The profile changes in pedagogical content knowledge of pre-service biology teachers based on the concept maps

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Abstract. Pedagogical Content Knowledge (PCK) is the teacher's expertise gained since becoming a student. There are changes in PCK for prospective teacher students during lecture and changes can be seen based on the concept map. This study aims to analyze the changing profile of prospective PCK teachers based on concept maps. This study was conducted for biology education students at one of the private universities in West Java during the 2017/2018 school year. Participants are 6 people. Participants are asked to make a speciation concept map during evolution, micro teaching and PPL. Concept maps were analyzed using qualitative descriptive analysis. The results show changes in the concept map that includes changes in the form of concept maps from simple to complex, increasingly meaningful and easily understood as propositions, and only important concepts emerge. Based on this, PCK changes with increasing education and training experience of prospective teachers.

1. Introduction

PCK according to Shulman (1987) is the expertise of a teacher in managing a topic or problem to be presented in the learning process so that it is easily understood by students. This skill is a professional skill that is needed by the teacher and obtained since becoming a student. PCK is one of the most important factors affecting the learning process carried out by pre-service or in-service teachers [1]. Even PCK, according to [2], is the main determinant of teaching practice and is important for teacher decision making in class. PCK has a decisive impact on the main aspects of the quality of learning and the ability of PCK teachers is positively correlated with learning effectiveness and student learning outcomes [3].

PCK is unique and individual so changes in PCK growth for each pre-service teacher vary [4]. The results of the study by [5] show that PCK pre-service teachers have varying speed and development. Although several studies have discussed the impact of various interventions to develop PCK for science [6] including its development, how the development process and / or changes have not been studied. The instruments that have been widely used to articulate, describe, and capture PCK knowledge of science teachers are CoRe (Content Representation) and PaP-eRs (Repertoire of Professional Experience) [7], Venn diagrams [8] and concept maps [9].

Concept maps can be used as tools to articulate, describe and capture teacher PCK knowledge [10]. In this case, the profile changes in the PCK of pre-service teachers based on concept maps are worth checking as a basis for subsequent PCK development. By knowing the profile changes in pre-service teacher PCK, the strategies and patterns of teacher professional development will be effective and efficient.

2. Methods

This qualitative research is designed and implemented from case studies that focus on one group so that a detailed description and understanding of the case is obtained. The method used in this study is observation, documentation and interviews.

Participants in this study were students of the Biology Education Program at the University of Kuningan in the academic year 2017/2018 and 2018/2019, amounting to 6 people, 2 people above average (A), an average of 2 people (T), and 2 people in below average (B). Participants are deliberately taken. During the academic year, students in semesters 6 and 7 take courses including evolution, microteaching and Field Studies (PPL). Participants were asked to work on a research instrument in the form of concept maps with speciation topics at the beginning of the sixth and seventh semesters, and the end of the seventh semester. Observations are made when participant's practice teaching in microteaching and partner schools use observation sheets to measure the ability to plan and implement learning.

3. Results and Discussion

Based on the results of the concept map analysis made by the participants as listed in Figure 1, it appears that all participants had a concept map score that improved from the beginning before participating in microteaching, after taking microteaching and after participating in field studies at partner schools. Increasing the score means that there is a change in the meaningful learning of the participants. Participants increasingly understand / master the speciation material. The concept map scores obtained by the participants when compared with the reference concept map scores that have a maximum score, the concept map scores obtained by participants ranged from 0-74.7%. The average value of the concept map obtained by the participants ranged from 24.5 - 52.5%. This shows that the mastery of speciation materials is still low.

The concept map scores obtained by the participants show conformity with the rank of achievement in their class. For example, Fer (B) and Fik (B) are included in the group below the average, then the map concept score they got is also below the other participants. That is the same as Ih (T) and Zul (T) belonging to the average group and Is A) and Lis (A) which are included in the above average group. Thus, it can be said that the concept map can be used as a participant evaluation tool. Concept maps are used as evaluation tools commonly used by researchers [11].

There are several different phenomena based on the number of concepts on the concept map made by Lis (T) and Fik (B), namely the number of concepts on the concept map 2 is higher than the concept map 3, but different from the number of propositions made namely the number of propositions on the concept map 2 is less than the concept map 3. This means that there are some invalid propositions that lead to misunderstanding. Misunderstanding occurred on the concept map made by other participants but not as much as the two participants. Misconceptions occur after completing micro teaching corrected when they complete field studies. So, there is an increase in their knowledge after they do an analysis of the existing misconceptions [12]. This phenomenon also shows instability in understanding the concept. This instability is one of the characteristics possessed by pre-service teachers as stated by research [13] that pre-service teachers have an unstable and inconsistent conceptual understanding of concepts, thus affecting the presentation of concepts.

