

Future biology teachers' opinions on technological pedagogical content knowledge

Assem Nogerbek ^{*1}, Abai Kazakh National Pedagogical University, Talas microregion 15-42, Taraz city, Kazakhstan, <https://orcid.org/0000-0001-8878-7909>.

Sergey Sumatokhin ², Moscow city university, Vtoroy Selskohoziastvenny proezd 129226, Moscow, Russia <https://orcid.org/0000-0002-9027-4085>.

Assiya Maimatayeva ³, Abai Kazakh National Pedagogical University, Shanyrak 2, Saryzhaz street 3, Almaty, Kazakhstan, <https://orcid.org/0000-0002-4256-0802>.

Gulnar Ziyayeva ⁴, Dulaty University, Alatau microregion 11-53, Taraz, Kazakhstan, <https://orcid.org/0000-0001-7260-2164>

Dzhumadil Childibayev ⁵, Abai Kazakh National Pedagogical University, Bostandyk region, Kekilbayeva street 207, Almaty, Kazakhstan, <https://orcid.org/0000-0002-6986-577X>

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Abstract

The purpose of this research is to evaluate the technological pedagogical content knowledge of future biology teachers. In this study, the qualitative research method was used while making associations about the findings. Twenty (20) students studying in the biology teaching department of various universities in Kazakhstan constitute the study group of the research. The data of the research were collected by semi-structured interview technique. Considering the purpose of the research, a semi-structured interview form developed by the researcher was prepared. As a result of the research, it was determined that the majority of the pre-service teachers found themselves somewhat inadequate regarding their teaching skills by suitably combining technology and teaching approaches. The vast majority of pre-service teachers find themselves inadequate regarding their ability to use information and communication technologies as a tool for students to share their thoughts and ideas.

Keywords: Content knowledge; pedagogical knowledge; technology knowledge.

* ADDRESS FOR CORRESPONDENCE: Assem Nogerbek , Abai Kazakh National Pedagogical university, Talas microregion 15-42, Taraz city, Kazakhstan,
E-mail address: asema10.93@inbox.ru

1. Introduction

The rapid development of science and technology brings up the necessity of adapting to this development to meet the needs of society (Litvinenko, 2020). The effective use of technology provides great convenience and superiority in education as in every field. Among the advantages of using technology in education are providing multiple learning environments, meeting the individual needs of the learners, and increasing the interest of the learners in the course by attracting attention. In the developing information society, the task of teachers is not only to transfer existing information but also to convey current and accurate information to students by constantly following innovations and developments and interpreting the data they collect with a critical perspective.

In this direction, teachers should not only use technology effectively in education but also be individuals who constantly renew themselves by making use of technology in their development processes. Therefore, the task of educational institutions that train teachers should be to train teacher candidates who can comprehend the importance of technology in life and its necessity in the education process and have the ability and self-confidence to use technology effectively in the education process (Erdemir et al., 2009).

1.1. Theoretical and conceptual framework

Changes and innovations in technology directly affect the education process. In particular, associating technology with the learning-teaching process is considered important for the realization of mastery of learning. In this approach, it is seen that teachers have important duties in the use of technology in education. For this reason, teachers are expected to have a high level of knowledge and skills regarding technology. In line with these changes and expectations, it is desirable to have sufficient knowledge about technology among the types of knowledge that teachers to be trained should acquire. The "technological pedagogical content knowledge (TPACK)" model considers teachers' technological knowledge together with pedagogical and content knowledge and touches on the interactions and relationships of these types of knowledge (Mishra & Koehler, 2006).

The concept of "pedagogical content knowledge" emerged by combining content knowledge (AB), which is one of the dimensions that teachers want to have, with pedagogical knowledge by Shulman (1986). Koehler and Mishra (2005), on the other hand, added the "technology" dimension to Shulman's (1986) concept of "pedagogical content knowledge" and introduced the concept of "technological pedagogical content knowledge" to the literature. Through this concept, it was revealed which elements of technology pedagogy content knowledge a teacher should have (Mishra & Koehler, 2006).

