The Relationship of Technological Pedagoical and Content Knowledge Capabilities with Mastery of Biological Concepts of Prospective Biology Teachers

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Article

Abstract

Technological Pedagogical and Content Knowledge is a framework that integrates technology into aspects of pedagogy and content. TPACK ability is very important for prospective teachers in era 4.0. Prospective teachers with good concepts mastery can avoid students misconception. This study would describe the ability of TPACK prospective biology teachers, master the concept of prospective biology teachers, and analyze the relationship between the two. The sample from this study was 64 prospective biology teacher in semesters 8 and 10. This study is a correlational research with multiple choice test and structured interview guidelines. The data analysis showed that the aspect of TK (58%), PK (63%), CK (64%), TPK (61%), TCK (62%) belonged to the sufficient category, while the PCK aspect (80%) was in the good category. Mastery of the concept of prospective teachers is in the medium category, with mastery of the highest concept on the concept of grouping animals based on their phylum, while the lowest is in the concept of ecosystems. From the results of mastery of the following concept is a concept measured mastery, namely the concept of biodiversity, classification of 5 kingdoms, viruses, fungi, plantae, animalia, cells, plant tissues, animal tissues, ecosystems, motion systems, digestive system, nervous system, growth and development, enzymes, genes, inheritance of traits, and evolution. Analysis of the two variables was tested using product moment correlation with coefficient of 0.230 stated in low category. Supporting aspects such as CK, TCK and PCK even when tested only pck aspects that occupy the medium category, for the CK and TCK aspects occupy the low category.

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INTRODUCTION

The teacher is the black box in a class, meaning that the teacher has an important role in the classroom. According to Anwar (2014) the professional ability of teachers is formed and supported by educational institutions, so that the right time for prospective teachers to prepare themselves as professional educators is when he is educated in college. Prospective biology teachers should have the knowledge ability about science, science learning, and teaching science (National Research Council, 1996), so that prospective teachers are able to bring interesting and meaningful science learning. Learning activities without the knowledge and teaching ability of teachers will be difficult to do therefore Shulman, (1986) proposed a framework known as Pedagogical Content Knowledge (PCK). Pedagogical Content Knowledge arises because a teacher needs pedagogical and content knowledge or material to teach science and interaction is both given the term PCK, because this PCK knowledge along with the new experience of prospective teachers about pedagogical knowledge and content so PCK will develop continuously so that students more easily capture the learning delivered (Loughran, et al. (2012)).

As the times changed by Mishra and Koehler (2006) PCK was given additional technology into it so that it became the term TPACK. The addition of technology to PCK makes a new breakthrough because of the changing times that make technology faster then if teachers only capitalize PCK will not be better with teachers who have TPACK capabilities. Technological Pedagogical and Content Knowledge is a framework that connects teaching skills (pedagogical knowledge), material capabilities (content knowledge), and technological skills (technological knowledge). The integration of technology has a positive impact as learning becomes more effective and efficient (Sa'adah and Karidiana. 2018).

Biological learning is often found difficult because of terms, cycles, and some things that make biology seem difficult to learn. Here, mastering the concept of prospective biology teachers is very important to make students understand biological materials without experiencing difficulties. From a biological point of view, difficulty comes from a foreign term or Latin name and the complexity of a concept due to the complexity of information of a concept (NTSA, 2013). Mastery of concepts for prospective teachers is very important to have, because with the right concept students will easily understand the material delivered. According to UUGD and PP No. 19/(2005) that professional competence is the mastery of material widely and in depth. Mastery of the concept of a good prospective teacher will prevent students from misconceptions that often occur in the learning process. Prospective teachers who have mastery of high concepts will have their own way to make their students understand little by little to avoid the occurrence of students who still do not understand one concept, but the teacher continues with a new concept. It can cause difficulties for students. Irani, et al (2020) that misconceptions are concepts that are not in line with the scientific understanding recognized by experts in the field and can make it difficult for students to understand the material or concepts.

The formulation of the problem in this study is how the ability of TPACK prospective biology teachers, how to master the concept of prospective biology teachers, and how the relationship between the ability of TPACK and the mastery of the concept of prospective biology teachers. The purpose of this study is to describe the ability of TPACK prospective biology teachers, describe the mastery of the concept of prospective biology teachers, analysis the relationship between the ability of TPACK and the mastery of the concept of prospective biology teachers.