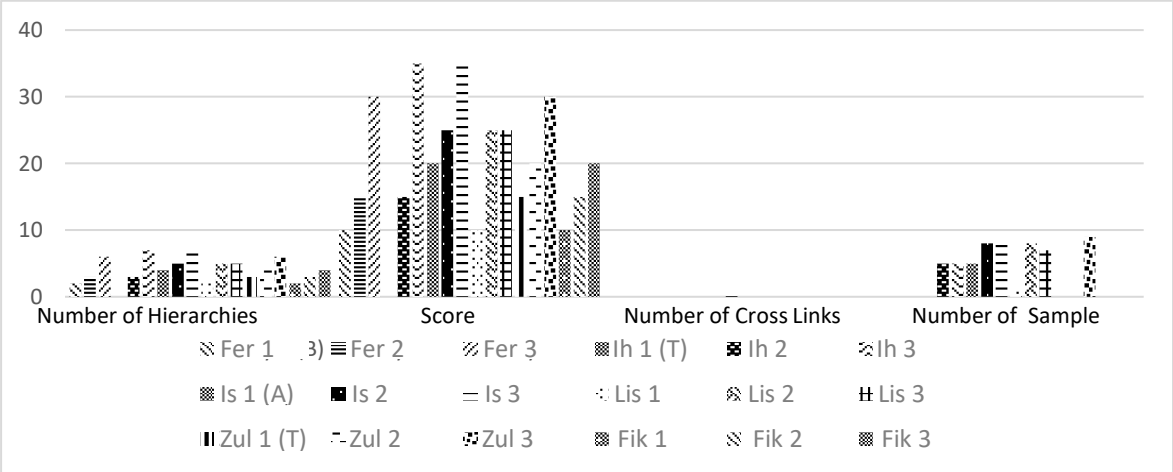

Figure 1. Results of Concept Maps Participants Analysis

Almost all participants did not show a cross-link, except for Is (A) and it was only found on the concept map 3. According to Ausubel, the cognitive learning theory that underlies the formation of the concept map, all participants have not yet achieved integrative adjustments marked by no cross-links on their concept map. Only one person is able to demonstrate the existence of a cross-link, Is (A), which means that Is (A) has achieved meaningful learning [14]. The existence of cross-links shows the existence of creative thinking skills [15]. Other participants are only at the stage of the cognitive structure of progressive differentiation that is meaningful learning, it is an ongoing process in which new concepts increase meaning if new relationships are obtained (proportional relationships). This is reinforced by the results of a high school student questionnaire in which participants conducted a field study, 50.1% of which stated that participants were not creative. Concept maps can empower creative thinking skills. There are two components in a concept map that are important for empowering creative thinking skills, namely a hierarchical structure (able to describe a good concept map) and one's ability to identify and create new cross links.

Lower group participants cannot provide examples on the concept map they made, in the average group on concept map 1 no examples are included while the upper group includes examples. Inability to show examples, according to Ausubel learning theory, participants experience imperfect differentiation of learning. Ausubel is a supporter of deductive teaching, namely general ideas taught first, followed by smaller and specific points. Give an example is a small and specific idea.

Based on the number of propositions (horizontally), all participants have an increasing number of propositions. This means that the breadth of knowledge possessed by participants increases. Likewise, vertically (indicated by the number of hierarchies), all participants showed an increase in the number of hierarchies. This means that the depth of knowledge possessed by participants increases. Pre-service teachers who have a deep understanding of concepts tend to be more flexible when choosing different representations.

PCK description of participants based on the ability to plan and implement learning:

3.1. Learning Plan

The results obtained as listed in Figure 2, there is a decrease and increase in the ability to plan learning. The increase occurred for example in the item "there is a formulation of learning that reflects the development of values in social functions" i.e. from 2.8 (enough) to 3.3 (good). The decline occurred for example in the item "clarity of the formulation of learning objectives (does not lead to multiple interpretations and contains learning outcomes behavior)" has decreased from 4.3 (very good) to 3.7 (good).

3.2. Learning Implementation

The results obtained as listed in Figure 2, there is a decrease and increase in the ability to carry out learning. The decline occurred for example in the item "preparing students to learn" from 4.50 (very good) to 3.80 (good) (figure 3). Improvements occurred for example on items reflecting or making a summary by involving students from 2.5 (enough) to 3.00 (good).