Content Knowledge: It is a subject to be learned or taught about the teacher or teacher candidate's field. • Pedagogical Knowledge: It is the knowledge of the teacher or pre-service teacher about teaching approaches, and with which approach he can teach the subject to be taught most appropriately. • Technological Knowledge: It is the knowledge of the teacher or pre-service teacher about standards (blackboard, book, etc.) and digital technologies (video, storytelling, smart board, educational software, etc.). • Pedagogical Content Knowledge: It is the knowledge of the teaching approach that a teacher or pre-service teacher can use for teaching a subject (field). • Technological Pedagogical Knowledge: It is the knowledge of the teacher or pre-service teacher about the competencies of technologies and how these competencies will change teaching. • Technological Content Knowledge: It is the knowledge of the teacher or pre-service teacher that technology and content knowledge are related. • Technological Pedagogical Content Knowledge: It is the knowledge of the teacher or pre-service teacher about the technologies and teaching approaches that they can use to teach a specific subject related to the field, consisting of a combination of technology, pedagogy, and content knowledge (Mishra & Koehler, 2006).

When the components of technological pedagogical content knowledge are examined, it includes tools of technology such as computers, the internet, video, pedagogy, learning, and teaching methods, strategies, processes. On the other hand, it is seen that content knowledge covers the subject area of knowledge to be learned. Technological pedagogical content knowledge does not mean bringing together pedagogy and content knowledge haphazardly, it is defined as the knowledge of teachers to use technology effectively in teaching environments in the light of their knowledge of the field and pedagogy (Graham et al., 2009). According to Niess (2014), technological pedagogical content knowledge is the teacher's use of 21st-century technologies in planning, organizing, criticizing, and summarizing a subject, considering student needs and classroom conditions, to support students' learning. As technology, teachers, students, and classroom content change, technological pedagogical content knowledge provides teachers with the necessary information to plan the program with digital technologies (computer and communication technologies and the Internet, special-purpose software programs, etc.) and focus their students' learning and thoughts on their fields to prepare for teaching with digital technologies. provides information in a dynamic structure.

1.2. Related research

Lee and Lee (2014), in their study on technology use proficiency of teachers and pre-service teachers, reveal that as their positive attitudes and skills towards using instructional technologies increase, their frequency and willingness to use these technologies also increase. In the study, it was revealed that teachers' attitudes towards computers and lesson planning skills are directly affected by their beliefs about technology integration.

In the research conducted by Archambault and Crippen (2009), the proficiency levels of 596 teachers who teach online were investigated in terms of technological pedagogical knowledge. In the study, it was revealed that although the participants' pedagogical, field, and pedagogical content knowledge were high, they had less self-confidence as a result of the addition of technological knowledge to this information.

In the doctoral thesis written by Timur (2011), the development of technological pedagogical content knowledge of 30 pre-service science teachers studying in their final year was examined. As a result of the research, the findings obtained from holistic multiple-case studies indicate that technology-supported instruction helps pre-service teachers develop four of the sub-components of technological pedagogical content knowledge (objective knowledge, curriculum, and curriculum materials knowledge, teaching strategies knowledge, and assessment knowledge).

In the study conducted by Koh, Chai, and Tsai (2010), the profiles of teacher candidates in Singapore were examined in terms of Technological Pedagogical Content Knowledge. In the study conducted with a total of 1185 pre-service teachers, it was determined that while the technological pedagogical content knowledge profiles of the pre-service teachers differed in terms of gender, they did not differ in terms of age and education levels.

Öztürk-Akar & Doğan (2013) evaluated pre-service teachers' technological pedagogical content knowledge according to some variables. In the study, while there is no significant difference according to the sub-dimensions of technological pedagogical content knowledge, there is a significant difference in terms of technological knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge, depending on whether the pre-service teachers feel competent in the use of technology. found to be.

Angeli and Valanides (2009), in their study, discussed the methodological and epistemological issues related to the Technological Pedagogical Content Knowledge structure to provide a better understanding of the Technological Pedagogical Content Knowledge structure, and for its development and evaluation, a study titled Information and Communication Technologies-Technological

Pedagogical Content Knowledge, which is a continuation of the related structure was discussed. model demonstrated.

1.3. Purpose of the research

This study aims to evaluate the technological pedagogical content knowledge of future biology teachers. In line with the purpose of the research, the following sub-objectives were determined, and answers were sought for these sub-objectives determined in the research.

1. What is the level of pre-service teachers' proficiency in lecturing skills by suitably combining technology and teaching approaches?
2. What is the level of pre-service teachers' ability to use information and communication technologies as a tool for students to share their thoughts and ideas?
3. What is the level of pre-service teachers' ability to apply the field knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment?

2. Method and Materials

In this section, the model of the research, the study group, the method followed, the data collection tool, the application of the data collection tool, and the analysis methods of the obtained data are described.

