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Investigation of Technology Integration Knowledge of Science Teachers: A Case Study

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Abstract

The distance education process, which was passed with the Covid-19 pandemic, once again demonstrated the importance of teachers' technology knowledge. In this direction, the purpose of this study is to examine the science teachers' knowledge of technology integration into their lessons. In this context, the participants' knowledge of technologies that can be used in science education was examined and their ability to use these technologies in their lessons, as well as their ideas about the necessity of technology integration into science education. The research was a qualitative study with a multiple holistic case study design. Participants were determined by criterion sampling method, and 16 science teachers from six different schools in the city center of Nigde province participated in the study. The data were collected in 2019-2020 academic year via a semi-structured teacher interview form, and a classroom observation form. As a result of the research, it was revealed that teachers thought that different technology applications should be included in science lessons by taking into account the subject and learner characteristics, but in the observation, Science teachers who participated in the study did not actually go beyond using computers and projectors. In order to find a solution to this situation, teachers think that it may be beneficial to include applied courses on technology integration to science courses in undergraduate education, to be able to choose courses from other departments to learn technology integration in undergraduate education, and to provide practical and in-service training in small groups by experts from universities.

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Keywords: Science teachers, technology knowledge, science education, technology integration

1. Introduction

It is known that the developing conditions in the developments in science and technology cause reforms affecting the education systems. The use of technology has become a necessity in the education of the generation Z, which is growing with technology today. On the other hand, it can be stated that the lessons enriched with technology

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integration have a rich visual content, make it more active only in the course, learn easily and permanently, in short, it increases the quality of education and makes teaching more powerful (Seferoğlu, 2008). This situation has also changed the knowledge and skills required for teachers (Cox, 2008; Yiğit, 2014). Now, it is not enough for teachers to have only the knowledge of content and pedagogy, but also those who have the technology knowledge that teachers need (Ivy, 2011; Mishra & Koehler, 2006; Pringle, Dawson & Ritzhaupt, 2015). As a matter of fact, the model that Mishra & Koehler (2006) gave Technological Pedagogical Content Knowledge draws a framework that integrates teachers' technology knowledge with their pedagogical content knowledge. It can be useful to learn the word of useful applications in the studies. However, this effect occurs only when teachers can use technology effectively (Dilworth et al., 2012). What is expected in this world is that they use the technology effectively and create environments where students can use technology productively (Abbitt, 2011; Chen, 2010). In addition, teachers are expected to be able to use new technologies as the current technological tools get old and acquire the knowledge and skills required by new technology (Mishra & Koehler, 2006). It is stated that teachers play a key role in the quality of these applications, which we can call technology integration into education (Dilworth et al., 2012; Escuder, 2013).

Despite this great importance of teachers, it has been revealed that teachers have difficulties in technology integration into their lessons, are not sufficient or do not trust themselves in terms of their competence, they do not see the use of technology in education as a necessity, and ultimately they cannot (can) use technology effectively and efficiently in their lessons (Agyei & Voogt, 2012; Bozkurt & Cilavdaroğlu, 2011; Ertmer & OttenbreitLeftwich, 2010; Keating & Evans, 2001; Nyikahadzoyi, 2015). This situation can be considered as an indicator that studies on the subject should continue (Niess, 2011). In this respect, it is believed that the current research will provide important data for the literature, bring a different perspective to existing studies and lay the groundwork for future research. The COVID-19 pandemic experienced all over the world has once again revealed the importance of teachers and students having technology knowledge. Because one of the strategies followed to minimize the negative effects of the epidemic has been the transition to distance education (Sahu, 2020). However, this transition to distance education was very sudden (Daniel, 2020), and many students and teachers who had never had distance education experience suddenly encountered this application (Laplante, 2020). Therefore, students and teachers with low levels of technology literacy and digital competence faced problems arising from not being able to use technology effectively and efficiently in the distance education process.

Also, it can be stated that working with Science teachers in this study is also a value for the research. Because in a lesson that includes abstract subjects such as Science, students generally approach with anxiety and consequently the success rate is low, teachers' thoughts and skills regarding technology integration are of great importance. In fact, with an effective technology integration, it may be possible to minimize all negative feelings of

students towards science lessons and to increase the success rate. There are many technological applications that can be used in science lessons. For example, according to Kartal (2017) these are: Web 2.0 has listed spreadsheets (Spreadsheets), scientific measuring tools, digital images and video, concept maps (Inspiration, Kidspration, Edraw Max), simulation (PhET, Crocodile Physics, Interactive Physics) and wisdom board (ActivInspire). In one aspect of the present study, it was investigated to what extent Science teachers used these technologies in their lessons by examining their knowledge about these technologies.

Another importance of this research stems from its methodology. Because in the literature, it is stated that in studies conducted on the technological pedagogical content knowledge of teachers and teacher candidates, Likert type scales are generally used as a data collection tool, but in fact, Likert type scales are more suitable for studies that examine affective characteristics (Archambault & Barnett, 2010). For this reason, semi-structured interview and observation were used as data collection tools in the present study.

