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ORIGINAL ARTICLE

Integration of Technology into Science Teaching: A Phenomenological Study on the Experiences of the Pre-service Teachers

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ABSTRACT

Improvements in science and technology have led to changes in education as well as in many other fields. These changes have made it necessary for today's individuals to have a set of skills in different fields. One of these fields is technology-related skills. Learning environments that require the use of technology undoubtedly play a key role in raising individuals with technological skills. In this direction, the aim of this research is to study the experiences of pre-service science teachers related to the use of technology within the scope of a course. In this qualitative research, a phenomenological methodology was used to reveal the understandings of pre-service science teachers on the experience of integrating technological applications into science teaching. In this context, in-depth semi-structured interviews were conducted with 10 pre-service teachers, about their experiences. As a result of the inductive content analysis, the following four themes, which reflect how the participants interpret the integration of technology in science teaching, were determined in line with the experiences of the participants: The technological tools used in the learning environment and why they are preferred, the necessity of the technological knowledge in the teaching profession, the necessity of the use of technology in the learning environment, and the characteristics of a qualified teacher. Based on the results, the practices for teacher education in the integration of technology in science teaching were discussed.

KEY WORDS: Pre-service science teachers; technology; technology literacy

INTRODUCTION

In today's world, improvements in science and technology have an impact on social and cultural changes. These changes are observed to lead to positive developments in different fields such as education and teaching (İşman, 2002; Martin et al., 2011; Önal, 2017; Önür and Kozikoğlu, 2019). Education and teaching technologies are examples of these positive developments. The concept of educational technology, apart from the use of tools and equipment in education (Özçiftçi and Çakır, 2015), is defined as a set of academic systems that effectively design learning-teaching environments and increase the quality and permanence of the learning product (İşman, 2002).

Today, the integration of technology into the learning environment has an important place in the education process. It is possible to mention that, educational technologies integrated into the learning process along with appropriate pedagogical practices provide many advantages for both teachers and students. First of all, the main function of integrating educational technologies into learning environments is defined as assisting students in reaching the specific goals that are set in the education programs (Deryakulu, 1991). In other words, the integration of technology into the educational environment is considered as an important resource for individuals who have the 21st century skills (Fadzil, 2018). The inclusion of educational technologies supports an efficient and effective learning practice by enriching the learning environments as it appeals to multiple senses (Boz and Özerbaş, 2020; Güneş and Buluç, 2017; Kuzgun and Özdinç, 2017). In addition to that, as technology provides the learners' participation in the process, individuals can learn by exploring and a permanent learning environment is provided (Kuzgun and Özdinç, 2017). As the learning environment becomes more attractive, the ability to construct new knowledge is apt to positively affect the motivation of the individuals (Güneş and Bulunç, 2017; Yılmaz, 2019). Another advantage of using educational technologies is that individuals, who are intertwined with technological elements, can adapt to innovations and be more open to change by being familiar to the developments in technology (Önür and Kozikoğlu, 2019). The way to raise individuals who can use these technologies effectively and efficiently is closely related to the integration of educational technologies into learning-teaching environments (Olszewski and Crompton, 2020; Ozan and Taşgın, 2017). By this way, students are provided with an individual learning environment and supported to be lifelong learners (Elvan and Mutlubaş, 2020).

While the integration of technology into education is expected to overcome some problems, the potential to create new problems has been interpreted as technological developments contain both hope and challenges (Sudarsana et al., 2019). These challenges were defined by Ertmer (1999) as "first and second order barriers." First-order barriers are actually non-teacher factors such as availability of equipment, access to resources, training, and support (Winter et al., 2021). Hinson et al. (2006) stated that one of the reasons for the failure of their project for teachers to integrate Web-based applications into their teaching was their assumption that all classrooms had internet access. Although years have passed since this project and access to the Internet is thought to have improved, a report published by UNICEF (2020) during the COVID-19 pandemic shows that globally, two-thirds of children and young people aged 25 and under do not have an internet connection at home. In this context, it is possible to say that one of the biggest obstacles to technology integration is the problem of access to the internet (de Guzman, 2022). Adov and Mäeots (2021) stated that schools and local governments should support the necessary technology access to solve the problem of poor infrastructure or internet in the context of their research. Dean (2020), another researcher working on barriers to technology integration in education, suggested that teachers should be supported to adopt new technologies and schools should have advanced Wifi as a solution to the problems of access to internet and computers and Wifi barriers. A secondary barrier to technology integration is teachers' intrinsic factors such as attitudes and beliefs about technology use, skills, and knowledge (Winter et al., 2021). Secondary barriers are teachers' lack of attitudes, beliefs, knowledge, and skills related to the use of technology (Ertmer et al., 1999). To eliminate these obstacles, it is necessary to provide support to faculties during teacher education, to involve faculties in decision-making processes by making them active (Brzycki and Dudt, 2005), and to support pre-service teachers' experience in the use of technology. In this context, it is thought that the research conducted in this context is important in terms of providing pre-service teachers with the opportunity to experience the integration of technology into education.