RESEARCH METHODS

This study is a type of quantitative research with a correlational design. This research data will be obtained with test instruments in the form of multiple choice questions to measure the ability of TPACK and mastery of scientific concepts of prospective biology teachers. Non-test instrument in the form of interview guidelines to classify respondents' answers further about TPACK capabilities. The test instrument is given simultaneously to prospective biology teacher students in semesters VIII and X, after which they have just conducted an interview.

The study was conducted at one of the universities in Indonesia with a 178 of semester VIII and X students as the population. The sample used was 64 prospective teachers. TPACK data and mastery of concepts that have been obtained will be tested for correlation using Product Moment.

RESULTS AND DISCUSSIONS

TPACK Profile

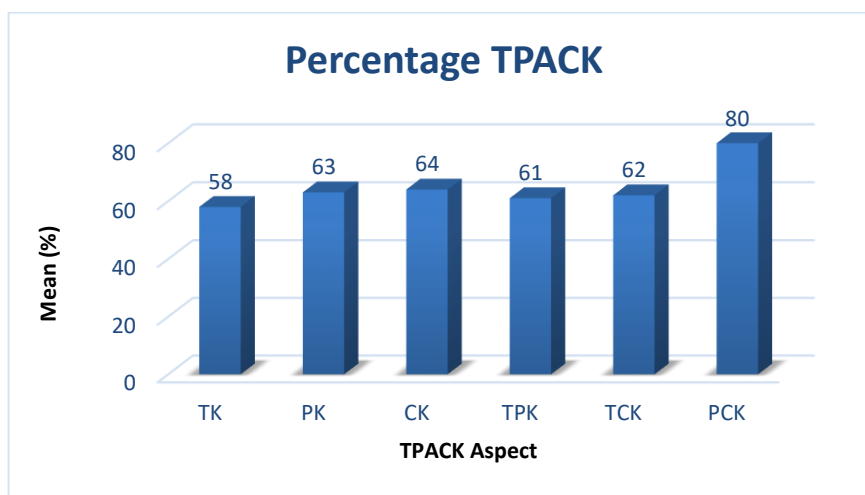Below are the results of TPACK prospective biology teachers:

Figure 1 The Percentage of TPACK Ability of Prospective Biology Teacher

Based on Figure 1 obtained the results that the ability of TPACK prospective biology teachers showed results with less categories compared to other abilities. The results of the analysis aspect that by simply integrating technology, content, and pedagogy are implemented separately from each other presented in Figure 2.
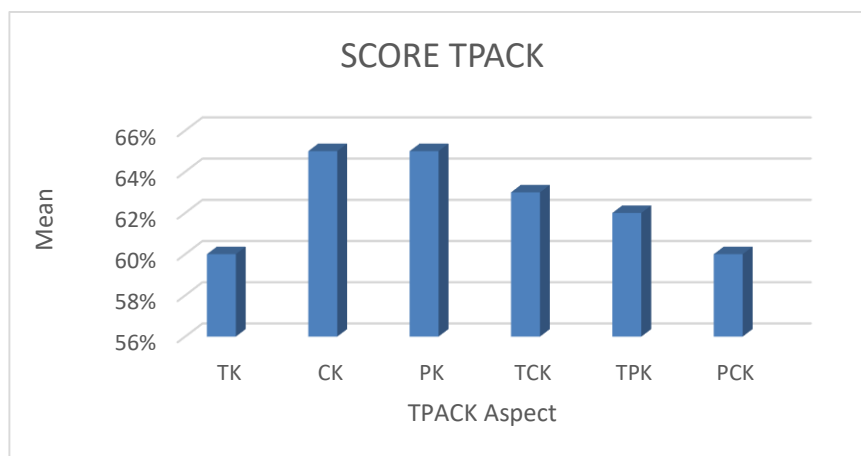
Figure 2 TPACK Ability Score of Prospective Biology Teacher

Technological Knowledge

Figure 2 obtained the results that the TK ability of prospective biology teachers showed results with sufficient categories. This is due to a lack of insight in technological advances. The results of the interview stated that prospective biology teachers are able to use technology and choose the technology to be used, but have not been able to use the technology as a whole. Most prospective teachers only master the power point because this application is often used in lectures, for zoom applications prospective teachers are only able to operate by simply joining the space provided but there are also those who can already create classes in zoom, then for kahoot applications mostly only become users not implementers.

National education minister regulation (Permendiknas) No. 16 of 2007 states about teacher competency standards, which teachers are expected to be able to utilize information technology, and communication to help the learning process. The thing that needs to be done is to improve the ability to use technology in one way, namely using the internet in biological learning (Safrudin, 2017). In addition to the potential of using the internet as a prospective teacher must also familiarize themselves with technology because it is now in the era of the industrial revolution 4.0 where the use of technology is very sophisticated. So that prospective teachers also inevitably have to get used to technology.

