assessment components include the knowledge of science materials (content), assessment strategies, and learning methods picked in material learning [18]. Observations and tests could be used to assess students' comprehension of science concepts.

Based on the problem analysis, the Living Organism Physiology and Anatomy topic should be fundamentally mastered by prospective science teachers since it belongs to the high difficulty level

subject. As a future teacher, owning a vigorous material mastery is rudimentary in addition to pedagogical skill. The research problem appeared was; "how was the prospective science teachers' pedagogical content knowledge on Living Organism Physiology and Anatomy topic?". An analysis indicated that future teachers' PCK was different from those of experienced teachers who had better skill in managing high difficulty level materials which may cause misconceptions [23]. Hence, this research tried to measure the prospective science teachers' PCK to obtain a vivid description of the future teachers' PCK, particularly on a difficult topic. The research objective was to analyse the prospective teachers' PCK on Living Organism Physiology and Anatomy topic. The research results were employed to provide an appropriate education preparation model for the prospective science teachers to own excellent pedagogical knowledge and content knowledge.

2. Methods

This research was carried out in January-July 2017 at the Integrated Science Department, Universitas Negeri Semarang. This study was an explorative, descriptive one referring to [24]. The research sample was all the 71 4th-semester students in the Living Organism Physiology and Anatomy course consisting of 26 male students and 45 female students selected using the purposive sampling technique.

The data were obtained from the students' content understanding and assessment based on their performance as the prospective science teachers in junior high school, particularly on the Living Organism Anatomy and Physiology. The data were in the form of Content Knowledge (CK) and Pedagogical Knowledge (PK) which were analyzed descriptively. The data of CK were to measure the students' content understanding of the Living Organism Physiology and Anatomy topic while the data of PK were to evaluate their planning and performing skill in learning.

The early data collection was done through analysing the content mastery of the students gained from the test of Living Organism Physiology and Anatomy. The data of CK mastery were collected by analysing three components comprising the concept mastery of Living Organism Physiology and Anatomy, portfolio analysis, and integration of theories and facts. The assessment of prospective science teachers' PK in Junior High School was limited by data collection, learning method selection, teaching flow, and classroom management.

3. Results and Discussion

The stages of PCK assessment were initiated by the analysis of concept mastery computation results. The measurement was done by deciding the score range of 0-100. The summary of CK analysis appears in Table 1 informing the CK of Integrated Science Education students was generally good though there were some of them experienced several obstacles, for instance, in explaining the various system of organisms such as the nervous system, transportation system, and secretion system. The preliminary knowledge needed to be strengthened for the students to be able to learn the content of Living Organism Physiology and Anatomy course. Such knowledge was a vigorous understanding of the previous class; Biology for Science. [25] explained that excellent early knowledge helps students comprehend the content. Therefore, a course requiring prerequisite knowledge must be the reference to recognize the CK of prospective Science teachers.

The content knowledge (CK) is an essential aspect of learning which supports the future Science teachers' competencies. The CK have to be mastered by them since it will illustrate and conclude how a future teacher delivers materials, develops and applies teaching materials, as well as evaluates the teaching-learning process. Besides, it determines the materials that are going to be taught [26]. Educators or teachers require to master teaching materials broadly and deeply in accordance with the competencies. The prospective Science teachers obtained two competencies; the materials/concepts (what to) and the way to deliver it (how to). The first aspect was the crucial aspect of a teacher in teaching a certain topic. The analysis results of the future students' CK on the Living Organism Physiology and Anatomy course indicated that 89% of them obtained good CK. This showed that most future teachers were able to comprehend the concepts. Some of them, who paid less attention and carelessly studied the topic, achieved low CK.