Academics, governments, and organizations emphasize the need to develop digital skills to make effective use of technology to enhance student learning (UNESCO, 2002; Olszewski and Crompton, 2020). Teachers are the ones who will support the development of these skills and integrate educational technologies into the learning-teaching process (Özçiftçi and Çakır, 2015). Therefore, the skills and perceptions of teachers related to the use of technology are very important (Güneş and Bulunç, 2017). The reports prepared on the technological practices revealed that teachers face several obstacles during educational practices (Voet and De Wever, 2017). One of these obstacles is the limited knowledge and skills the teachers have related to the use of technology (Hew and Brush, 2007). For the teachers to overcome these obstacles, the teacher training institutions should offer technology-supported education (UNESCO, 2002; Türker, 2019). The inclusion of the educational technologies in educational environments is considered necessary in every discipline, as well as science courses, to make sure that the individuals can get the required knowledge and skills (Önal, 2017). By this way, teachers can support meaningful learning through the inclusion of (Boz and Özerbaş, 2020) assistive technologies such as animations, simulations, videos, PowerPoint, and ready-made content (Bonk, 2016). From this point of view, the technologies that pre-service teachers use in the classroom environment and their opinions and experiences regarding to the use of these technologies are of great importance for them to be competent for their students who are the individuals of the digital age (Önal, 2017). In this context, the aim of this study is to reveal the experiences of pre-service science teachers regarding to the integration of educational technologies into the teaching process.

METHODS

Research Design

In this study, a qualitative research approach with a phenomenological design was used to explore the experiences and perspectives of pre-service teachers on the integration of technological applications into science teaching. The phenomenological studies focused on analyzing the perceived or the experienced phenomena (Flynn and Korcuska, 2018) and searching for the general essences or the basic structures related to the context (Giorgi, 1985). Accordingly, this study aimed to gain more insight into the understandings of pre-service teachers on the experience of integrating technological applications into science teaching and to reveal patterns related to the phenomenon.

The Study Group

The participants of this study were 10 senior students who were studying in the Department of Science Teaching at a medium-sized university in Turkey, during the fall semester of the 2019–2020 academic year. Purposive sampling method was preferred for selecting the participants. In a qualitative study, it is recommended to use a relatively small and purposefully selected sample group (Miles and Huberman, 1994) to increase the depth of understanding (Palinkas et al., 2015). Therefore, purposive sampling method is used in the qualitative research to select participants who are most likely to provide appropriate and useful information (Kelly, 2010). In this study, to reveal the understanding of the pre-service teachers related to the experience of integrating technological applications into science teaching, the study group consisted of pre-service science teachers who received the necessary pedagogical background through courses such as science teaching and instructional technologies. Eight of the participants were female and two of them were male.

Planning and Practice of Technology-based Teaching Process

In the scope of the study, the participants were asked to use their teaching experience for teaching a subject of their own choice

specific to the field of science at the higher education level, by planning and delivering a course in which technological applications are integrated through any teaching method. In this direction, the researchers guided the pre-service teachers individually in the stages of deciding on the technological applications, they preferred to use and planning the course. The planning process took approximately three weeks of the participants. The participants preferred to use different technological applications in the presentation and evaluation processes of the course in the subject area (physics, chemistry, and biology) of their own choice. Each participant individually performed the teaching plan they prepared under the guidance of the researchers, in a course period. At the end of this practice, their views about the experience of *integrating technological applications into science teaching* were received through a semi-structured interview.

Semi-structured Interview

Within the scope of this research, a semi-structured interview form was prepared to receive the views of pre-service teachers on their experiences of teaching science using technological applications. In this interview form, there are questions, which aim to evaluate the experiences of the participants, about the technological applications preferred by the participants and their reasons for preferring them, the planning process (such as deciding on the technological application and its integration into the teaching practice, the research process for the application, determining the research source, and its reliability) and the place and importance of technology in the teaching profession. Right after the practices, the interviews were conducted individually in approximately a 30-min-period and recorded on a voice recorder.

Data Analysis

The data gathered through semi-structured interviews about the experiences of pre-service science teachers in *integrating technological applications into science teaching* were analyzed based on inductive content analysis approach. The purpose of using this approach is to build a broad description of the related phenomenon by creating themes and categories from the data set (Elo and Kyngäs, 2008; Zhang and Wildemuth, 2009). Accordingly, the researchers conducted open coding by reading the views of the participants for several times. The interview contents were analyzed to note all the aspects. Following the open coding process, the data were grouped and categories and themes with a broader scope were determined. As a result of the analysis of the data, the following themes came out; the technological applications preferred and the reasons why they were used, the planning of the teaching process, and the place and importance of technology in the teaching profession. The categories and coding created within the scope of these themes as well as quotations from the participants are gathered under the title of Findings.