When all these points are taken into consideration, it can be stated that it is necessary and important to examine the technology knowledge of Science teachers. As a result of such a study, it is believed that concrete data will be revealed for the program makers of the Science course, science teaching undergraduate program, teachers and teacher candidates. Based on this, the research question of this research was determined as “What are the science teachers' ideas about technology integration into their lessons? Also, what is the technology knowledge of the participants? ".

2. Method

2.1. Research Design

In this study a case study from qualitative paradigm design was adopted. Case study can be defined as a design that offers the opportunity to examine the current situation in depth with how and why questions (Yin, 2009). The reasons for choosing the case study as a research design in the study are that the research subject (Science teachers' technology knowledge) is current and can change over time, and the data is collected in the life experiences of the participants with more than one data collection tool (Yin, 2009). In addition, holistic multi-case design, one of the case study designs, was used in the study. In this pattern, there is more than one situation that can be perceived as holistic on its own. Each situation is handled in a holistic way and then compared with each other (Yıldırım & Şimşek, 2008).

2.2. Participants

The participants of the study were determined by criterion sampling, one of the purposeful sampling types. The criteria taken into account in determining the participants are as follows:

• Teachers have a professional seniority of 5-15 years,

• Teachers are working in schools with technological infrastructure and equipment in the city center of Nigde. In this context, the criteria of having Internet connection, smart board and computer in the classrooms in the selected schools were taken into consideration.

As a result, working in the center of the small town of Nigde province in Turkey's Central Anatolia Region by 16 science teachers participated in the research. The demographic characteristics of the Science teachers participating in the study are presented in Table 1.

Table1. Demographic characteristics of the participants

Code of participants	**Gender**	**Seniority**
T1	Female	8 years
T2 +Observed	**Male**	**15 years**
T3	Female	13 years
T4	Male	10 years
T5 +Observed	**Male**	**12 years**
T6	Female	9 years
T7	Female	10 years
T8	Female	6 years
T9	Female	11 years
T10	Male	15 years
T11	Male	11 years
T12	Female	14 years
T13	Female	8 years
T14	Male	5 years
T15	Female	12 years
T16 +Observed	**Male**	**13 years**

While observing in the study, the lessons of three teachers, who were determined by criterion sampling among the participants, were observed. As a criterion, the observation of the lessons of three teachers who stated that they use technology intensively in their lessons and who have the highest level of knowledge about technologies that can be used in Science lessons were taken as a criterion.

2.3. Data Collection

2.4. Interview

Semi-structured interviews were conducted with each of the participants in the study. Semi-structured interviews are carried out by preparing certain questions in advance in order to get the same type of information from the participants by addressing similar issues (Patton, 2002). Before the interviews, an interview guide containing the questions to be asked to the participants in line with the information the researcher wants to obtain from the participants was prepared. Interview guides enable researchers to be more comfortable in semi-structured interviews (Merriam, 1998). The questions in the interview guides were prepared by the researchers in line with the research questions by scanning the relevant literature. The prepared guides were submitted to three experts in the field to evaluate the questions in the guide in terms of their suitability to research questions and participant groups, and to a language expert for examination in terms of language. Two of the field experts are in Science Education and one is in the field of Computer Education and Instructional Technology. Interview guides were revised according to the feedback from experts. After the revised version of the guidelines was once again checked and approved by the experts, pilot and main applications were started.

A pilot application was carried out with two Science teachers before the final applications in order to determine the time required for the interviews with the teachers, to eliminate possible problems that may be encountered in the interview and to ensure that the researcher gains experience. Before the pilot and final implementations, the participants; They were informed about ethical issues such as that no harm would be caused to them due to the interviews, interviews would be recorded if permitted and their names would not be published anywhere. In the interviews with the teachers, questions were asked to the teachers within the scope of their professional experiences, the technologies they used in science lessons, their knowledge about technologies that can be used in science education, and their views on the use of technology in science education.

The interviews were conducted only with the presence of the researcher and the participant on the days and hours when teachers were available at the schools where they work. The reason for conducting the interviews in this environment is to ensure easy access and safety of the participants. During the interviews, interviews were recorded with a tape recorder in line with their approval and approval. The interviews were

completed in an average of 35 minutes. The recorded interviews were transcribed as soon as possible. While the data was transcribed, it was written down and never interfered with what was spoken. In addition, the participant's symptoms such as pauses (like waiting, thinking), joy (like laughing) and distress were also transcribed. Since data collection and analysis processes go hand in hand in qualitative research, the transcribed data was analyzed and necessary changes were made in the later stages of the data collection process in the light of the obtained information.

2.3.2. Observation

Within the scope of the research, three Science teachers were observed for a total of four lesson hours (40 minutes per lesson). When it is done systematically and sensitively towards a specific research question, observation can be used as a data collection tool in qualitative research (Merriam, 1998). Observations can be used as the main data collection source in a qualitative research, as well as for data diversification (triangulation). In this case, the purpose of the observation is to prove the findings obtained from the interview and document analysis (Merriam, 1998). In this research, the observation was carried out for such a purpose.

