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Patterns of Changing Pedagogical Content Knowledge Prospective Biology Teachers in the Covid-19 Pandemic

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Abstract. This study analyzes the pattern of changes in the PCK of prospective Biology teachers related to the application of alternative teaching practices in the Covid-19 pandemic. This study uses a cross-sectional quantitative method with a sample of prospective Biology teachers in semesters 3, 5 and 7 with a total sampling technique. The instruments used are CK, PK, PCK test sheets and concept map tests. The research data were analyzed by ANOVA test and multiple linear regression assisted by SPSS 22. The results showed the average CK test results for prospective student teachers in semester 3 > 7 > 5, PK in semester 5 > 3 > 7, PCK in semester 5 > 3 > 7, and concept maps in semester 5 > 3 > 7. Based on the results of the ANOVA test there is no difference in the average CK and concept map and vice versa for PK and PCK students of prospective teachers in semesters 3, 5 and 6. Based on the results of multiple linear regression analysis there is no effect of CK and PK on PCK in all semesters. Based on this, the pattern of changes in CK, PK, PCK and concept maps in learning during the pandemic does not run linearly with the number of semesters that have been taken. This has implications for learning during a pandemic by LPTKs should be able to increase learning outcomes, especially CK, through the creation of a special curriculum for the pandemic.

Keywords: Biology Teachers; Pedagogical; Content Knowledger

1 Introduction

Pedagogical content knowledge (PCK) is a representation of the combination of content knowledge (CK) and pedagogical knowledge (PK) which defines as an understanding of how certain topics, problems or issues are organized, presented, and adapted according to the needs and abilities of students and presented in learning [1]. PCK is also defined as knowledge that is compiled together by subject matter knowledge (SMK), pedagogical knowledge (PK), and knowledge of context (KC) [2]. To put it simply, PCK is a teacher's professional ability in presenting teaching materials in such a way that is adapted to the conditions of students in order for the teaching materials to be easily understood by students. This ability grows alongside a prospective teacher's experience studying at the Education Personnel Education Institute (LPTK).

The results of previous research [3] shows that there are differences in the growth of PCK as a prospective teacher's knowledge with PCK as a skill. PCK as knowledge is not linear with the increase in the number of semesters taken. On the contrary for PCK as a skill, PCK

increases with the increase in the number of semesters taken. The results of the study are consistent with the result [4] that when the class level of prospective teachers increases, the PCK level of prospective teachers also increases. The results of previous study on PCK [3] also show that the increasing PCK ability of prospective teachers is correlated with training and teaching practice experience as throughout the period of prospective teachers studying at LPTKs. The results of this study are in accordance with the research [5] strengthening the finding that prospective teachers who are undergoing PPL (Field Experience Practice) have better PCK than experienced teachers of more than 15 years and have been certified educators.

Teaching practice exercises for prospective teachers that took place in LPTKs prior to the Covid-19 pandemic consisted of teaching skills practice (PKM) and microteaching. PKM consists of three stages, namely PKM I carried out in semester 3, PKM II carried out in semester 5 and PKM III carried out in semester 7. While microteaching is carried out in semester 6. In PKM I, the prospective teachers are introduced to school environmentment by observing a school's situation and culture. On the next stage of PKM II, the teacher candidates make observations in schools about the school administration including teacher administration, curriculum administration and school administration in general. The outcome of PKM II is that prospective teachers are able to design learning implementation plans (RPP). Furthermore, in PKM III the teacher candidates carry out learning practices in school to experience and apply the necessary skills of teachers in classroom. Meanwhile, the implementation of microteaching (peer teaching) is carried out on campus with of fellow teacher candidates as audiences. Under normal circumstances, the implementation of microteaching and PKM is carried out face-to-face. In such a pattern, students are expected to have an almost perfect PCK and are ready to become teachers, as the results of Abidin's research [3].

The Covid-19 pandemic, however, has changed the pattern of teaching practice exercises, both for microteaching and pre-teacher service. Practitioners are not allowed to hold practical teaching exercises face to face, and instead conducting it online. This change in teaching practice patterns during the Covid-19 pandemic affects the PCK of prospective teachers. Online learning causes prospective teachers to lose the opportunity to train and develop some of the teacher basic skills, namely questioning skills, reinforcement skills, variety skills, explaining skills, opening and closing lessons, skills guiding small group discussions, class management skills, and individual teaching skills. According to [3], prospective teachers conducting teaching practice under normal conditions show low abilities in terms of skills in conducting variations and skills in providing reinforcement. Even at the teacher level, the results show that teachers have weaknesses in terms of the ability to create student-centered learning, the ability to vary learning methods, the ability to conduct classroom conditioning to create an effective learning atmosphere [6]. Based on this situation, this research analyze the changes in the PCK of prospective Biology teachers during the Covid-19 pandemic.