However, judging from the overall average score, the participants' planning scores increased in their micro teaching, the average planning score obtained was 66.97 and the planning score was 70.95 in the implementation of the field study. Likewise, the average implementation of learning has increased, especially in microteaching, the average learning score obtained was 67.92 and a score of 71.74 in the implementation of field studies (figure 2).

Based on observational data on the participatory learning planning and implementation evaluation documents made during microteaching and field studies as listed in Figure 2, it can be seen that 1) learning planning scores for each participant generally increase between microteaching and field study scores, but on learning implementation scores, each participant is different; 2) learning planning scores cannot distinguish between lower, middle and upper groups. This can be seen, for example, the score owned by Lis (A) has a score far below the lower group. Likewise, Ih (T) and Zul (T) have below Fer (B) and Fik (B) scores.

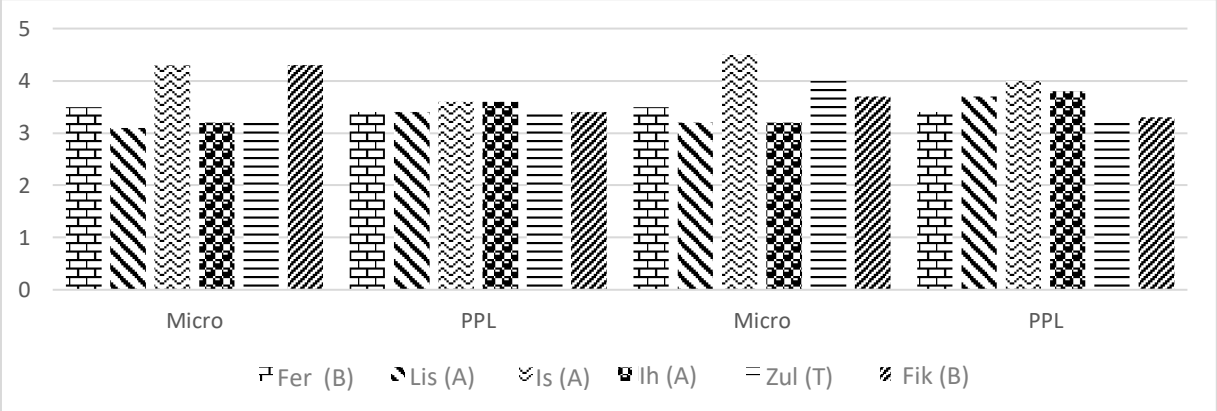

Figure 2. Results of Learning Planning and Implementation Assessment

Concept map descriptions made by participants with participant PCK descriptions are consistent in terms of changes from the beginning before taking part in microteaching, and after participating in microteaching and field studies. Changes that occur include changes in the concept of knowledge, the ability to plan and implement learning (PCK). The changes that occur are basically changes in PCK due to the concept of knowledge, the ability to plan and implement learning included in the PCK component. Thus, PCK changes that occur based on the analysis of participant concept maps and observational data from the ability to plan and carry out learning are as follows: (1) PCK participants experience changes along with the addition of knowledge and learning experiences in accordance with the learning theory and practice they receive; (2) Changes in PCK participants are influenced by the academic level of participants; (3) Changes in participants' PCK will continue to grow and develop healthily like lush trees with large branches, so that the PCK growth of students is at the level of adolescent growth (not yet mature). This means that the participant's PCK has the potential to continue to change; (4) Changes in participants' PCK in their components do not develop at the same rate. The constituent elements of each PCK component exhibit relatively different features. This is not surprising because PCK is a heterogeneous construction. Therefore, it consists of many intrinsic elements, which are difficult to decipher; (5) In general, participants have an idea of adequate pedagogical knowledge in the context of PCK. Although they have enough theoretical knowledge about instructional methods, techniques, strategies, measurements and assessments, they have found several problems in transferring theoretical

knowledge to practice [16]; (6) all participants experience misunderstandings, especially at the beginning before participating in micro teaching. The phenomenon of pre-service teachers experiencing misconceptions is a normal phenomenon as stated by [17] that through PCK students can know and misunderstand knowledge about a topic. Some pre-service teachers do not have enough information about teaching strategies and assessment knowledge about a topic.

4. Conclusion

Prospective PCK teachers change from time to time in accordance with increased knowledge and experience in learning experiences. Such changes lead to a longer maturity than professional teachers. Such a change requires proper training so that prospective teachers still experience many misunderstandings.

Acknowledments

We would like to thank the University of Kuningan for providing support so that we can carry out the research well. We convey the same expression to the teaching staff of the Postgraduate Study Program in Natural Sciences, Semarang State University for comments on the manuscript. This research did not receive special grants from any funding agency in the public, commercial or non-profit sectors.

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