Developing Technological Pedagogical Content Knowledge (TPACK) in Animal Physiology

F Pusparini1*, R Riandi1 and S Sriyati1

1Departemen Pendidikan Biologi, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*fitriapusparini@student.upi.edu

Abstract. The purpose of this study is to describe pre-service teacher’s learning during lecturing Animal Physiology and investigate it’s impact on pre-service teacher’s technological pedagogical content knowledge (TPACK). How was the lecturing process can improve TPACK of preservice teacher on Biology education especially in Animal Physiology. There are four experiment classes using Solomon four group design, there are pedagogic treatment, content treatment and technological treatment, the last class without any treatment. Both quantitative and qualitative data were collected. Quantitative data were collected through a questionnaire of TPACK. Qualitative data were collected through a lesson plan and teaching simulation. Findings has revealed that participants experienced significant gains in all TPACK constructs. Both of pedagogic and technology treatment is better than others, but pedagogical treatment didn’t also increase PCK most of participants. Findings has implications for teacher education programs to be a professional teachers and for researchers interested.

1. Introduction

The 21st century demands qualified human resources, generated by professionally managed institutions to produce superior results. Education as part of efforts to improve the quality of human resources also changes and follows the times. Therefore, professional teachers are required. To prepare a professional teacher must be prepared from the beginning, that is when they are still students (preservice teachers). During the course of lectures, preservice teachers of the University of Galuh Ciamis Biology are equipped with knowledge about Biology as content, pedagogy, and technology. These three types of knowledge interact and form new knowledge known as Technological Pedagogical Content Knowledge (TPACK) (Mishra and Koehler, 2006). TPACK which is owned by biology preservice teacher has an important role, because TPACK will influence the student how preservice teachers in teaching (Srisawasdi, 2012). Effective teachers not only know their subject matter but they also able to create a stimulating learning environment and apply pedagogical strategies, including technology-rich strategies that engage students while helping them improve their achievement (NCATE, 2010).

The TPACK framework was developed by Mishra and Koehler based on Lee Shulman’s concept of PCK by adding technology. One form of TPACK application in learning is the use of technology in teaching certain materials. Technology is considered important to be integrated in learning to respond to the challenges of the 21st century. Teachers are not only required have the ability of PCK but also apply technology in learning, so technology, pedagogy and content has become a part of teacher education programs to prepare preservice teachers. Applying technology in its teaching process. This research was conducted in order to analyze TPACK development process in Biology preservices.
teacher and to analyze how the training received during lecturing can support TPACK of Biology preservice teacher in animal physiology material (digestive system and circulatory system).

2. Experimental Method
This research is examining how preservice teachers develop and apply technological pedagogical content knowledge (TPACK) throughout their teacher preparation program. As part of the research plan, we constructed the Survey of Preservice Teacher’s Knowledge of Teaching and Technology to collect data on preservice teacher’s self-assessment of the seven knowledge domains within the TPACK framework. These knowledge domains include: technology knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and finally, technological, pedagogical content knowledge (TPACK). This instrument adopted from TPACK instrument developed by Widodo (2017).

Respondents who participated in this study are biology preservice teacher enrolled in a fourth semester in Biology Department of Universitas Galuh Ciamis. The participants were students of the researcher’s classes, the first class was designed to introduce participants the technology that can use to teach animal physiology, the second class was designed to introduce participants focus on pedagogical tasks, the third class is combine both technological and pedagogical treatment, and the other class doen’t get any treatment. At the beginning and end of course participant complete the TPACK instruments consist of questionaire and open ended question. The instrument constructed contained 35 items for measuring preservice teachers's self-assessments of the seven TPACK domains: 6 TK items, 5 CK items, 5 PK items, 6 PCK items, 4 TCK items, 4 TPK items, and 5 TPACK items. For these 35 items, participants answered each question using the following five-level Likert scale:
1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree.

3. Result and Discussion

3.1 Technological Knowledge (TK)
Technology knowledge refers to the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet, digital video, Interactive whiteboards, and software programs. Based on analysis, the profile of TK preservice teachers of Biology is presented in table 1.

| No | Statement                                                                 | M    | SD  | Criteria |
|----|---------------------------------------------------------------------------|------|-----|----------|
| 1  | I follow the latest technological developments                             | 4.00 | 0.68| Good     |
| 2  | I am proficient at using word processing programs, number processors, and presentations like Ms. Office | 4.14 | 0.53| Good     |
| 3  | I can store data on digital media (upload or download)                     | 4.07 | 0.73| Good     |
| 4  | I can use internet as a tool for communication such as having email and social networking | 4.57 | 0.51| Good     |
| 5  | I can use printers, scanners, projectors and cameras                       | 4.00 | 0.88| Good     |
| 6  | I can create a discussion forum on email or social networking              | 3.71 | 0.83| Good     |
|    | **Mean**                                                                  | **4.08** |     | **Good** |