Findings

As a result of the analysis of the data, four themes, which represent the understanding of the pre-service teachers on the integration of technological applications into science teaching, came out, which are: The technological tools included in the learning environment and the reasons why they were preferred, the requirement of the technological knowledge in the teaching profession, the necessity of using technology in the learning environment and the characteristics of a qualified teacher. The coding conducted within the scope of these themes, as well as quotations from the participants, are presented under the following titles:

Views on the Technological Applications Used and the Reasons why They were Preferred

Information on the pre-service teachers' use of technology is presented in Table 1. The pre-service teachers used the technology of their own choice at different stages of the course. Three pre-service teachers (T2, T8, and T10) used the technological tool(s); they chose only for presentation, while the other pre-service teachers used them for both presentation and evaluation. The frequency of the use of the technological tools for presentation is respectively as follows: Video (seven), web-based simulation (four), animation (three), slide (two), picture (two), smart board (one), and Publisher program (one). Similarly, the technological tools used for assessment are Kahoot program (four), video (two), and Quizzes (two).

The pre-service teachers mentioned that they spent 2 h, a few days, a week or 1–2 months to decide on the technological means. While most of the pre-service teachers decided according to the suitability for the subject by receiving the information from the research source, only one pre-service teacher (T5) clearly stated that they spent a long time to decide on the technological means and also spent much time due to the fact that they created the technology themself. This pre-service teacher expressed this situation as follows: "*Videoscribe took me a lot of time. Dubbing was very difficult. It was already difficult to create that video and it was also very difficult to adjust its duration and the duration of the text. The picture did not challenge me that much, but finding the video and finding the other video in the summary section took me a lot of time. It took me a month and a half. I've been working and researching non-stop for a long time*." T2, who reported a research period of one week, stated that they conducted the process on a daily basis research, as follows: "*I performed research for minimum 4-5 hours every day. I looked for ideas by calling and asking my friends about how I could use technology."* On the other hand, T3 stated that they were good with technology and therefore, did not spend much time on the research process: "*I did not spend a lot of time to create it as I am very fast about subjects that I have an idea about in technology. Therefore, preparing all the materials did not even take me half a day*." T10 stated that they conducted the research with the help of peers and the area of profession of these peers was related to technology and thus, their practical experiences were taken as a reference. T10 expressed this situation as follows: "*I also consulted my friends. I have friends who study in Ankara, they are actually teachers. They are doing their Master's degree and at the same time, they are teaching at private schools. I contacted*

Table 1: The technological tools pre-service teachers preferred

Technological tools	Presentation	Video	T1, T3, T4, T6, T7, T8, T10
		Web-based simulation	T2, T5, T7, T9
		Animation	T2, T4, T8
		Slide	T3, T8
		Picture	T4, T5
		Smart Board	T3
		Publisher Prog./cartoon dubbing	T4
	Evaluation	Kahoot	T3, T6, T7, T9
		Video	T4, T5
		Quizzes	T1, T3,
Research duration		2 h	T8
		A few days	T1, T3, T4, T10
		1 week	T2, T6, T7, T9
		1–2 months	T5
Research source		Internet	T1, T2, T3, T4, T5, T6, T8
		Peer	T1, T2, T5, T6, T7, T8, T10
		Book	T9
Testing the reliability of the information in the source		Yes	T4, T6, T7, T8, T9, T10

my friends studying in the department of Computer Education and Instructional Technologies. I asked them "What can I do?", "How can you help me?". Most of them recommended this website. They said that it was very useful and used in private schools as well. Then I researched and I really liked it, so I used it."