During the observations, the researcher assumed the role of participant observer. Participants observed in such observations know that the researcher is there for observation and is trying to get information about them, but they do not know what the researcher observes (Merriam, 1998). Throughout the observations, the researcher used pen, paper, and a clock to note what happened there based on the questions given above.

The code names of the teachers observed are T1, T5 and T16. Since the subjects covered by the teachers in the same time period were the same, the observations were carried out simultaneously and in the lessons of the same grade level. For this, a planning was made by meeting with the teachers so that the lessons would not overlap. The observations were made in Science Lessons in the sixth grade.

2.5. Analysis of Data

The data collected through interviews and observations in the research were analyzed by content analysis. In the content analysis, it is aimed to reach the concepts and relationships that can explain the data collected. For this purpose, the collected data must first be conceptualized, then organized in a logical manner according to the emerging concepts and the themes explaining the data must be determined accordingly (Yıldırım & Şimşek, 2008).

The data collected before starting the data analysis process in the research were prepared for analysis. In this context, word-for-word transcripts of interviews with 16 teachers were made between January and February 2020. After the interviews recorded with the voice recorder with the permission of the participants were converted into

Microsoft Word document, each participant was given a code from T1 to T16. In the stage of organizing observation data, the notes of each teacher regarding the lesson observation were classified according to their dates. After the preparation of the data was completed, the two researchers analyzed the data separately and then came together and compared the encodings to reach a common opinion.

2.6. Validity and Reliability

In qualitative research, the terms believability (internal validity), transferability (external validity) and reliability are mentioned instead of validity and reliability in quantitative research (Lincoln & Guba, 1985). The most important way to ensure credibility in a qualitative research is to make variation. In this context, data collection with interview and observation techniques in the research is data collection diversity. Secondly, the researcher doing the data collection process in the natural environment of the participants is another way to ensure credibility. For this reason, the data of the research were collected in the schools where the teachers worked (Lincoln & Guba, 1985). Again, long-term interaction with participants and member control mechanism are among the measures taken to ensure credibility. Within the scope of the member control, the opinions of the participants regarding the data analysis results and their comments on the results were obtained.

In order to ensure transferability (external validity) in this qualitative research, measures have been taken for the researcher to define his / her role in the research process, to define the participants in detail, to define the environment of the research, and to explain the data collection and analysis processes in detail (Yıldırım & Şimşek, 2008). In this way, another researcher who wants to repeat the research can reach similar results with similar applications and acceptances.

In order to ensure reliability in the study, the data obtained by interview and observation tools were analyzed comparatively. In addition, analyzes were carried out by two researchers separately. The results obtained from the two analyzes were read in detail and carefully, discussed about the meaning they contain, and a common coding was made with 100% consensus. In this direction, it can be stated that reliability is achieved with a common understanding in the coding process (Yıldırım & Şimşek, 2008).

2.7. The Role of the Researcher

The first role of the researchers in this study was to raise the awareness of the participants about their roles. Therefore, at the beginning of the study, the participants were informed about the purpose of the research and the research questions, and how important they were for the research. Afterwards, the participants were asked about their experiences on the subject in order to find answers to the research questions.

Another role of the researcher was to encourage the participants to answer the questions asked and to be open to sharing with the researcher and to create an environment where the participants could express themselves comfortably. An appropriate acquaintance was developed with each participant. During the interviews, a comfortable environment was created for the participants to explain their opinions in detail.

In qualitative research, in the data analysis process, researchers should keep their subjective perspectives away from research. In this process, called bracketing by Moustakas (1994), another role of our researchers in the research has been to keep our biases, our own subjectivity, away from the research and focus entirely on the opinions of the participants.

3. Results

3.1. Opinions on Using Technology in Science Lesson

In the research, firstly, whether the participants used technology in their lessons was examined. All of the Science teachers participating in the study stated that they used technology in their lessons. It was found that the applications that science teachers who participated in the study frequently use were Power Point presentations, Education and Informatics Network (EBA), smart board, Schoolistics, Education Center, Projection and Computer. Conversely, the least used applications by teachers were models, virtual reality, augmented reality, Kahoot, WEB 2.0 concept mapping tools and digital stories. However, three teachers stated that they do not have information about which technologies they can use.

"So why did you state in the first question that you use technology in your lessons?" When asked, "We use what is foreseen in the program, but we do not know what we can use or do." response has been received.

Following the first question in the interview, the participants were given the names of some technology integration applications that can be used in science lessons and they were specifically asked whether they knew how to use them or not. The findings reached as a result of the analysis of the obtained data are presented in Table 2.