2.1. Research method

In this study, the qualitative research method was used while making associations about the findings. Qualitative research is the research in which qualitative data collection methods such as observation, interview, and document analysis are used, and a qualitative process is followed to reveal perceptions and events realistically and holistically in the natural environment (Lune & Berg, 2017). This research was carried out in a phenomenological pattern, one of the qualitative research methods, to evaluate the technological pedagogical content knowledge of future biology teachers. In phenomenology studies, data sources are individuals or groups that experience the phenomenon that the research focuses on and can express or reflect this phenomenon. Phenomenological studies may not yield generalizable results. However, these studies can provide examples, explanations, and experiences that provide results that will help to better recognize and understand a phenomenon. Phenomenology studies focus on phenomena that we are aware of but do not have an in-depth and detailed understanding of. The purpose of studies using the phenomenology pattern is to describe the different ways people use to experience, interpret, understand or conceptualize a certain phenomenon (phenomenon) or a certain aspect of reality. In this way, insights into a particular phenomenon are revealed and these understandings are classified according to conceptual categories (Giorgi, 1994).

2.2. Participants

Convenience sampling was used in this study. Students studying in the biology teaching department at various universities in Kazakhstan constitute the participants of the research. Research participants were selected voluntarily. Participants of the study were selected from students who were actively studying in biology teaching departments in the 2021-2022 academic year. Information on the gender and the total number of senior biology students participating in the research is given in Table 1.

Table 1

Information on demographic characteristics of teacher candidates

Gender					
Female		Male		Sum	
F	%	F	%	F	%
27	45	33	55	60	100

In Table 1, the gender distribution of the 4th-grade biology teacher department students participating in the research is given. 45% of the teacher candidates are women and 55% are men, and it is seen that 60 students participated in the research.

2.3. Data collection tools

The data of the research were collected by semi-structured interview technique. Considering the purpose of the research, a semi-structured interview form developed by the researcher was prepared. During the creation of the interview form, a preliminary interview was conducted with 7 senior students in the biology teaching department at two different universities in Almaty.

To ensure the content validity of the prepared interview form, it was made ready for application by taking the opinions of three field experts. In the semi-structured interview form, there is one demographic question to determine the gender of teacher candidates and six open-ended questions to evaluate their technological pedagogical content knowledge. The semi-structured interview form is given in Appendix-1 at the end of the research.

2.4. Data collection process

The answers given by the teachers to the questions in the interview form were recorded with a voice recorder, and the use of a voice recorder largely eliminated the possibility of incomplete or inaccurate data. The data relating to the research were collected through one-to-one interviews conducted between September 2021 and November 2021 at the time and place deemed appropriate by the pre-service teachers participating in the research. During the interview, it was tried not to be influenced by the researcher while the pre-service teachers were answering the questions, and the interview took an average of 30 minutes.

2.5. Data analysis

The content analysis method, one of the qualitative data analysis methods, is used to reach the necessary concepts and relationships to explain the data collected in the research. The content analysis enables us to define the data and bring them together in certain frameworks by conceptualizing the data obtained for research, logically shaping it according to the emerging concepts, and determining the themes that explain the data accordingly (Elo & Kyngäs, 2008). In this study, content analysis was carried out by two researchers separately and the data that were written down in the process were examined repeatedly by the researchers. The research findings were accepted as the theme based on the interview questions and presented by creating sub-themes from the answers given by the participants to the interview questions. Sentences that were thought to be used as one-to-one quotations were determined and included as one-to-one quotations in the findings section when deemed necessary. In addition, the frequency and percentages of the sub-themes were tabulated by calculating how often they were repeated.

3. Results

In this section, the answers given to the questions in the semi-structured interview form prepared to be applied to the teacher candidates participating in the research were analyzed.

In Table 2, pre-service teachers' proficiency in lecturing skills was evaluated by combining technology and teaching approaches appropriately.

Table 2

Opinions of pre-service teachers on their teaching skills by combining technology and teaching approaches appropriately

Proficiency Level	F	%
I find it very sufficient	5	8,3
I find a little sufficient	6	10
I'm undecided	7	11,6
I find it a little insufficient	35	58,3
I find it very insufficient	7	11,6
Sum	60	100

In Table 2, the competencies of the pre-service teachers participating in the research regarding their teaching skills were evaluated by combining technology and teaching approaches appropriately. 8.3% of the pre-service teachers found it very sufficient, 10% found it somewhat adequate, 11.6% found it undecided, 58.3% found it a little insufficient, and 11.6% found it very insufficient. From this, it is possible to say that the majority of the pre-service teachers who participated in the research found themselves somewhat inadequate regarding their teaching skills by suitably combining technology and teaching approaches.

