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## Analysing Technological Pedagogic Content Knowledge of Science Teacher Candidates According to Various Variables

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### Abstract

*The aim of this study was to analyze science teacher candidates' technological pedagogic content knowledge level according to various variables. Technological pedagogic content knowledge of teacher candidates was measured by qualitative semi-structured interviews by the researchers. Teacher candidates' content knowledge was analyzed according to sex, class, age and having technology education or not. In this study, qualitative data analysis techniques was used to analyze data. This study was carried out with 12 teacher candidates from Sakarya University, Faculty of Education, Science Teacher Teaching Department. According to the results of the study, it is found that they were provided with the sufficient education on technology and pedagogy at university.*

### 1. Introduction

Shulman (1986) developed the idea of pedagogical content knowledge (PCK) to describe the relationship between the amount and organization of knowledge of a particular subject-matter (content) and knowledge related to how to teach various content (pedagogy). According to Shulman, PCK includes knowledge on how to teach a specific content or subject-matter knowledge, extending beyond simply knowing the content alone (Archambault & Barnett, 2010). Pedagogical content knowledge (PCK) reflects the ways teachers consider the connections between subject matter and instructional strategies. Learning is promoted when teachers consider how pedagogy can be adapted to meet the unique content and skills of varying subject areas such as science or language arts. Technological content knowledge (TCK) considers the ways in which subject matter and technology are related. Although technology applications may constrain the representation of subject matter, newer technologies may provide opportunities for more varied and effective ways to represent content knowledge. Technological pedagogical knowledge (TPK) addresses the ways in which specific technology tools can promote teaching and learning and how the teaching process itself may change an outcome of using specific tools (Ward & Benson, 2010).

TPACK, as described in the literature involves an understanding of the complexity of relationships among students, teachers, content, technologies, practices, and tools (Archambault & Barnett, 2010). Mishra and Koehler developed the TPACK framework in 2006. It is being used extensively in theory and practice to explain the complex relationship between content, pedagogy, and technology knowledge and how this knowledge is used in teaching and learning. Based on Shulman's work (1986) on PCK (pedagogical content knowledge), Mishra and Kohler address the complex, multifaceted and contextual nature of teacher knowledge in their conceptual framework (Ward & Benson, 2010).

At the core of Mishra and Koehler's framework, there are three areas of knowledge: Content, Pedagogy and Technology (Koehler & Mishra, 2005):



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*Content (C)* is the subject matter that is to be learned/taught. High school mathematics, undergraduate poetry, 1st grade literacy, and 5th grade history are all examples of content that are different from one another.

*Technology (T)* encompasses modern technologies such as computers, the Internet, digital video, and more commonplace technologies including overhead projectors, blackboards, and books.

*Pedagogy (P)* describes the collected practices, processes, strategies, procedures, and methods of teaching and learning. It also includes knowledge about the aims of instruction, assessment, and student learning

The TPACK framework describes good teaching with technology by including the components of content, pedagogy, and technology. Shulman's (1986, 1987) idea of pedagogical content knowledge (PCK) is the basis for this framework with the inclusion of the domain of educational technology. Technological pedagogical content knowledge describes how teachers' knowledge of technology, content, and pedagogy interact to use technology strategically for instruction (Landry, 2010).

Rather than just allowing students to use technology in the classroom, teachers should learn how to use technology to transform teaching and create opportunities for student learning. The strategic use of technology in science instruction is critical and teacher educators and professional developers should know how to support teachers as they learn ways to use technology to enhance instruction (Landry, 2010).

Many science education researchers have done research related to technology and science education without explicitly using TPACK as an organizing framework (Graham, Burgonye, Cantrell, Smith, Clair & Harris, 2009).

In *Handbook of Technological Pedagogical Content Knowledge for Educators*, McCrory (2008) identifies ways scientists and science educators use technology to transform science content as well as their pedagogical practices :

1. Speeding up time via simulations of natural events (e.g., geological animations)
2. Saving time through data collection devices and/or recording data that would otherwise be hard to gather (e.g., digital probes)
3. Seeing things that could not otherwise be seen (e.g., digital microscopes)
4. Organizing data that would otherwise be hard to organize (e.g., spreadsheets, graphical visualization models).