Content Knowledge

From Figure 2 obtained the results that the ability of CK prospective biology teachers showed results with sufficient categories. This aspect of CK is an aspect of material or content controlled by prospective biology teachers. Prospective biology teachers are quite master of the material because they can convey biological materials, but before delivering the material they first prepare or learn related to the material to be delivered. This means that prospective teachers need an increase in CK. Increased knowledge of concepts can be done by mastering various terms, theories, ideas, and frameworks (Shulman, 1986). The teacher is someone who plays a role in transferring knowledge to students so that knowledge about this content is very important, because if the teacher conveys inappropriate material it is feared that there will be misconceptions and more feared will bring new concepts to the student's mind. According to Fahmi (2013), the success of teachers can be seen from the extent to which students absorb material that cannot be separated from the preparation of a teacher before doing learning.

Pedagogical Knowledge

From Figure 2 obtained the result that PK ability shows results with sufficient categories. This aspect of PK is the teacher's ability in the pedagogical field from preparing lesson plan (RPP) to assessment to be done in the classroom. Pedagogical Knowledge in the

category can be quite due to some misunderstanding of learning methods, approaches, and models. There are still teachers who answer wrongly between the three. Prospective teachers are able to distinguish between approaches and methods of learning but, when asked questions to name examples of known approaches and methods, many of them are mistaken. Prospective teachers mention the approach correctly, but when mentioning examples of learning methods there are some prospective teachers who are wrong and instead mention the learning model. According to Fadlan (2010) that all kinds of pedagogical knowledge must be made systematic efforts so that teachers can develop skills that will later be applied in the management of learning, designing learning activities, eavaluation, and improvement. This was added by Agustina (2015) that according to her, PK biology students as prospective biology teachers need to master aspects of learning scenarios and learning simulations.

Technological Content Knowledge

From Figure 2 obtained the results that the ability of TCK prospective biology teachers showed results with sufficient categories. This is because some students have not mastered technology so they tend to use that technology to teach biological materials, even though there are many technology references to help prospective teachers to make their students understand the material delivered. Prospective teachers reveal that all technologies can be used to teach biology depending on how the teacher can choose which one is suitable for use in certain biological concepts to facilitate in the biological learning process. Technological Content Knowledge is the use of technology to facilitate the understanding of material content. The technology used here must certainly be in accordance with the material that will be given to students. Teachers must choose suitable technology in order to achieve the learning goals desired by KD. According to Abbit (2014) states that TCK is a knowledge of how technology can affect and can be used in exploring disciplines. This makes prospective teachers must be able to choose the right technology for learning.

Technological Pedagogical Knowledge

From Figure 2 obtained the results that the ability of TPK prospective biology teachers showed results with sufficient categories. This is because prospective biology teachers are mostly not able to combine the use of the right methods, approaches, and models so that, to be applied with technology prospective teachers only often use PPT technology, videos, and images only, as well as methods that are often done is the lecture method. Prospective teachers when practicing teaching, some have implemented the use of new applications and blended with teaching methods that are packaged in such a way.

According to Suyamto, et al. (2020) stated that TPK must have a reciprocal relationship between technology and pedagogy. In other words, the use of what technology can make it easier for prospective teachers or teachers in achieving the goals of pedagogical. According to Schmidt, et al. (2009), TPK is knowledge of how various technologies can be used in teaching and the use of such technology can provide changes in the way teachers teach. This ability is very instrumental in improving student competence because if the teacher mastered TPK, the teacher will use technology to facilitate the teaching process. Technology combined with pedagogy will increase children's interest in learning because it is not monotonous to listen to teachers only, but there is a role of technology also that is able to attract students.

Pedagogical Content Knowledge

From Figure 2 obtained the results that the ability of PCK prospective biology teachers showed results with good categories. This is because prospective teachers who can integrate both well. There are already many prospective biology teachers who use ways or stages to make their students understand the material delivered. Prospective teachers explain that they

initially provide perceptions to make students stimulated, there are also those who do pre-tests first to measure the initial knowledge of students, then they convey the material with interesting models and methods, at the end of learning prospective teachers do Q&A and post tests to measure the extent to which students capture and pay attention to explanations from teachers.