Table 2. Participants' knowledge of some technology integration applications that can be used in science lessons

Apps	**I do not know**	**I only know its name**	**I do not know**
Digital Story	9	6	1
STEM activities	7	5	4
Animation	4	7	5
Simulation	4	6	6
Makey Makey	16	-	-
Ardunio	15	1	-
Robotics	11	5	-
Coding	13	2	1
Web 2.0	14	1	1
Gamification apps like Kahoot / Socrates	14	1	1

When Table 2 is examined, it is seen that Science teachers participating in the study do not know the applications of Makey Makey, Ardunio and Robotics. However, it is understood that there is a serious lack of knowledge in coding, gamification applications such as Web 2.0, Kahoot / Socrates, and digital story preparation applications. The most common application names that the participants expressed that they know how to use were simulation and animation. However, most of these participants also stated that they heard simulation and animation or that they bought and used ready-made materials but did not know how to develop them. The following quotes are examples that reflect the views of the participants:

T3 (Female, 13 years of seniority): *"To be honest, I only heard animation, simulation or something o Makey, coding, Ardunio, etc. I have never heard of them even by name. I had the children watch the animation several times, but you know, I never prepared it. Can we prepare them? "*

T5 (Female, 12 years of seniority): *"I think that I am good at this kind of practice, at least I try to give more place to such practices than other teachers. I know C Sharp coding, but I do not show it to students because it is heavy, I use simulation for example, in between ..."*

T14 (Male, 5-year seniority): *"Sir, STEM applications are now a trend, and the name robotics is also mentioned. I've heard Ardunio twice as if it's in STEM. I have no idea how to prepare it, so how to develop and use it. I used a digital story and found it ready on*

YouTube. Animation / simulation is very common in our daily lives, but I don't know that online gamification or coding. Do you need to use them? I am one of those who think that it should be questioned too."

The field notes taken in the observations made within the scope of the research are in line with the findings obtained during the interviews. It was observed that the teachers who did not use the above-mentioned applications in their lessons, did not use any application other than the use of smart boards placed in the classrooms by the ministry within the scope of technology integration. The education hall is the pages frequently visited by the school and EBA teachers, and it has been observed that the participants do not perform any activities in addition to the related topics covered in these pages. An interesting situation drew attention when the STEM applications were evaluated. Science teachers currently configured Science and STEM-based changes in 2017 in Turkey is implementing the curriculum but only four participants stated they knew they STEM practices and implementation difficulty. The excerpt below is from a teacher who commented in this direction:

T16 (Male, 13 years of seniority): *"My teacher (thinking), frankly, I got a STEM certificate and I think I'm fine about it. My practices are always in this minimal."*

Science teacher T7 (Female, 10 years of seniority), who stated that she does not have a command of STEM applications, said, *"I know that there is a STEM thing, I heard, my teacher, we are practicing it as in the book, as told to us, but exactly what is the philosophy of the work, how is it done? I cannot say that I know what is not. I cannot design an event myself."* expressed with his thoughts.

3.2. Science Teachers' Views on the Reasons of Technology Integration into their Lessons

"Why do you think technology integration is necessary in Science lessons?" he was asked. The findings obtained as a result of the analysis of the answers are given in Table 3:

Table 3. Reasons for technology integration in science classes according to the participants

Theme	Category	Cod	Frequency*
Reasons	Learner Features	Appealing to the new generation	5
		Appealing to students' interests	4
		Digital competence development	4
		The opportunity to learn according to the pace of the student	2
		Developing technology use skills	2
		Research skills development	2
	Benefit for Cognitive Gains	Permanent learning	8
		Embodimenting abstract science topics	7
		Higher-order thinking skills	5
		Striking	4
		Increasing class attendance	3
		Meaningful learning	2
		Making learning easier	2
	Benefits for Affective Gains	Making the lesson fun	5
		Liking the lesson	4
		Drawing attention	4
		Extraordinary	2
	Course Benefits	Access to hard-to-reach content	6
		Dangerous science experiments	4
		Multi-sensory appeal	4
		Access to a hard-to-reach place	3
		Making the lesson effective and efficient	3
		Enriching the lesson	3
		Saving time	3
		Systematic order	2
		Opportunity Equality	2
		Increasing engagement	2
		Access to more information	2

**Since each participant gives more than one opinion, the total frequency is equal to the total number of encodings, not the number of participants. This situation is valid for all encodings.*

According to Table 3, the opinions of the Science teachers participating in the study about the necessity of technology integration into their lessons are distinguished in four categories as learner features, benefits and benefits to the lesson.

From some of the innovations that gave opinion, a new generation of feedback and searches that learned the news that appeal to their interests emerged. Less participants, on the other hand, cited features such as developing digital competence, the opportunity to learn in accordance with the teaching own learning pace, the use of student technology, and the development of research skills as necessary in using technology in science classes. The excerpt that exemplifies this category is as follows:

T1 (Female, 8 years of seniority): *"Using technology has become inevitable now. Because it's suitable for new kids, they live with technology. They should learn with technology. Children's interests are also in this direction. The more they use it, the more they develop in technology use and skills… "*

The benefits category for cognitive gains focuses on the benefits of technology integration into science classes such as providing permanent learning for students, concretizing abstract science subjects and improving higher-order thinking skills. A small number of participants also mentioned the benefits of these practices such as increasing class participation, providing meaningful learning and facilitating learning. The following excerpt is an example of this category:

T9 (Female, 11 years of seniority): *"The use of technology in science lessons facilitates learning and ensures permanent learning. Because abstract issues turn into concrete."*