The pre-service teachers emphasized that they used the internet, peers, and books as research sources while conducting this research. They clearly stated that they conducted research on the internet, especially through search engines such as Youtube, Google, Edu Media, etc., and completed the process by testing the reliability of the information they reached. They mentioned about testing the reliability of the information that video might be reliable if it is referenced or published by an official institution or broadcast by well-known documentary channels; likewise, it is important that the sources of the pictures are included and that they reflect the truth. For example, T1 reflected these issues as follows; "*I mean*, *this video was like a public service announcement. I believed that it was reliable because I didn't just watch the video. I already had a knowledge about this subject from usual sources, I had done a research about it earlier. In my opinion, all the information presented was good. Thus, I thought, it was suitable.*" T1 emphasized the fact that it was a public service announcement as well as evaluating it by reasoning it out. T2, on the other hand, stated that, they preferred to conduct the research on the websites of official institutions, and that, comparing the websites with each other was a way of testing the reliability of the information: "*I mostly preferred to search on the official websites, where, as you know, I cited my videos from. Apart from that, I took information from the pages at the points I envisioned something extra to the information that is already accepted today. For example, I took many different websites as source for these. I paid attention to the consistency of different statements from different websites*." On the other hand, when the same pre-service teacher was asked whether she compared the information she took as a source with the chemistry books within the scope of her subject, she said, "*No, I did not check it with the chemistry book, to be honest.*" T4 stated that they evaluated with reference to the undergraduate course source and stated that: "*We already study this kind of subjects in special subjects in biology. There are studies that include articles about these studies in the content of our course. I also read the articles and I copied the photographs from the articles, not by saying, "Oh, this sheep," but by saying, "this sheep is really Dolly," for example. Then, there was also a cloned cow called Emi… I searched on Google on the internet and chose the best quality picture."* T7, who believed that the video of a program on a documentary channel was reliable and explained as follows: "*I searched on YouTube. I mean, I was randomly browsing and I found the most reliable one. It was a how-to video on the Discovery Channel. In general, I thought it was reliable because it was very well-known. At the end, I think there was an electromagnetism video from National Geographic. I showed that whole video..."*

The pre-service teachers gave reasons why they used the technologies they chose. The findings related to this issue are presented in Table 2. Respectively from the most frequent to the least, the pre-service teachers stated that they used the technologies they chose because they were helpful for learning, suitable for the level, enabled concretization, ensured permanence, reflected content in detail, were completing, reflected the subject as a whole, were understandable and attractive, were easy to use and free of charge.

T1, who considered it as helpful for learning stated that: "*I thought that, the video was explanatory. I did not mention the benefits and harms of antibiotics. I thought, when they watch this video, they would understand it and even if they hadn't had an idea, they could get an idea about it. I thought the*

Table 2: Reason for the technology used

Reason for use	Pre-service teacher
Helps learning	T1, T2, T3, T4, T5, T6, T7
Suitable for level	T2, T3, T4, T5, T6, T7, T8
Enables concretization	T2, T3, T4, T5, T6, T7, T10
Ensures permanence	T1, T2, T3, T5, T6, T10
Reflects content in detail	T1, T2, T3, T5, T6, T10
For completion	T2, T3, T4, T7, T9
Reflects the subject as a whole	T1, T2, T5, T8
Understandable	T1, T2, T4, T7
Attractive	T3, T4, T6
Reflective	T10
Easy to use	T1
Free of charge	T9

quiz program would serve as a consolidation for the subject. That is why I preferred them." Based on personal experience, T7 emphasized that it was understandable and stated that: "*It seemed understandable when I first watched it. I intended my classmates to have that same feeling when they watched it because frankly, physics and electromagnetism were subjects that I was a little afraid of. Then, when I watched the video, I said to myself that, if I understood it, my classmates would understand it as well, therefore, I used it."* One pre-service teacher (T6) even stated that it provided better learning because it was visual: "*When it is visual, it is more permanent in the brain. I chose it to pay attention.*" T5 created their own simulation and used it in the process. The reason for this action is summarized in a dialog between the researcher and T5:

> *R: How did you come up with this idea? Why didn't you deliver it on a piece of paper, rather than creating a simulation?*
> *T5: In fact, if I had delivered it on paper, it would be very simple. There are many different kinds of technologies today and technological applications are constantly in our lives. As a teacher, I have researched a lot about such applications and if I intend to ask questions, there are many applications about asking questions. But I thought, if I create a video with videoscribe, it will be more permanent in their minds. I turned it into a story. If I just asked them a question by telling them that, there is a sensor and a flash, I don't think it would have much of an effect on them.*
> *R: You actually delivered it in a plot*
> *T5: Yes.*
> *R: How did you come up with the idea of creating Videoscribe?*
> *T5: Actually, no one advised me. I had already mentioned that I was going to set up such a plot. I had to create a question and enter the class with that question. Then I thought, it would be better if I delivered it through a case study. I knew the train paradox, but I thought, I shouldn't deliver it only through it. Then, we had a material course, in which I learned how to adapt it to technology. Our teacher showed us a lot of applications. I discovered this application in that course and I adapted it.*

T2 compared the videos they accessed and stated that the video they chose provided more retention than the others due to the fact that the video was detailed and provided concretization:

> *I chose two videos about the circulatory system and an animation from YouTube, which were suitable for the level. In my opinion, they were good. They were describing the structure of the heart by demonstrating everything from the atria to the beating of the ventricles and were more memorable and concrete than the other videos. The other videos were very difficult to understand. For example, the sources I chose were demonstrating the atria and the beating of ventricles and their contraction and relaxation, while the other videos did not include such demonstrations. They were providing only verbal information while the one I chose was demonstrating the beats and everything, visually.*