## 2. Method

In this research phenomenology, which is one of the methods of qualitative research, was used as a model. Phenomenology model, which is preferred in order to explain one's opinion and experiences, concentrates on the phenomena that are known but not in detail with a deep understanding. (Yıldırım and Şimşek, 2008). In this research, such a technique was used due to the desire of evaluating the opinions of trainee teachers of science and technology on their feelings about being sufficient or not about the integration of technology in the base of pedagogical content model.

The depth and width of data planned to be obtained is inversely proportional with the size of the experimental group. Due to the limited resources and the characteristics of data gathering and methods of analyzing it is not healthy to work with a lot of people (Yıldırım and Şimşek, 2008). For this reason, considering accessibility, the research group consisted of 12 trainee teachers of Science Education in Education Faculty of Sakarya University, which are in the 4th year of their education in 2011-2012 fall term and they were chosen at random. While choosing the research group proper sampling method was preferred. The research group consisted of 8 female 4 male trainees. 5 trainees are at the age of 22, 4 of them are 23, 2 of them are 21 and one of them is



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24. 2 of the trainees stated that they have inadequate knowledge of technology, 5 of them stated that they have moderate knowledge, 5 of them stated that they have adequate knowledge.

In the research a questionnaire was used which consisted of open ended questions in order to obtain the opinions of trainee teachers. In the questionnaire 2 questions were asked about TPACK in total. These questions are "To what extent do you feel yourself capable of using technology, pedagogy and knowledge of field while teaching a subject in a science class? Why?". "To what extent do you feel your knowledge of technology, your knowledge of field is adequate about effective teaching, using interactive smartboards and tablets? Why?" These questions were gathered with the questionnaires that are sent to trainees via internet. While analyzing the data, descriptive analysis was used. The results are presented with descriptive explanations and the findings are explained and interpreted with direct citations (Yıldırım and Şimşek, 2008). Codes such as 1E, 2K... 12E are used in this study while expressing the statements of teacher trainees according to their order of taking place to the study.

### 3. Findings

The Question "To what extent do you feel yourself capable about using technology, pedagogy and knowledge of field while teaching a subject in science class? Why?" was asked to the trainee teachers taking place in the study. This question was evaluated as three separate questions. In this question the feelings of teachers about how capable they find themselves about technology was analyzed. 9 of trainees taking place in the research stated that they are capable (1E, 2K, 3K, 4K, 6E, 7K, 8E, 10K and 12K) whereas 3 of them stated that they feel moderately capable (5E, 9K and 11K). Trainee teachers stated the effect of university education. One of the trainees, 1E who expressed that he had adequate education in university stated: "I find myself excessively capable, except for smart board used in our school, I own all the systems and I know how to use them well" and 7K stated "I find myself capable enough to have an efficient class. I think my knowledge of technology increased thanks to the courses about technology we have in our school now and the assignments that we prepare each term. Thanks to the knowledge I have, I can plan more effective and appealing courses for students." 5E who is feeling moderately capable stated "I find myself moderately capable. Because the courses given were in limited numbers and possibilities gave me chances at a moderate level".

When the part of study which is about the extent to which trainees feel able on pedagogy analyzed, 9 trainee taking part in the research (1E, 2K, 3K, 4K, 5E, 7K, 9K, 10K and 12K) stated that they feel capable whereas 3 of trainees (6E, 8E, 11K) stated that they feel partly capable. In the capability of trainee teachers, university education, having teacher acquaintances around and the effect of the experience are stated. Among the trainees, 1E expressed that "I find myself capable and I have no fear about it. We will implement our manner and our approach to the student as we learned in our courses. In my family, each member's being teacher is also a reason for this. For years I've learned a lot from those examples around.", 7K "I think some of my pedagogical classes contributed to my knowledge of field a lot. However, in our training course studies I recognized that students have a variety of characteristics and it is possible that at any moment unexpected things might happen and I concluded that our existing knowledge is not enough and in most of these cases we can overcome with experience." And 10K stated "I feel myself capable. I'm quite good at teaching the classes in our training school, I teach with confidence and with enough knowledge on the subject. When I observe other teachers in training school I feel myself even more successful as I think I can teach better than them. 6E, feeling moderately capable, stated "I can say that I'm not good at all and quite incapable about this subject. Because I began this occupation unwillingly and did not pay attention about this." And 8E expressed "To some extent I have capability but in order to perform teaching properly there should be more applied courses and opportunities for training.