Table 1. Technological Knowledge Score Biology Preservice Teachers
The average score TK of preservice teachers is 4.08, it is in the good criteria this indicates the ability of technological preservice teacher has been good average that the highest on the item statement is “I can use internet as a tool for communication such as having email and social networking”

3.2 Pedagogical Knowledge (PK)
Pedagogical knowledge refers to the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning. Based on analysis, the profile of PK preservice teachers of Biology is presented in table 2.

| No | Statement                                                                 | M    | SD  | Criteria |
|----|---------------------------------------------------------------------------|------|-----|----------|
| 1  | I can use a variety of learning strategies                                | 3.50 | 0.76| Adequate |
| 2  | I can manage and master the class well                                   | 3.50 | 0.76| Adequate |
| 3  | I can use various assessment methods and techniques                       | 3.43 | 0.76| Adequate |
| 4  | I am aware of the possibility of misconceptions and learning difficulties experienced by students | 3.57 | 0.85| Good    |
| 5  | I do reflective actions to improve the quality of learning               | 3.57 | 0.76| Good    |
| 6  | I can use a variety of learning strategies                                | 3.51 | 0.76| Good    |

Mean 3.50 Adequate

The average score PK of preservice teachers is 3.50, it is in the good criteria this indicates the ability of pedagogical preservice teacher has been good average that the highest on the both item statement is “I am aware of the possibility of misconceptions and learning difficulties experienced by students” and “I do reflective actions to improve the quality of learning”

3.3 Content Knowledge (CK)
Content knowledge is the "knowledge about actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006, p. 1026). Teachers must know about the content they are going to teach and how the nature of knowledge is different for various content areas. Based on analysis, the profile of CK preservice teachers of Biology is presented in table 3.

| No | Statement                                                                 | M    | SD  | Criteria |
|----|---------------------------------------------------------------------------|------|-----|----------|
| 1  | I understand the concept of digestive system and transportation system and its application | 3.57 | 0.65| Good    |
| 2  | I follow the development of science, especially related to the digestive system and the circulatory system | 3.57 | 0.76| Good    |
| 3  | I use the latest reference sources (such as books and journals) to augment the knowledge that I have | 3.71 | 0.83| Good    |
| 4  | I attended a seminar related to the field of Biology                     | 3.43 | 0.65| Adequate |
| 5  | I can design and implement Biology experiments for learning purposes      | 3.57 | 0.85| Good    |

Mean 3.57 Good

The average score CK of preservice teachers is 3.57, it is in the good criteria this indicates the ability of content knowledge preservice teacher has been good average that the highest on the item statement “I use the latest reference sources (such as books and journals) to augment the knowledge that I have”.

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3.4 Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge refers to the content knowledge that deals with the teaching process (Shulman, 1986). Pedagogical content knowledge is different for various content areas, as it blends both content and pedagogy with the goal being to develop better teaching practices in the content areas. Based on analysis, the profile of PCK preservice teachers of Biology is presented in table 4.

Table 4. Pedagogical Content Knowledge Score Biology Preservice Teachers

| No | Statement                                                                 | M   | SD  | Criteria |
|----|---------------------------------------------------------------------------|-----|-----|----------|
| 1  | I can help students keep understanding the material of the digestive system using various strategies without using technology | 3.79 | 0.70 | Good     |
| 2  | I can engage students actively in meaningful discussions on the material of the digestive system even without the use of technology | 3.86 | 0.77 | Good     |
| 3  | I can make students actively solve real problems on the topics of the digestive system without using technology | 3.64 | 0.74 | Good     |
| 4  | I can help change the thinking process of students in order to master a difficult topic on the material of the digestive system without using technology | 3.29 | 0.61 | Good     |
| 5  | I can evoke meaningful reflection on the students on the material of the digestive system without using technology | 3.50 | 0.52 | Good     |

The average score PCK of preservice teachers is 3.61, it is in the good criteria this indicates the ability of pedagogical content knowledge preservice teacher has been good average that the highest on the item statement “I can engage students actively in meaningful discussions on the material of the digestive system even without the use of technology”.

3.5 Technological Pedagogical Knowledge (TPK)

Technological pedagogical knowledge refers to the knowledge of how various technologies can be used in teaching, and to understanding that using technology may change the way teachers teach. Based on analysis, the profile of TPK preservice teachers of Biology is presented in table 5.

Table 5. Technological Pedagogical Knowledge Score Biology Preservice Teachers

| No | Statement                                                                 | M   | SD  | Criteria |
|----|---------------------------------------------------------------------------|-----|-----|----------|
| 1  | I use computer apps in every lesson                                      | 3.79 | 0.70 | Good     |
| 2  | I choose technology that suits the approach and strategy of learning in the classroom | 3.36 | 0.50 | Adequate |
| 3  | I use internet facilities (like social networks, emails and blogs) to communicate with students | 3.86 | 0.66 | Good     |
| 4  | I use online quiz (such as Quipper School, Edmodo, Socrative) to do the tests | 3.43 | 0.76 | Adequate |

The average score TPK of preservice teachers is 3.61, it is in the good criteria this indicates the ability of technological pedagogical knowledge preservice teacher has been good average that the highest on the item statement “I use internet facilities (like social networks, emails and blogs) to communicate with students”.