While sharing their own experiences, the pre-service teachers sometimes self-evaluated the process and sometimes could not answer the questions. For instance, T3 stated that their previous presentations were inadequate due to the lack of technology:

> *My previous presentation, in which I included a slide show, was very monotonous and dull. I didn't care much if the students understood or not. However, I enriched this presentation with visuals, thus, it became more memorable. Also, according to a source I read, students can remember more easily when they visually render what they see. Therefore, I included pictures or videos as technological applications, so that it could be more memorable and course-based and also to encourage the students to participate. I wanted to draw students' attention, what is red cabbage?, what kind of characteristics does it actually have?, using pictures and through someone else's voice, rather than me lecturing all the time. I tried to make the course more interesting for the students. I think, this applies to everyone; hearing different voices and different opinions or encountering with different sources is more important in terms of the content of the course.*

Some pre-service teachers made sure that the technological application they chose covered the whole subject. For instance, T8 stated it as follows: "*I preferred the most detailed one that describes the content of my subject. For example, some of them did not demonstrate the choledochal ducts coming from the liver while the one I chose was clearly demonstrating them all. For the detailed description, I chose the one that was suitable for the level.*" Moreover, we observed that the issue of suitability for the level also took place in the statements of the pre-service teachers. The pre-service teachers specifically stated that they were careful to choose the technology that is suitable for the level. Sample statements from the pre-service teachers on this issue are as follows:

T3: Actually, it is a bit impossible for a middle school student to use Kahootu. They aren't allowed to use phones and tablets. It is an application that can only be used on the board, under the assistance of the teacher. However, since we are at the university level here, I actually thought, it would be interactive and better.
T6: I used Kahoot. I showed a video from Youtube about the plasma state of the matter. In fact, I searched a lot for the video and about what can be done, but it was the most reasonable one suitable for the university level. The other videos were mostly in the form of lectures.
T7: Exactly, its being appropriate for the level. Then it should also be understandable. And actually, I also paid attention to the image quality, the sound and the suitability for the location. I can't think of anything else right now.
T8:...I actually included it at the end of the course to provide retention. In the same way, it was describing the subjects in detail, according to the level. The video was 23 minutes, but I showed 10 minutes of it.

The pre-service teachers stated in the interviews that sometimes their own descriptions or a technological tool they used cannot be sufficient alone and that they used it for completion. For example, T4 emphasized that the use of technological applications supported their development, facilitated their work, and was helpful for the students in the process, as follows: "*In this way, I improve myself. Sometimes, when there is a subject that is impossible or difficult to define, it is helpful to make the best of the technology. I think it will be more useful both for myself and for my students during the course."* The pre-service teachers also stated that using only one kind of technology can be insufficient sometimes, thus, they chose more than one technological tool to support each other. Related to this issue, T9 stated that: "*I used both Kahoot and simulation because they would be insufficient by themselves.*"

Reflections on the Need for the Technological Knowledge

The pre-service teachers were asked to evaluate whether the technological knowledge is required in determining or using the technological applications they choose, or not. Half of the pre-service teachers (T2, T3, T5, T6, and T7) thought that it was necessary, four of them (T1, T4, T9, and T10) stated that it was not necessary, and one (T8) did not provide an answer for this question. The pre-service teachers stated that they felt the need for the technological knowledge while determining the technological application, they used and that, they sometimes felt themselves inadequate, therefore, they consulted people who had technological knowledge, during their research. However, T10, who stated that the technological knowledge was not required, actually used a research source that contradicted this idea. T10 clearly stated this situation by also evaluating themself, as follows:

I actually studied computer science in high school. I have a little more knowledge in this field. I am actually a graduate of technical high school, but so many things have changed from that time until now and technology has improved a lot, so, of course, I haven't been able to catch up with it while studying in this department. However, since my friends work at private schools, they are a little more interested in this field. Thus, their opinions were a little more valuable for me.

T3 stated that it is important to have the technological knowledge and that, this knowledge is necessary for proper, timely, and accurate use of technology: "*The teachers need to have a good command of all the materials and programs in which technology will be used. They need to think about where they can use them during the course. They need to consider in detail as they provide permanent information to the students. If the students get something wrong, it can be very difficult to correct it while using technology."*. T2 and T7 also made a similar statement and they mentioned that the technological knowledge is required to be able to adapt to life and keep up with the age. Furthermore, T5 clearly stated that the technological knowledge is necessary and that this knowledge can be obtained also through technology. With reference to their experience of a video that they individually worked on and created, T5 stated that:

Actually, yes, it is required. However, you can always access everything through research. After all, I didn't know everything about it. I had seen that videoscribe in the class, yes, but I didn't know the details. You can reach it by making and trying and through mistakes and research. In this respect, technology is very useful.