Table 1. The Analysis Result Description of Prospective Science Teachers' *Content Knowledge*

Components	Sub-components	Mastery Content Average	Description
Mastering the concepts of living organism physiology and anatomy	1. Understanding the concept of animal and human coordination systems; 2. Understanding the concept of animal and human digestive systems; 3. Understand the concept of organism transportation system; 4. Understanding the concept of organism reproductive system; 5. Understanding the concept of organism excretion system; 6. Understanding the concept of immune system; 7. Understanding the concept of nutrient plants.	89	Students generally understood well the concepts presented.
Portfolio Analysis	Comprising a history of student performance as a whole on the organism anatomy and physiology	86	Predominantly, the students were able to retell the materials that had been delivered by the lecturer, describe the faced difficulties in certain concepts and find solutions to overcome these problems.
Integrating the theories and facts	1. Understanding the concepts of anatomy and physiology that are integrated with facts and mentioning the examples in life; 2. Proposing tentative solutions to real life problems integrated with the living organism anatomy and physiology.	92	The students were mostly able to mention examples of facts existing in the environment in accordance with the concept of living organism anatomy and physiology.
	The Average Percentage of Students' CK	89	

The portfolio results presented a favourable average score of 86%. The portfolios comprised several components; the students' ability in elucidating the delivered concept, describing their obstacles, and finding out solutions. The percentage indicated the 'good' category on the concept of mastery. This influenced the increase of the course's final score, which was higher than the last year.

This study also analysed the extent to which the students were able to integrate the material concepts of Living Organism Physiology and Anatomy with the latest facts existing in the surrounding environment. The research results showed that 92% of the students were capable of mastering such skill. They generally could mention the example of facts related to the concepts of Living Organism

Physiology and Anatomy and propose tentative solutions of the faced problems. This was parallel with [27] stated that a teacher's content knowledge and its integration would result in practical teaching.

In teaching Science, a future teacher has to master how to prepare the known science. Good educators/teachers must have knowledge of the curriculum, students' condition, teaching strategies and learning evaluation instruments (assessment). Hence, in addition to the CK, the PK is remarkably salient.

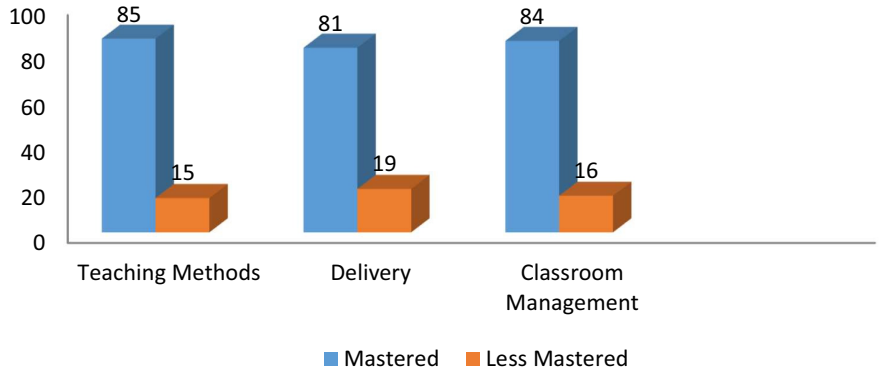

Figure 1. The Indicators of Pedagogical Knowledge Components of the Students in Teaching Science

Some components of the teaching-learning process related to the Pedagogical Knowledge (PK) included the planning and implementation of learning, classroom management, and assignment [28]. The PK cultivation among the future Science teachers was the way a lecturer prepares favourable Science teachers in managing classes. Such efforts to improve teachers' skill in managing classes, planning, and preparing lessons were carried out systematically and directly so that it would result in conducive and facile learning [29].

The evaluation of prospective science teachers' PK consisted of the selection of teaching method, the way of delivering the materials, and classroom management. The teaching method selection of each student indicated that 85% of them succeeded in mastering the materials. This showed that the students were capable of improving soft-skill teaching in adjusting appropriate teaching methods on a particular topic. Other than that, 81% of the students categorised as 'good' in delivering materials, and it suggested that their fine competencies supported their performance.

The material delivery was undoubtedly reinforced by knowledge mastery of the prospective Science teachers. Furthermore, their classroom management skill denoted a pleasing result, in which 84% of them were declared succeeded. [30] found that a teacher owning good classroom management has a more significant opportunity to run effective learning. An excellent classroom management skill supports the success of a teacher in delivering materials since it would generate a pleasant and conducive teacher-student interaction.

4. Conclusion

The research results suggested that the average percentage of Content Knowledge was 89%. Also, the Pedagogical Knowledge component on the indicator of method selection was 85%, the material delivery was 81%, and the classroom management of Junior High School was 84%. Stood on the above results, it concluded that the PCK on Living Organism Physiology and Anatomy topic influenced the increased quality of prospective Science teachers.

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