The views of some of the pre-service teachers participating in the research on their teaching skills by combining technology and teaching approaches are as follows;

55. TC: I find myself sufficient in technology. Today's educational environments require pre-service teachers to have technology knowledge. I also think that I have a great command of teaching approaches. Based on this, I answered that I find it very sufficient.

17. TC: *Actually, I think I have a separate knowledge of technology and teaching approaches. But when they are used together, the situation is different. That's why I want to say that I find a little enough.*

2. TC: *Although we have received training in both fields at the university, I cannot decide how much competence I have on how to apply them in a blended way.*

41. TC: *Instructional approaches and technology are two important areas that should be combined in today's teaching approach. However, I do not think that we have received sufficient training in this direction. Therefore, I find myself somewhat inadequate.*

23. TC: *In our university education, we have lessons on teaching approaches, but we did not take lessons on how to use technology in the field. That's why I find myself so inadequate.*

In Table 3, the skills of pre-service teachers to use information and communication technologies as a tool for students to share their thoughts and ideas were evaluated.

Table 3

Opinions of pre-service teachers on their ability to use information and communication technologies as a tool for students to share their thoughts and ideas

Proficiency Level	F	%
I find it very sufficient	3	5
I find a little sufficient	5	8,3
I'm undecided	7	11,6
I find it a little insufficient	37	61,6
I find it very insufficient	8	13,3
Sum	60	100

In Table 3, the skills of pre-service teachers participating in the research to use information and communication technologies as a tool for students to share their thoughts and ideas were evaluated. 5% of the pre-service teachers answered that I find it very sufficient, 8.3% find it somewhat sufficient, 11.6% find it undecided, 61.6% find it a little insufficient and 13.3% find it very insufficient. It is possible to say that the majority of the pre-service teachers participating in the study found themselves somewhat inadequate regarding the ability to use information and communication technologies as a tool for students to share their thoughts and ideas.

The views of some of the pre-service teachers participating in the research on the ability of students to use information and communication technologies as a tool to share their thoughts and ideas are as follows;

2. TC: Since I have a great command of information and communication technologies, I can easily use this as a tool for students to share their thoughts and ideas.

41. TC: I find myself somewhat sufficient in this regard. I think that I can help students use technology to express themselves to some extent.

21. TC: I was undecided about this. I have not yet had the experience of using the knowledge I have. Therefore, I do not know if I can fully enable students to express themselves by using information and communication technologies.

60. TC: I think it is necessary to have the experience to be completely successful in this subject. Information by itself means nothing. So, I can say that I find myself a little inadequate.

34. TC: I find myself very inadequate in this regard. Because the training we received does not have the content to be equipped for such a situation.

In Table 4, the competence of teacher candidates to apply the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment was evaluated.

Table 4

Opinions of pre-service teachers on their ability to apply the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment

Proficiency Level	F	%
I find it very sufficient	2	3,3
I find a little sufficient	5	8,3
I'm undecided	2	3,3
I find it a little insufficient	43	71,6
I find it very insufficient	8	13,3
Sum	60	100

In Table 4, the competence of teacher candidates to apply the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment was evaluated. 3.3% of the teachers found it very adequate, 8.3% found it somewhat sufficient, 3.3% 'undecided', 71.6% found it somewhat inadequate and 13.3% found it very inadequate. From this, it is possible to say that the majority of the pre-service teachers who participated in the research found themselves somewhat inadequate in applying the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment.

The opinions of some of the pre-service teachers participating in the research on their ability to apply the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment are as follows;

11. TC: I think that I have a good command of field knowledge, technology, and teaching approaches and that I can successfully apply them in the classroom by blending them.

3. TC: The education I received actually leads me to success in theory. However, since I have no practical experience, I think that I find myself a bit sufficient.

58. TC: I find myself sufficient in-field knowledge. I also think that I use technology well. I have no idea how far I can use teaching approaches in practice. I was also undecided on how to use all of these in the same environment.

29. TC: I think I am a little inadequate. I have not yet had the experience of using all of these applications in the same environment. I would also expect the education I received to cover more of this field.