Although pre-service teachers stated that technology makes life easier, they also emphasized that the technological knowledge is not required. In fact, mentioning the characteristics of an efficient teacher, T4 emphasized that, the use of technology is not that important: "*Even if the teachers don't know how to use technology, I believe they will be able to manage by using their skills and the board in the best way. However, I also think that having knowledge about technology will always be helpful*". T9 also made a similar contradictory statement by mentioning that, they did not need the technological knowledge although they already emphasized the necessity of it by mentioning their own technological knowledge: "*Actually, I did not feel the necessity of technological knowledge. I already knew how to use Kahoot and I had seen how to use the simulation from the teacher."* T10 also stated that, the Edu Media program they used is a program that everyone can use, so, no extra knowledge is required to use it.

Thoughts on the Question, Why Use Technology?

Pre-service teachers explained why a teacher should use technology by mentioning several reasons. They stated that technology helps learning, being an efficient teacher, keeping up with the age, saving time, concretizing, attracting attention, providing easy access to resources, reinforcement, reaching many resources, and being technology literate. Table 3 presents the findings regarding the reasons.

Table 3: Reasons for using technology

Reasons	Pre-service teacher
Helps learning	T1, T3, T5, T6, T7, T8
To be an efficient teacher	T2, T3, T6, T7, T8
To save time	T2, T7, T8, T9, T10
To keep up with the age	T1, T5, T6, T7, T10
To Concretize	T2, T7, T8, T9
To attract attention	T1, T5, T6, T10
For easier access to resources	T5, T7, T8
To consolidate	T2, T8, T10
To be able to reach many resources	T7, T10
To be technology literate	T2, T8

The pre-service teachers mostly emphasized that the use of technology should help their own development, such as being an efficient teacher and keeping up with the age. Especially T5, who emphasized the importance of adapting to the process in this technological age, stated that: "*Actually, teachers should have a good technological knowledge, which I don't think I have. To gain this knowledge, I have to research and follow technological applications constantly. There are a lot of new applications and programs. Technology is actually constantly renewing itself. While information was previously a concept that could be accessed in a month, nowadays it can be accessed very quickly. New information may come out even within hours. So, we have to keep up with it."* T2 also emphasized that they wanted to receive training during their studies to be able to use technology effectively: "*I really don't know how to use technology, but I'm going to be a teacher. Therefore, as I need to learn, I will apply to the summer courses offered by our municipality*." Pre-service teachers think that it is important to keep up with the age, which is also a prerequisite for being an efficient teacher. T6 emphasized this issue as follows:

> *A teacher should use technology. I felt the lack of it. Our age is the age of technology and the children improve themselves very fast and as I mentioned, they get more interested in the course when they use technology. I also experienced it during my internship period. When teachers use technology, they have self-confidence and are better in classroom management.*

The pre-service teachers emphasized that technology should be used in line with its purpose, when it is required and serves for the improvement of the teachers and their teaching skills. T3 emphasized that, to be efficient, teachers should be good guides for using technology and clearly stated that technology should not be included as a routine. T3 explained it as follows: "*It is sufficient in terms of student participation, but if it is routinized, it will bore the students. The efficiency of the teacher is important here, they should direct and guide the students.*" T4 also made a similar explanation by emphasizing that, technology should be used effectively, at the appropriate time and for the right purpose and stated in the interview that:

> *It should not be used randomly at any time and any point. It should be used at the right point, at the right time, and for the right purpose. Although technology is necessary, it might be diverted to different directions by students. For example, you shouldn't just use the application in a smart board and leave. If you leave the students alone with it, they might browse for inconvenient content. Or there should be limitations for the students, so that they know when to use it.*

The pre-service teachers clearly stated that the effective use of technology by the teachers has a reflection on the students. They strongly emphasized the fact that using technology helps students to learn better and retain the course as it helps the teachers to fulfill their own inefficiencies, helps to access easily to more resources, helps reinforcement, and makes the class more interesting for the students. T7 stated that using technology is beneficial for both the teacher and the student and even for the parents and expressed it as follows:

> *Actually, it makes it easier for both the teacher and the student. It saves a lot of time. It not only appeals to the verbal learning skills of the students, but also to their visual or auditory learning skills. It can provide permanent learning. The teacher can teach more effectively. As there are so many applications, it even helps the parents as well. There are various things. For example, feedback applications are very advantageous for parents as they can keep track of their children.*

Only two of the pre-service teachers stated that use of technology is important for being technology literate. Moreover, some of the pre-service teachers emphasized that technology should be used in moderation, otherwise it may lead to unwanted consequences. For instance, related to this issue, T7 stated that:

> *It should be used in moderation. I mean, it should be understandable without boring the student. If the teachers already have a good command of the subject and have the required knowledge about the technology, they can use it very easily and adapt it in moderation. However, if they aren't efficient in the field and don't know how to use the technology well, then there may be some problems. They might not know what to do at what point, or may encounter unwanted consequences. Students may get detached and the subject may deviate from its aim.*

Reflections on the Characteristics of a Qualified Teacher

The pre-service teachers listed the characteristics of an efficient teacher as; having a good command of the field, having a vision and technological knowledge, being able to ask good questions, having pedagogical knowledge, being good at classroom management, being able to act as a guide, having communication skills, caring about the individual differences, being able to manage the time, being innovative and just, and being able to choose the suitable technology for the level. Table 4 presents the findings on teacher characteristics.