Science teachers who gave their opinions in the category of benefits for affective gains stated that they found the use of technology necessary in their lessons because these practices made the lesson fun, liked the lesson, were remarkable and offered students the opportunity to teach with a new technique beyond the usual. The following excerpt exemplifies this category:

T11 (Male, 11 years of seniority): *"Technology supported science lesson gives students the opportunity to learn by having fun, so students like science lesson more."*

Finally, the category of benefits related to the lesson consists of the participants' views within the framework of the contribution of technology integration to science lessons. Among the opinions in this category, the most repeated ones were technology integration to facilitate access to the difficult subject content in science lessons, to provide the opportunity to safely apply some dangerous science experiments and to address more than one sense. In addition, benefits such as providing the opportunity to experience difficult-to-reach places, making the lesson effective and efficient, enriching the lesson and saving

time are also among the views expressed in this category. The following excerpt exemplifies this category:

T2 (Female, 11 years of seniority): *"Of course, the use of technology in science education is now necessary. The first reason is to reach difficult issues and impossible places. For example, we cannot go to space or the moon, but we can watch and see videos. Simulation is also called simulation in difficult subjects. It works very well. The lesson gets richer once. "*

The observation notes taken in the study, on the other hand, do not correspond to these views of the participants. Because teachers who believe in the above benefits are expected to include different educational technology applications in science lessons by taking into account the subject and learner characteristics. In fact, science teachers who participated in the research were not (could not) go beyond using computers and projectors.

3.3. Science Teachers' Views on the Reasons of the Problems Encountered in the Process of Technology Integration into their Lessons

The teachers who participated in the research were asked "What are the problems encountered during the technology integration process in the Science course?" he was asked. The results of the analysis of the answers are given in Table 4:

Table 4. According to the participants, the problems encountered during the technology integration process in science lessons

Theme	**Category**	**Cod**	**Frequency**
Issues	Internal Factors	Teacher's incompetence	12
		Teacher's bias	8
	External Factors	Lack of technical infrastructure at school	11
		No permanent material	10
		Getting away from real life	10
		Impossibilities for students	9
		Lack of equipment in schools	8
		Cost	8
		Poor use of technology	6
		Not suitable for all subjects	6
		Time consuming	6
		Distractibility	5
		Habituation to laziness	4
		Information pollution on the Internet	2
	Absence	-	2

According to Table 4, the problems experienced by science teachers participating in the study at the point of technology integration into their lessons are divided into two categories as internal and external factors. The category of internal factors represents the problems stemming from the teacher. Among the opinions of the participants in this category are the teacher's inadequacy in technology integration and their prejudices about the necessity of this. Below is a sample quote from the views in this category.

T6 (Female, 9 years of seniority): *"If my teacher does not know how to use which technology in his lesson, of course he will have problems if he does not know whether that technology is suitable for his student."*

The second category of the problems theme is the category of external factors. This category includes the opinions of the participants about the problems caused by other reasons than the teacher. Among these, problems such as lack of technical infrastructure in school, lack of permanent materials, moving away from real life, lack of technological equipment due to financial difficulties in students, lack of equipment in schools, costs can be listed. Below is a sample excerpt from this category.

T16 (Male, 13 years of seniority): *"The first problem that comes to my mind is that the teacher does not want to use technology in his lesson. But other than that there are problems in every province of Turkey in every school and every family will get no materiality technology and cost method. Later, when the student does not take notes, when he uses technology, a picture is taken immediately, it's gone, and that's the problem. "*

In the observation notes taken in the study, it was reported that there were no problems such as technical infrastructure and equipment, Internet access in the schools where the participants were working (it was already a criterion for the selection of the participants), and the subject covered during the research was suitable for technology integration. In the interviews conducted, although all of the participants expressed their opinion that technology integration is absolutely necessary in science lessons, it was revealed that there was serious lack of knowledge on the subject. As a result of the observation, it can be stated that the inadequacy of teachers regarding technology integration is the most important problem. For example, most of the participants choose a student to turn on and off and use the smart board in their classroom. A small number of teachers, on the other hand, open the pages recommended by the Ministry from the smart board and teach their lessons using conventional methods.

3.4. Science Teachers' Opinions Regarding Solution Suggestions Regarding Problems Encountered During Technology Integration Process

Another problem examined in the study is the solution suggestions for the problems experienced by the participants during the technology integration process. According to the findings, the solution suggestions of the participants are as follows:

• Including applied courses on technology integration into science lessons in undergraduate education,

• Selecting courses from other departments during undergraduate education,

• Practical and in-service training in small groups by experts from the university.