44. TC: I don't find myself adequate at all. I received training on all of these, but a training where I could use technologies, field knowledge, and teaching approaches together was not given at a sufficient level.

4. Discussions

It is possible to say that the majority of the pre-service teachers who participated in the research found themselves somewhat inadequate regarding their teaching skills by suitably combining technology and teaching approaches. Wang, Schmidt-Crawford, and Jin (2018) stated in their research that the courses taken during university education are not always successful in integrating technology into education. It is possible to say that the majority of the pre-service teachers who participated in the research found themselves somewhat inadequate regarding the ability to use information and communication technologies as a tool for students to share their thoughts and ideas. Angeli and Valanides (2009) and Kay (2006) stated in their research that teacher candidates have a lot of problems in integrating technology into education.

It is possible to say that the majority of the pre-service teachers who participated in the research found themselves somewhat inadequate in applying the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment. In his study, Padmavathi (2017) stated that the development of content knowledge, pedagogical knowledge, and technological knowledge is not sufficient to improve teachers' technological pedagogical content knowledge and that training should be given specifically on technological pedagogical content knowledge. In their study, Hur, Cullen, and Brush (2010) put forward the opinion of experts and authorities on teacher education policies and strategies that technology integration into learning environments can only be achieved through an effective reform in the pre-service teacher training process.

Russell, Bebell, O'Dwyer, and O'Connor (2003) stated in their studies that teacher candidates in education faculties focus on improving their technical knowledge rather than improving their technological pedagogical content knowledge. This situation has been shown as one of the most important reasons why teachers who start their profession in the future cannot use technology effectively in their classrooms. In the research, it has been determined that most of the teachers who have just started their profession use technology while preparing their teaching plans instead of integrating technology with the learning activities in their classes, and they feel uneasy, especially when using technology in the classroom.

Ucar, Demir, and Higde (2013) found in their study that as the frequency of computer use increases, the level of teachers' self-confidence in technological pedagogical content knowledge also increases. It can be said that the increase in the self-confidence of teachers in technological

pedagogical content knowledge is related to the increase in the level of technological pedagogical content knowledge.

5. Conclusion

Technological Pedagogical Content Knowledge, which is the education understanding of the age we live in, appears as one of the models that prioritize teacher competencies to ensure the effective integration of technology into education. With the examination of teacher knowledge, skills, and competencies within the scope of technological pedagogical content knowledge, the necessity of developing some methods to measure the level of technological pedagogical content knowledge of teachers in any field has been increasing in recent years. Therefore, this study, it is aimed to evaluate the technological pedagogical content knowledge of future teachers who are studying in the biology teaching departments of various universities in Kazakhstan.

As a result of the research, it was determined that the majority of the pre-service teachers found themselves somewhat inadequate regarding their teaching skills by appropriately combining technology and teaching approaches. The vast majority of pre-service teachers find themselves inadequate regarding their ability to use information and communication technologies as a tool for students to share their thoughts and ideas. In addition, the majority of pre-service teachers stated that they found themselves somewhat inadequate in applying the content knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment.

6. Recommendations

In line with the results obtained from the research, the following suggestions were developed to improve the technological pedagogical content knowledge of teacher candidates.

1. The content of teacher training programs aimed at improving the technological pedagogical content knowledge of teacher candidates should be rearranged.
2. It should be ensured that teacher candidates combine technology and teaching approaches in an appropriate way and practice to improve their teaching skills.
3. Educational content should be prepared to improve pre-service teachers' skills in using information and communication technologies as a tool for students to share their thoughts and ideas.

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Annex 1
Semi-structured interview form

Gender:

Class:

It is of great importance for the reliability of the research that you answer the questions in this area sincerely. We remind you that any of your personal information will not be shared in the research, and your views will be conveyed through coding, thank you in advance.

What are your views on your ability to teach by suitably combining technology and teaching approaches?

I find it very sufficient	I find a little sufficient	I'm undecided	I find it a little insufficient	I find it very insufficient

Opinions:.....
.....

What are your views on students' ability to use information and communication technologies as a tool to share their thoughts and ideas?

I find it very sufficient	I find a little sufficient	I'm undecided	I find it a little insufficient	I find it very insufficient

Opinions:.....
.....

What are your views on the competency of applying the field knowledge, technology, and teaching approaches they learned during their undergraduate education in the classroom environment?

I find it very sufficient	I find a little sufficient	I'm undecided	I find it a little insufficient	I find it very insufficient

Opinions:.....
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