Table 4: Characteristics of a qualified teacher

Characteristics of teacher	Pre-service teacher
Efficient in the field	T1, T2, T3, T4, T5, T6, T7, T10
Has a vision/has the technological knowledge	T1, T2, T3, T4, T5, T7, T8
Asks good questions	T1, T2, T4, T7, T8, T9
Has pedagogical knowledge	T1, T4, T5, T7, T9, T10
Has good classroom management skills	T1, T5, T6, T7
Guide	T1, T5, T6, T8
Has communication skills	T1, T4, T6
Cares for individual differences	T2, T6
Has time management skills	T2, T9
Innovative	T2, T10
Just	T2
Able to choose the right technology for the level	T2

Seven of the pre-service teachers emphasized the characteristics of having a vision with technological knowledge and one pre-service teacher emphasized the characteristic of being able to choose the suitable technology for the level, as a result of this practice they participated in. The characteristics that help completing the course effectively were strongly emphasized. Some sample statements cited from the pre-service teachers are as follows:

> T1: *Having good pedagogical knowledge, using appropriate vocabulary, having good communication skills, being good at classroom management, for example, when the teacher asks questions, it is important whether the students listen to the teacher or not, and being able to keep the classroom in an order.*
> T4: *Especially, as we mentioned earlier, the way of addressing and the field knowledge are really important. The questions asked by the teacher are very important, especially in terms of being understandable. Techers can always define a subject, but if they aren't aware of the level of the student, it will be hard to deliver that subject to the student. I think these issues are important.*
> T5: *The teacher must have a good command of the classroom, have a good knowledge of the subject and really know what to use at what point. For example, the teacher must have an idea about the technological applications, when to ask questions, and most importantly, I think, have a good command of the classroom.*
> T6: *The teacher must have a good command of the classroom and be able to see all the students. While communicating with a student, the other students must not be ignored. I realized in my own presentation that, the teacher should not only deal with the student who is on the board, but should be able to address the whole class. The teacher also must have good field knowledge, which will provide better self-confidence and make it easier to manage the classroom. Individual differences also mustn't be ignored.*

CONCLUSION AND DISCUSSION

The aim of this study is to reveal the experiences of the pre-service science teachers regarding to their preferences and processes of use of technology, within the scope of a course. In this context, different views of pre-service science teachers on the integration of technology were focused on, throughout the research. The most important of these views were related to the type of technology that the pre-service teachers preferred to integrate into the course process, the stage of the course in which the technological tools were integrated, the time they spent on integrating the technology and the main research sources they used in the process. In this regard, video was the most preferred tool by the pre-service teachers, at the presentation stage, while the smart board and the Publisher application were among the least preferred tools. In the evaluation stage of the course, Kahoot program, video, and Quizzes program were employed as technological tools. The majority of the pre-service teachers stated that they included the technological tools they preferred in both the presentation and evaluation stages of the course. Another aspect focused on in the study was the information sources used in the process and the evaluation of these sources. It was observed that the majority of the pre-service teachers tested the reliability of the sources they used, which were the internet, the peers, and the books. Therefore, it is possible to say that pre-service teachers questioned the reliability of the information sources. Another context this research focused on was revealing the reasons underlying the technology preferences of the pre-service teachers. The pre-service teachers expressed the following reasons for preference: Being helpful for learning, being suitable for the level, providing concretization and permanence, reflecting the content in detail, being complementary, reflecting the whole subject, being understandable and attractive, and being easy to use and free of charge. Another part of the research consisted of the evaluations of the pre-service teachers about the requirement of technological knowledge to implement course plans that include technology. While half of the pre-service teachers thought that technological knowledge was necessary, four of them stated that it was not necessary and one of them did not answer this question. The question of the requirement of technological knowledge prompted the researchers to learn the opinions of the pre-service teachers on the use of technology and how they position the technological knowledge among the characteristics of a qualified teacher today. It was observed that having technological knowledge was listed among the characteristics of a qualified teacher by the majority of the pre-service teachers.