When the solution suggestions offered by the participants for the problems experienced in technology integration are examined, it is understood that they have offered solutions for the category of internal factors that include teacher-induced problems. Science teachers participating in the study stated that teachers' knowledge and skill levels (digital competence) about technology integration should be increased and stated that pre-service and in-service training should be provided. It is recommended that these trainings be given to small groups by experts in the field. Below is a sample quote:

T4 (Male, 10 years of seniority): "*It is necessary to train the teacher well in order to solve the problems. The first thing to do for this is to get practical training while studying at the university, but of course this does not solve the problem of the teachers who are currently working. In-service training should be organized for them as well. Yes, there is in-service training from time to time, but the truth is that this is ineffective. Because all the teachers in the city participate, it is said to use technology in your lessons without practicing. In general, it is not possible to get efficiency from the people who tell. These trainings should be divided into small groups of teachers and given by really experts in a practical way. "*

4. Conclusion, Discussion and Suggestions

In this study, it was aimed to determine the opinions of Science Teachers about the examination of technology integration knowledge into their lessons. As a result of the research, it was found that Science teachers who participated in the research frequently used technologies such as PowerPoint presentations, EBA, smart board, Schoolistics, Education House, Projector and Computer; They rarely use models, virtual reality, augmented reality, Kahoot, concept mapping and digital story tools. While it was expected that different technology applications would be included in science lessons by taking into account the subject and learner characteristics in the research, Science teachers participating in the study did not really go beyond using computers and projectors. Similarly, in the study conducted by Adıgüzel & Yüksel (2012) with the participation of 12 teachers from four different branches, it was determined that all teachers mostly used teaching technologies such as smart boards and PowerPoint presentations in their lessons. Zengin, Kağızmanlı, Tatar & İşleyen (2013) revealed in their studies that 79% of the participant mathematics teachers now use the interactive board, which is common in almost all schools in our country, but none of them use a dynamic software related to their branch. In the large-scale studies conducted by Avcı, Kula & Haşlaman (2019) with the participation of 1680 teachers, the first three technologies most used by teachers;

presentations, educational animation / flash and educational digital games and videos / films. In the same study, it is understood that online education platforms such as EBA, Edmodo, Okulistik, Morpa Campus, Class Dojo and Vitamin are relatively more preferred than other technologies.

In the present study, the participant Science teachers; It has been revealed that they do not know about Makey Makey, Ardunio and Robotics applications at all, however, gamification applications such as coding, Web 2.0, Kahoot / Socrates also have a serious lack of knowledge in digital story preparation applications, only using ready-made simulations and animations in their lessons, but they do not know how to develop them themselves. These results of the research explain the results of Şendurur and Arslan's (2017) study called change in factors affecting technology integration in education. Şendurur & Arslan reveals that teachers mostly benefit from the internet in terms of content, and their lack of software and pedagogical knowledge can be effective in their inability to prepare their own content. Similarly, although many perceive robotic technology as a useful tool in the learning and teaching of some science subjects, it is thought that robotic activities take too much time, preventing teachers from training all subjects until the end of the semester and in this case, it is thought that there are not many reasons for preference (Alimisis, 2013). Göktaş, Yıldırım & Yıldırım (2008) also supported this idea by stating that teachers did not have enough time, opportunities and competencies to prepare e-content suitable for the achievements of each course and the physical, cognitive and affective development of students.

Judging terms STEM applications in research, science teachers stated that Turkey now changing in 2017 and STEM-based structured Science lessons, although the curricula application 16 teachers from only four teachers STEM know the application and it course in practice difficulty that. Bozkurt Altan, Yamak & Kırıkkaya (2016) stated that in order for teachers to carry STEM applications to their classes, they should have features such as the structure of scientific research and technological inventions, the use of necessary tools and equipment in the classroom, the association of design creation processes with daily life, and the integration of STEM fields while doing activities in the laboratory. They stated that they should be. It can be said that the majority of the study group of this research carried out also needs the features mentioned by Bozkurt et al. STEM should be taught to in-service and pre-service teachers in order to use new methods and approaches effectively in science education (Holdren, Lander & Varmus, 2010). However, since STEM is a new approach in our country, increasing the quality of STEM educators (Çorlu, 2014), organizing educational activities and projects related to STEM education for teachers trained in education faculties of universities (Akgündüz & Ertepınar 2015) will be very beneficial.

The problems experienced by science teachers participating in the study at the point of technology integration in their lessons were divided into two categories as internal and

external factors. The category of internal factors has been in the form of inadequacy in technology integration caused by the teacher and his prejudices about the necessity of this. In the category of external factors, the participants consisted of problems such as the lack of technical infrastructure in the school caused by other reasons other than teachers, lack of permanent materials, moving away from real life, lack of technological equipment due to financial impossibility, lack of equipment in schools and costs. In particular, the Covid19 pandemic process we are in has revealed the importance of teachers' skills to produce and use digital competence and technology-supported materials. This process has shown us that nothing will ever be the same as before, and that we should not waste time in taking the necessary steps to eliminate the problems caused by both internal and external factors as soon as possible.

In the observation notes taken in the study, it was reported that there were no problems such as technical infrastructure and equipment, Internet access in the schools where the participants were working (it was already a criterion for the selection of the participants), and the subject covered during the research was suitable for technology integration. In the interviews conducted, it was revealed that although all of the participants stated that technology integration is absolutely necessary in science lessons, there are serious lack of knowledge on the subject. As a result of the observation made, it can be stated that the inadequacy of teachers regarding technology integration is the most important problem. This may be due to teachers' perception of technology integration such as knowing only the names of educational technologies they want to use, making presentations with PowerPoint or watching / watching videos (Avcı, Kula & Haşlaman, 2019). However, in the application models related to technology integration, it is emphasized that teachers can choose and use technologies that will support their pedagogical approaches suitable for learning and teaching processes (Haşlaman, Mumcu, & Usluel, 2008; Mishra & Koehler, 2006).