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When the part of study which is about to what extend trainee teachers feel themselves able on knowledge of field is analyzed: 6 of them (5E, 6E, 9K, 10K, 11K, 12K) stated that they feel capable whereas 6 of them (1E, 2K, 3K, 4K, 7K and 8E) stated that they feel themselves partly capable or incapable. Within the adequacy of trainees' knowledge of field, the university education and the effect of education continued for years are mentioned. Moreover, disunity of syllabus, changes in the approaches of education and that the education taken lack direct effect on improving field's knowledge are stressed. One of the trainees, 5E said " I find myself capable. High quality courses from teachers of field contributed my knowledge of field", 6E " I can't say that I have a perfect knowledge of field but I find myself capable enough to tell about myself. Because if I prepare the materials accordingly I can be successful in teaching the subject." And 11K said "Fairly enough...I can transfer my knowledge and easily realize if the understanding took place or not. Besides I can simplify my teaching and reteach. Also 3K, one of the trainees who evaluated themselves as capable or incapable said " I don't think my scientific background relating to the subject is not rich enough because what we study in the lesson and the curriculum clash. It requires having preparations in advance. It's only sufficient with preparations." 4K "I don't feel qualified enough. I need to donate myself on this especially during the first two years after graduation. Because the subjects are now not taught the way we were taught. I will definitely have some missing knowledge on my branch. For example; teacher presents the data on simple machines but the students aren't directly given the formulas. The students are supposed to infer them on their own. The change of the methods imply that it will be harder". 7K "I don't find myself adequate on my field. Because I don't think what we learned at university hasn't got much in common with the field. In addition, as we are generally focused on KPSS (an examination system in Turkey held every year to determine the government employees on various fields including teaching), we get estranged from our fields towards the last years before the graduation.

The question " To what extend do you feel adequate on using smart board or notebook for effective teaching in Science Classes? Why?" was asked. For the question one of the trainees, 6E declared him/herself capable while 11 of them ( 1E, 2K, 3K, 5E, 7K, 10K, 11K, 12K) declared themselves as moderately capable. All declared they hadn't had education on how to use these devices. 6E said " I trust myself on using these kinds of technological devices. Because I have a tendency for technology." And 3K said " We have smart board in our school but we don't know how to use it as we only use the class with the smart board on exam days. It's the same for notebook. So I don't feel capable enough with those, I only will if I have a training on how to use them. And finally 8E stated " Zero capability I have because I had zero education on these."

#### 4. Results and Recommendations

Trainees attending to the study declared that they were provided with the sufficient education on technology and pedagogy at university. While some attendants signified that there must be more teaching at university on technology, some declared a relatively enough pedagogical background due to lack of applied classes and their own dislike of the profession. In addition, lack of knowledge on the field seems to be the common area with which the trainees have trouble the most. Some stated they are capable enough on field knowledge as they have been taking seminars on their field for years. Some attendants also noted that there is disunity within the curriculum of primary schools and the subjects taught in university. And some noted that there is constructivist education style in primary schools while in universities behaviorist and cognitive style of education are predominantly adopted. It was also added that field knowledge isn't included in KPSS and they don't spare time for it either.

There is a new project which includes the act of delivering each class a smart board, each teacher a notebook, each student a tablet and an enriched digital book. Relating to this the trainees, who are teachers to be, were asked a question with the aim of eliciting info on their compatibility with this project. Within this



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question all stated they are incapable except for one. Considering all the questions wholly, the fact that their declaring themselves capable of using technology for the first question clashes with the comments they did on their future and likely incapacities with the devices to be delivered and it displays a negative situation.

Within the research, when the data is implemented through TPACK, it is visible that they lack knowledge and background relating to their field. And for the subsequent studies, it is considered to be crucial to have a more qualified and thorough studies that are field oriented. The fact that trainee teachers declared themselves insufficient on the technology within the project to take place in Turkey is also notable. Within this respect, it is recommended to form a curriculum in universities that includes teaching how to use tablets, smart boards and digital books. It is also important that in education faculties each class should get donated with smart boards and tablets. Along with the necessities faculty members should actively use these devices to constitute a role model for trainee teachers.

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