3.6 Technological Content Knowledge (TCK)

Technological content knowledge refers to the knowledge of how technology can create new representations for specific content. It suggests that teachers understand that, by using a specific
technology, they can change the way learners practice and understand concepts in a specific content area. Based on analysis, the profile of TCK preservice teachers of Biology is presented in table 6.

| No | Statement                                                                 | M    | SD  | Criteria |
|----|---------------------------------------------------------------------------|------|-----|----------|
| 1  | I use technology to help understand the concept of the Digestive System and Circulatory System | 3.29 | 0.61 | Adequate |
| 2  | I can download the application of computer and animation related to Digestive System and Circulatory System | 3.57 | 0.51 | Good     |
| 3  | I can develop student activities and tasks that involve the use of technology | 3.79 | 0.70 | Good     |
| 4  | I can create self-learning activities for students using ICT devices (eg. webquest or flip) | 3.43 | 0.65 | Adequate |

The average score TCK of preservice teachers is 3.52, it is in the good criteria this indicates the ability of technological content knowledge preservice teacher has been good average that the highest on the item statement “I can develop student activities and tasks that involve the use of technology”.

**3.7 Technological Pedagogical Content Knowledge (TPACK)**

Technological pedagogical content knowledge refers to the knowledge required by teachers for integrating technology into their teaching in any content area. Teachers have an intuitive understanding of the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies. Based on analysis, the profile of TPACK preservice teachers of Biology is presented in table 7.

| No | Statement                                                                 | M    | SD  | Criteria |
|----|---------------------------------------------------------------------------|------|-----|----------|
| 1  | I understand how to integrate Biological knowledge (especially the Digestion System and Circulatory System), pedagogical knowledge and technological knowledge | 3.50 | 0.85 | Adequate |
| 2  | I can choose a learning strategy and technology that match the material of the Digestive System and Circulatory System that will be delivered in class | 3.50 | 0.65 | Adequate |
| 3  | I can integrate knowledge of the content, pedagogical knowledge and knowledge of technology to realize meaningful learning | 3.71 | 0.61 | Good     |
| 4  | I can apply different learning strategies and varying technologies in the implementation of Biology learning | 3.50 | 0.52 | Adequate |
| 5  | I can enable students to construct deep and meaningful insights into the material of the Digestive System and Transportation System using various technologies (such as Google site or concept maps) | 3.71 | 0.73 | Good     |

The average score of TPACK Biology teacher candidates is 3.58 are in good criteria this indicates TPACK candidate ability Biology teacher is good. Although the means to integrate the three content knowledge, pedagogy and technology are still sufficient criteria, the selection and application of
technology in learning strategies is also sufficient, but prospective teachers are good enough in constructing meaningful knowledge in learning the transport system and the digestive system.

The preservice teachers has different capability in each component of TPACK. Preservice teacher has very good knowledge about technology, it shown by the technological knowledge mean was the highest. But although the TK is high, the TCK is lower than TK it means the preservice teachers still doubt to apply technology in content of animal physiology. Both of pedagogic and technology treatment is better than others, but pedagogical treatment didn’t also increase PCK most of participants. The lowest is pedagogical knowledge, it is cause most of the participants doesn’t have an experience in teaching. The other component of TPACK (CK, TPK and PCK) almost the same. The capabilities of preservice teacher in every components of TPACK is describe in Figure 1.

![Figure 1. The capability of preservice teacher for each component TPACK](image)

In general, the ability TPACK prospective teachers Biology University Galuh has good criteria with an average of 3.58. Prospective Biology teachers who are analyzed do not have a long teaching experience (less than 2 years old), and some do not have teaching experience. Animal Physiology Lectures that provide knowledge of content related to material that is mastered by the teacher form Content Knowledge preservice teacher. Technological treatment is given so that preservice teachers can improve their technology knowledge and pedagogical treatment is given so that preservice teachers have pedagogical knowledge. Thus it is hoped that preservice teachers can integrate all three when he will teach animal physiology.

### 4. Conclusion

The aim of this study is preservice teachers can certainly develop their technological, pedagogical, and content knowledge separately, but integrating these types of knowledge through the development of their TPK, TCK and TPACK gives them a more holistic view of their teaching and helps them transition from learners of Biology to teachers of Biology. Our data show that close attention must be paid to the relationship between the university classroom and the field placement; ideally, every preservice teacher would see that what they learn in the university classroom has an impact on their work in the field. Field placements are where preservice teachers face the reality of a classroom and experience first-hand that how they design tasks affects student learning. Using advanced methods classes puts preservice teachers in the position of being learners. This allows them to pay explicit attention to developing their TCK, which in turn encourages them to reflect on their PCK and CK. Thinking about, and engaging with, advanced technologies gives preservice teachers advantage point to examine their beliefs about, and attitudes towards, what it means for their students to be successful.
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