Solution suggestions for the problems faced by the participants during the technology integration process; including applied courses related to technology integration to science courses in undergraduate education, selection of courses from other departments during undergraduate education, applied and in-service training in small groups by experts from the university. Similarly, Tanık Önal (2017) suggests that the use of technology in teacher education should be widespread, thus enabling pre-service teachers to use technology more qualitatively when they become teachers. In addition, the fact that the participants offered solutions for internal factors suggests that teachers are aware of the importance of the technology integration in education, and it is also important in that they do not present only financial or hardware problems by throwing the responsibility from them.

According to the researches, it has been observed that new generation teachers feel more comfortable using technology and giving lessons compared to experienced teachers (İnan & Lowther, 2010; Lee & Tsai, 2010). The generation of the near future that grows

with technology shows us that yesterday's methods should be abandoned and an education should be given within the framework they demand.

As a result of the research, it was determined that the participant Science teachers had significant deficiencies in their technology knowledge. It was also revealed that teachers had problems in technology integration into their lessons. The underlying reason for most of these problems is the lack of technical infrastructure and equipment in schools, not technical features such as connection problems, but the lack of technology knowledge of teachers. Considering these results, it can be suggested to increase the applied courses in which teachers will gain technology knowledge in undergraduate programs or to implement practices that will increase the efficiency of existing courses. Within the scope of these 'new' applications, suggestions can be made such as conducting the relevant courses in undergraduate programs by instructors with a doctorate in educational technologies, realizing projects that will increase their technology knowledge with teacher candidates and use this knowledge. As stated by the participants, it is important to give practical in-service trainings in small groups for teachers who are currently working, and that these trainings are given by trainers who are experts in the field and who truly believe in the importance of digital competence.

4.1. Limitation of the Research and Future Studies

The current research is limited to the participation of 16 Science teachers working in Nigde. In this study based on qualitative paradigm, the number of participants does not constitute a problem since generalization concerns are not motivated by its nature. However, in order to reach generalizable results in future studies, quantitative studies with large samples or mixed method studies can be conducted to detail the results.

Technology knowledge of the participants was emphasized in the research. For this reason, in future studies, Science teachers' Technological Pedagogical Content Knowledge levels can be examined as a whole or other components separately. Using technology for mathematics, which is another lesson that includes abstract topics such as Science, can provide many benefits. For this reason, a comparative study comparing the technology knowledge of science and mathematics teachers may be the agenda of another research. Interviews were conducted as the main data source in the present study and observation was used to support these data. In future research, observation can be used as the main data, or observation, interview and document analysis can be used together to increase internal validity.

References

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education*, *43*(4), 281-300.

Adıgüzel, A. & Yüksel, İ. (2012). Öğretmenlerin öğretim teknolojileri entegrasyon becerilerinin değerlendirilmesi: Yeni pedagojik yaklaşımlar için nitel bir gereksinim analizi. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 6*(1), 265-286.

Agyei, D. D.,& Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian journal of educational technology*, *28*(4), 547-564.

Akgündüz, D. & Ertepınar, H. (2015). *STEM eğitimi Türkiye raporu: "Günün modası mı yoksa gereksinim mi?"*. İstanbul Aydın Üniversitesi STEM Merkezi ve Eğitim Fakültesi. İstanbul: Scala Basım.

Alimisis, D. (2013). Educational robotics: Open questions and new challenges. *Themes in Science and Technology Education, 6*(1), 63-71.

Archambault, L. M.,& Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education*, *55*(4), 1656-1662.

Avcı, U., Kula, A. & Haşlaman, T. (2019). Teachers' opinions on technology that they want to integrate into the learning-teaching process. *Acta Infologica, 3*(1), 13-21.

Bozkurt- Altan, E., Yamak, H. & Buluş- Kırıkkaya, E. (2016). FeTeMM eğitim yaklaşımının öğretmen eğitiminde uygulanmasına yönelik bir öneri: Tasarım temelli fen eğitimi. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 6*(2), 212-232.

Bozkurt, A. & Cilavdaroğlu, A. K. (2011). Matematik ve sınıf öğretmenlerinin teknolojiyi kullanma ve derslerine teknolojiyi entegre etme algıları. *Kastamonu Eğitim Dergisi*, *19*(3), 859-870.

Chen, R. J. (2010). Investigating models for preservice teachers' use of technology to support student-centered learning. *Computers & Education*, *55*(1), 32-42.

Cox, S. M. (2008). *A conceptual analysis of Technological Pedagogical Content Knowledge*. Doctoral dissertation, Brigham Young University, United States.

Çorlu, M. S. (2014). FeTeMM eğitimi makale çağrı mektubu. *Turkish Journal of Education, 3*(1), 4-10.