2 Methodology

This study uses a cross sectional quantitative method with a sample of prospective Biology teachers in semesters 3, 5 and 7 using total sampling technique. Prospective teachers for semester 3 are taking Teaching Skills Practice (PKM)1, semester 5 PKM 2 and semester 7 PKM 3.

The instrument used was a CK test sheet with the sub-concept of speciation; PK test sheets with material for learning planning, teaching and learning strategies, educational evaluation, introduction to educational science, educational psychology, curriculum and learning, education administration; PCK test sheets with material for mastering the curriculum of a discipline (curricular knowledge), recognizing learning styles and learning difficulties, assessing students' conceptions (preconceptions and misconceptions), having learning strategies according to students' topics and conditions, and 5) assessing student learning outcomes; and a concept map test sheet with speciation sub-concept material. Instruments are applied on different days of the same week. The research data were then analyzed using ANOVA test and multiple linear regression test assisted by SPSS 22.

3 Result and Discussion

The pattern of changes in the PCK of prospective biology teachers in learning during a pandemic is seen on the data from the results of content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK) tests, and concept maps. The average CK test results for prospective student teachers in semester $3 > 7 > 5$, the average of PK test is semester $5 > 3 > 7$, PCK $5 > 3 > 7$, and concept maps is $5 > 3 > 7$ as shown in Figure 1.
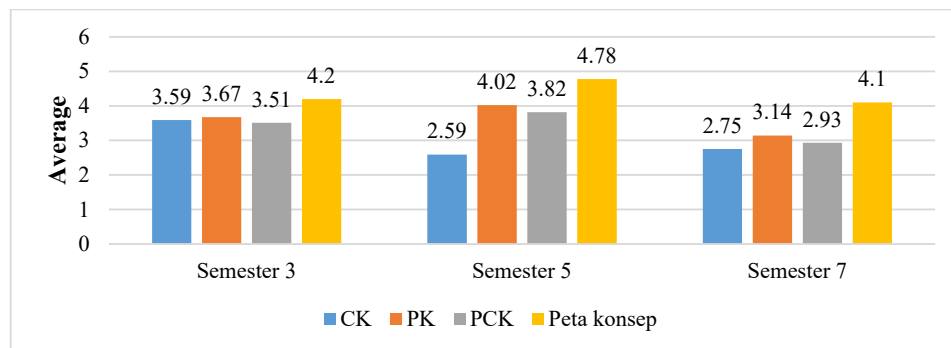

Figure 1. Average PK, CK, PCK and Concept Map

Based on the average test results shown in Figure 1, the pattern of changes in CK mastery is not linear with the increase in the number of semesters taken. There is a anomaly in CK mastery shown by pre-teacher students in semester 3 having higher CK than pre-teacher students in semester 5 and 7 students. In contrast to the research conducted in normal times before the pandemic [3], the pattern of changes in CK is linear with the increase in the number of semesters taken, namely 8th semester students $> 6 > 4$. The results of the ANOVA test on the mean CK at a significance level of $= 0.05$ obtained P-value $= 0.202$. Thus, P-value $> = 0.05$ so that H0 is accepted, i.e. there is no significant difference in CK mastery between student teacher candidates in semesters 3, 5 and 7. This is different from the results of research by [7] and [8] which shows that students learning biology online attain very good learning outcomes. Similarly, this result also shows a different outcome with previous study [9] showing that the CK of teacher education students in Germany from the first to the third year is significantly different and as the number of semesters increases, the mastery of CK

increases. Furthermore, based on the results of the regression test for the effect of CK on PCK in the third semester, the significance value = 0.805 > 0.05; semester 5 obtained a significance value = 0.914 > 0.05; and semester 7 obtained Significance = 0.941 > 0.05 so that it is stated that CK semesters 3, 5 and 7 have insignificant effect on PCK. These results are the same as the research [3] stating that CK semesters 4, 6 and 8 have insignificant effect on PCK. Similarly, the results of research [10] and [11] found a low correlation of CK to PCK. However, other researchers show the the effect of CK on PCK as stated by Baki & Arslan [12].

Based on the average test results shown in Figure 1, the pattern changes in PK mastery during the pandemic has a non-linear pattern change with the increase in the number of semesters taken. This result is consistent with the previous study pre-pandemic [3]. The difference, however, appears in the sequence of semester. In learning process during the pandemic, the order of semester is 5 > 3 > 7, meanwhile, in the normal situation pre-pandemic, the semester order is 8 > 4 > 6. This means that the mastery of PK during the pandemic is not in accordance with the learning outcomes as it should be, namely the 7th semester students are better than 3rd and 5th semester students. Furthermore, the results of the ANOVA test on the average PK at the significance level of 0.05 obtained P-value = 0.025. Considering that the P-value is < = 0.05, this means the H0 is rejected, i.e. there is a significant difference in PK mastery between student teacher candidates in semesters 3, 5 and 7. ; semester 5 obtained a significance value = 0.806 > 0.05; and semester 7 obtained significance = 0.160 > 0.05 implying that PK in semesters 3, 5 and 7 has insignificant effect on PCK. This result is different from previous pre-pandemic study stating that the PK of semester 4 students has an effect on PCK, semester 6 PK has no effect on PCK and semester 8 PK has an effect on PCK [3]. The result showing insignificant effect of PK on PCK in learning during the pandemic indicates that the implementation of online PK course group lectures has limitations in integrating knowledge that can enrich PCK.