The global community and the information age have been shaping the use of technologies to enhance changes in the economic, cultural, and communication spheres in today's world (Ejikeme and Okpala, 2017). In particular, changes in information and communication technologies have transformed many different fields, and education has also been affected by this transformation (Liesa-Orús et al., 2020). With the inclusion of technology in the educational scenarios,

the learning styles of 21st century students have started to differ from those of the previous generations (Shafie et al., 2019). With the increasing integration of technology in K-12 classrooms, this change makes it necessary for teachers to have a deep understanding and efficiency in technological tools to be able to train individuals with the skills required for using the 21st century technological tools (Giles, 2019). Thus, it was observed that teacher education programs aim to train pre-service teachers with the necessary skills to integrate technology into teaching and learning experiences (Francom and Moon, 2018). The presence of pre-service teachers with these skills will lead to future good practices (Giles, 2019). This study is important in terms of providing an opportunity for pre-service teachers to practice technology integration in their courses. Revealing which technological means the pre-service teachers preferred in their practices related to the integration of technology into the context of science courses was the starting point in revealing the process this practice. Video was the most preferred tool by the pre-service teachers. T1 and T7 stated that they preferred video because it was easy to understand. As the pre-service teachers stated, there are studies in the literature revealing that video can be a very effective educational tool (Moore and Smith, 2012; Lloyd and Robertson, 2012; Rackaway, 2012; Hsin and Cigas, 2013). MacHardy and Pardos (2015), on the other hand, stated in their research that, videos do not contribute much to the performance of the students. Regarding the source of this difference, on how to maximize the benefit of the videos, Brame (2016) stated that the teachers should focus on how to manage the cognitive load of the video, how to maximize the interaction of the students with the video, and how to encourage active learning through the video. Simulation was another technology preferred by the pre-service teachers. The reason for using simulation was mentioned as making the content more effective (T5). It is possible to say that the effectiveness of simulation is included in the literature with studies that reveal the positive overall effects of the simulation-based learning contexts on the progression of complex skills (D'Angelo et al., 2014; Chernikova et al., 2020; Wu and Anderson, 2015).

Another aspect focused on in the context of the research was the sources of information that pre-service teachers consulted about the technologies they preferred and their experiences about whether to test the reliability of these sources or not. The pre-service teachers stated that they consulted the internet and their peers during the process of integrating technology into their course plans. They also stated that they tested whether these sources were reliable or not by making sure that they are referenced sources or published by an official institution etc. The results obtained reveal that the students cited the sources that are assumed to be the most reliable (Strømsø and Bråten, 2014). This can be interpreted as, they are able to make an informed judgment about the reliability of the texts they read (Forzani, 2020).

Pre-service teachers expressed the reasons for their preference of the technologies they used as; being helpful for learning and suitable for the level, providing concretization, reflecting the details of the content, providing permanence, being easy to use, and free of charge. These reasons expressed by the pre-service teachers are grouped under headings such as advantage, suitability, and convenience. This result is similar to the discourses of the theories regarding the decisions of individuals in the processes of adaptation to innovation. In other words, it is observed that the participants consider the advantage, suitability, convenience/complexity of the innovation during the process of decision-making (Rogers, 2003; Karahanna et al., 1999). The fact that the pre-service teachers were asked to integrate technology into their course content as a new practice method instead of a familiar one reveals that the reasons underlying the decision-making processes of the pre-service teachers are compatible with the theories in the literature.

Today's students are expected to have various skills to be successful in their future professional lives. These skills, which are mentioned as, 21st century skills, have been defined by several international organizations and projects (Valtonen et al., 2021; Ananiadou and Claro, 2009; Binkley et al., 2012; Partnership for 21st Century Skills, 2015). All these definitions emphasize the importance of the information and communication technologies skills. The use of information and communication technologies as a tool in the other skill areas such as collaboration, problem-solving, and creative and innovative thinking is particularly required. Therefore, the information and communication technologies skills have become crucial for the 21st century skills (Valtonen et al., 2017). With the expectation of the development of the 21st century skills, it is possible to say that a number of requirements have emerged for teachers (Valtonen et al., 2017; Valtonen et al., 2021). The teachers need to update their competence profiles for students learning in the 21st century (Caena and Redecker, 2019). Technology-related skills are among these profiles that need to be updated. Therefore, the European Commission's Joint Research Center created the European Framework for Digital Competence of Educators (DigCompEdu) to better understand the digital competences that teachers need to improve to be able to meaningfully integrate digital technologies into education and support students' acquisition of digital competences (Redecker, 2017). In the context of the research, the emphasis of the pre-service teachers on the requirement of technology for their own improvement, such as being an efficient teacher and keeping up with the age, indicates that they have a perspective that is in line with the expected teacher profile in the 21st century. Considering the results of the research and the related literature, it is deemed necessary to offer more practices that will enable the pre-service teachers to gain integrated experience in the use of technology and a course process by including learning environments that support the use of technology in different course contexts during their undergraduate studies.

Ethical Statement

Personally identifiable data were not collected. All participants voluntarily participated in the study and were informed about the content of the research.

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