Daniel, S. J. (2020). Education and the COVID-19 pandemic. *Prospects*, 1-6. https://doi.org/10.1007/s11125-020-09464-3.

Dilworth, P., Donaldson, A., George, M., Knezek, D., Searson, M., Starkweather, K., Strutchens, M., Tillotson, J., & Robinson, S. (2012). Editorial: Preparing teachers for tomorrow's technologies. *Contemporary Issues in Technology and Teacher Education*, *12*(1), 1-5.

Ertmer, P. A.,& Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284.

Escuder, A. (2013). *Middle school teachers usage of dynamic mathematics learning environments as cognitive instructional tools*. Doctoral Dissertation, Florida Atlantic University, Florida.

Göktaş, Y., Yıldırım, Z. & Yıldırım, S. (2008). The keys for ICT integration in K12: Teachers' perceptions and usage. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 34*, 127-139.

Haşlaman, T., Mumcu, F. K., & Usluel, Y. K. (2008). *Integration of ICT into the teaching learning process: Toward a unified model*. Paper presented at World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA), Vienna, Austria.

Holdren, J. P.,Lander, E., & Varmus H. (2010). *Report to the president prepareandinspıre: K-12 educatıon in science, technology, engineering, and math (STEM) for America's future.*

Executive Office of the President President's Council of Advisors on Science and Technology, Prepublication Version. http://www.whitehouse.gov/ostp/pcast

Ivy, J. T. (2011). *Secondary mathematics teachers' perceptions of their integration of instructional technologies.* Doctoral Dissertation, The University of Mississippi, United States.

İnan, F.,& Lowther, D. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development, 58*(2), 137-154.

Kartal, T. (2017). *Fen eğitiminde teknoloji entegrasyonu.* Demirci Güler, M. P. (Ed.), Fen bilimleri öğretimi: Yaklaşımlar ve kazanımlar doğrultusunda uygulama örnekleri. Ankara: Pegem Akademi.

Keating, T.,& Evans, E. (2001). Sınıfın arka planındaki üç bilgisayar: Teknoloji entegrasyonunun önlemli öğretmenlerin kavramları. *Bilgi Teknolojileri ve Öğretmen Eğitimi Uluslararası Konferansı Derneği* (s. 1671-1676). Eğitimde Bilgisayar Gelişimi Derneği (AACE).

Laplante, P. (2020). Contactless U: Higher education in the postcoronavirus world. *IEEE Annals of the History of Computing*, *53*(07), 76-79.

Lee, M.H.,& Tsai, C.C. (2010). Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instructional Science: An International Journal of the Learning Sciences, 38*(1), 1-21.

Lincoln, YS.,& Guba, EG. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.

Merriam, S.B. (1998). *Qualitative research and case study applications in education*. Jossey-Bass Publishers: San Francisco.

Mishra, P.,& Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017-1054.

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA: Sage.

Niess, M. L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educatıonal Computing Research, 44*(3), 299-317.

Nyikahadzoyi, M. R. (2015). Teachers'knowledge of the concept of a function: A theoretical framework. *International Journal of Science and Mathematics Education*, *13*(2), 261-283.

Patton, M.Q. (2002). *Qualitative research and evaluation methods* (3rd Sage Publications). Thousand Oaks: CA.

Pringle, R. M., Dawson, K., & Ritzhaupt, A. D. (2015). Integrating science and tchnology: Using Technological Pedagogical Content Knowledge as a framework to study the practices of science teachers. *Journal of Science Education and Technology*, *24*(5), 648-662.

Sahu, P. (2020). Closure of universities due to Coronavirus Disease 2019 (COVID-19): Impact on education and mental health of students and academic staff. *Cureus*, *12*(4). doi:10.7759/cureus.7541

Seferoğlu, S. (2008). *İlköğretim okullarında teknoloji kullanımı: Yaşanan sorunlar, gözlemler ve çözüm önerileri.* I. Uluslararası Eğitimde Küreselleşme ve Bilişim Teknolojileri Konferansı, Bakü.

Şendurur, P. & Arslan, S. (2017). Eğitimde teknoloji entegrasyonunu etkileyen faktörlerdeki değişim. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi,* (43), 25-50.

Tanık-Önal, N. (2017). Bilgi ve iletişim teknolojileri kullanımı: Fen bilgisi öğretmen adaylarının görüşleri. *International Journal of Active Learning, 2*(1), 1-21.

Yıldırım, A. & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri (7. Baskı).* Ankara: Seçkin Yayıncılık.

Yiğit, M. (2014). A review of the literature: How pre-service mathematics teachers develop their Technological, Pedagogical, and Content Knowledge. *International Journal of Education in Mathematics, Science and Technology, 2*(1), 26-35.

Yin, R. K. (2009). *Case study research.* (4th ed). Los Angeles, CA: Sage.

Zengin, Y., Kağızmanlı, T. B., Tatar, E. & İşleyen, T. (2013). Bilgisayar destekli matematik öğretimi dersinde dinamik matematik yazılımının kullanımı. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 10*(23), 167-180.

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