In relation to PCK, based on the average test results as listed in Figure 1, the pattern changes in PCK mastery during the pandemic has a non-linear pattern of change with the increase in the number of semesters taken. This is the same as the results of research conducted before the pandemic [3]. The order of semester also shows similar sequence with learning during the pandemic shows the order of semester 5 (level 3) > 3 (level 2) > 7 (level 4) while the normal learning period it has the order of semester 6 (level 3) > 4 (level 2) > 8 (level 4) [3]. Thus, there is insignificant difference in PCK mastery between learning during a pandemic and learning in normal times because the level 3 students before pandemic and during pandemic achieve the highest PCK score. This is in accordance with previous research [13] which shows that pre-teacher students in level 3 have better PCK than students in level 4 and even practicing teachers. Furthermore, the results of the ANOVA test on the average PCK at a significance level of = 0.05 obtained P-value = 0.035. With the P-value < = 0.05, this means that the H0 is rejected, i.e. there is a significant difference in PCK mastery between student teacher candidates in semesters 3, 5 and 7. The average PCK test of each level obtained PCK knowledge of each level was not significantly different.

In addition, based on Figure 1, it can be seen that the pattern of changes in concept map mastery during the pandemic has a non-linear pattern of change with the increase in the number of semesters taken. This shows the similar result with pre-pandemic study but with different order of semester [3]. The order of concept maps mastery in learning during the pandemic is semester 5 (level 3) > 3 (level 2) > 7 (level 4), while in the normal learning period the sequence is semester 8 > 4 > 6. Moreover, the ANOVA test results on the average concept map on significance level = 0.05 obtained P-value = 0.452 which means that the H0 is

accepted, that is, there is no significant difference in concept map mastery between student teacher candidates in semesters 3, 5 and 7.

It is shown that, in the online learning during covid-19 pandemic, students in semester 3 achieve the highest score in both mastery of concept maps and mastery of PCK. in learning This indicates that there is a relationship between PCK and concept map [14], which is explained that teachers who have good PCK have an average number of concepts and the number of links from the concept map they make is higher than teachers who have good CK, experienced teachers (have good PK) and novice teachers. This result is strengthened by study stating that teachers who have a high PCK are better than biologists [15]. The previous result [16], furthermore, shows that after controlling students' prior knowledge, the online learning environment has a more positive impact on the PCK and PK of prospective teachers than face-to-face learning. However, for CK there is insignificant difference between the two learning environments.

The evidence suggest that LPTKs in developing PCK in learning during the Covid-19 pandemic should pay more attention to the increasing mastery of CK and PK in order to increase the contribution of CK and PK to PCK. After all, good mastery of CK and PK can improve student learning achievement, later when the prospective teacher become a teacher. Additionally, the results show that teachers' CK affects student achievement [9] and teachers who have insufficient knowledge about the subject are more likely to have insufficient knowledge to help students learning the content. Thus, the development of PK needs to be improved because it shows that even teachers who are equipped with sufficient level of PK through pre-service teacher education programs may still struggle to incorporate PK into their own teaching scenarios [17]. Likewise, the research show that teachers' mastery of pedagogic competence is lower (68%) than professional competence (91%) [18]. This can be seen more clearly in the results of the 2015 Teacher Competency Examination (UKG) where the average CK score is higher than the PK for teachers at all levels of education in Indonesia. To improve learning outcomes through online learning, more questions, formative assessments, and technology tools should be used to keep students engaged online [19].

4 Conclusion

The pattern of PCK changes during learning during the Covid-19 pandemic, which is not linear with the number of semesters that have been taken by prospective teacher students. It requires LPTK seriousness to provide strategies, approaches, models and appropriate learning methods to increase PCK in accordance with the number of semesters taken. This finding shows that LPTKs can make various efforts to generate teacher candidates with good PCK, who are deemed to be better than teacher candidates with good CK or good PK. This finding also shows that learning during the Covid-19 pandemic is able to equip pre-teacher students' PCK despite the non-linear increase with the semesters taken, but it is a different cases for CK and PK. In this regard, LPTKs need to find appropriate strategies, approaches and learning models so that they can improve the mastery of CK and PK for prospective teacher students.

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