According to Purwaningsih, et al. (2010) stated that the PCK aspect cannot be ignored, without knowledge of pedagogical content allows a teacher to transfer only mastered subject matter knowledge, without giving students the opportunity to build knowledge and encourage students to think correctly.

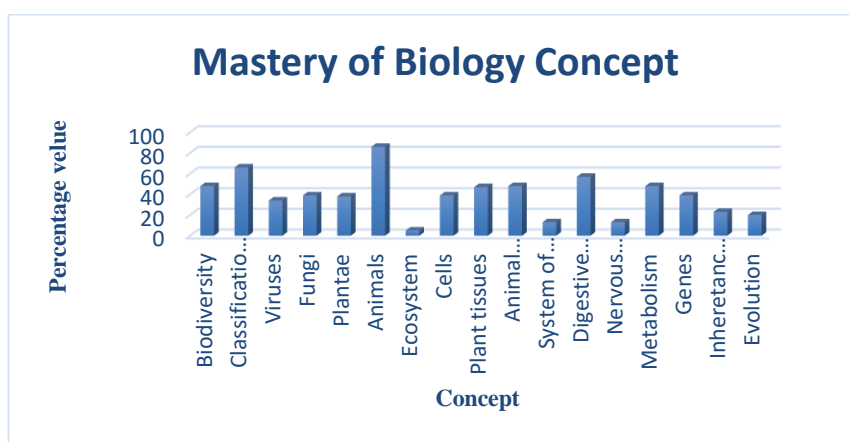**Concept Mastery Profile**

Figure 3 Mastery of the Concept of Prospective Biology Teacher

Based on Figure 3 shows that prospective biology teachers have a mastery of medium concepts, with mastery of the highest concept in the concept of grouping animals based on their phylum, while the lowest in the concept of ecosystems. The concept of grouping animals into its phylum becomes the highest concept mastered by prospective biology teachers because in 3 questions of cognitive ability including C4, C3, and C3 problems where the difficulty lies in the ability of prospective teachers to analyze the characteristics of the animals intended in the problem, so that if the prospective teacher has been fluent in mastering the characteristics of animals based on their phylum they will easily answer the question. Then the concept of ecosystems becomes the lowest concept mastered by prospective biology teachers because this problem is included in the cognitive level C6, where the difficulty of the problem lies in the way students make the food chain of a marine ecosystem.

The Relationship between TPACK's Ability of Prospective Biology Teacher and Their Mastery of the Concept in UNNES

Table 1 Correlation Results

Correlation	Results
TPACK & Mastery of Biology Concept	0.230
CK & Mastery of Biology Concept	0.388
TCK & Mastery of Biology Concept	0.303
PCK & Mastery of Biology Concept	0.408

From Table 1 it can be stated that the ability of TPACK with concept mastery, CK aspect with mastery of concepts, and TCK aspects with mastery of concepts of prospective biology teachers have a low correlation relationship, while PCK aspect with concept mastery has a moderate correlation category. TPACK and the results of mastery of the concept of prospective biology teachers are calculated using product moment correlation and produce the number 0.230. This figure indicates that TPACK and mastery of the concept have relationships but fall into a low category. This can be because TPACK consists of several aspects that are not only aspects of content but exist in terms of technology and pedagogy. Mastery of concepts is the main science that must be mastered as an educator, and from there a good educator must develop his ability as the times develop so that teachers must master TPACK to develop mastery of their concepts in order to provide good learning and follow technological developments.

Aspects of CK with mastery of concepts have relationships in low categories. This is because in this study the sample was less careful in working on the given problem. Aspects of TCK with mastery of concepts have relationships in low categories. This can be caused from the aspect of TCK there is already an addition of technology, while the PCK aspect with mastery of the concept has a relationship that falls into the category of being this because prospective teachers will easily capture the material by explaining the teacher, in this study students in 2016 tend to be more master of TPACK and mastery of concepts. This can be proven by existing data that biology students as prospective biology teachers in the class of 2016 answered more appropriately than students in the class of 2017 and more samples from students in the class of 2016.

CONCLUSION

Based on the results of research, data analysis, and discussion can be concluded that:

The TPACK profile of prospective biology teachers in each aspect is less comparable because, the average acquisition of TK aspects (58%), PK (63%), CK (64%), TPK (61%), TCK (62%) so that all five are in the category of sufficient, while the PCK aspect (80%) is in the good category and mastery of the highest concepts on the concept of grouping animals based on their phyla, while the lowest on the concept of ecosystems so the relationship between TPACK and mastery of the concept of prospective biology teachers UNNES has a low relationship.

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