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AN EXAMINATION OF PRE-SERVICE TEACHERS' EXPERIENCES IN CREATING A SCIENTIFIC DIGITAL STORY IN THE CONTEXT OF THEIR SELF CONFIDENCE IN TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

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Abstract. *Digital stories are a form of expression that emerges by combining the art of storytelling with multimedia tools such as sound, picture, and video. In this research, examining the experiences of pre-service teachers in creating digital stories in accordance with the science curriculum and the effects of this process on the pre-service teachers' self-confidence in technological pedagogical content knowledge was aimed. This research, using a mixed model approach, was conducted with 24 fourth-grade pre-service teachers. In the study, the "Technological Pedagogical Content Knowledge Confidence Scale" (TPACK) was applied as a pre-test and post-test. The quantitative findings of the study revealed that the experiences of pre-service teachers in creating a scientific digital story increased statistically significantly in the TK dimension of the TPACK scale and in the TPACK total self-confidence scores. The qualitative findings of the research showed that it had a positive effect on TCK, TPK, and TPCK dimensions, as well as on the TK and total score of TPACK. In the light of these findings of the research, the use of digital stories in educational environments can be recommended since the use of digital stories in educational environments is effective in developing students' TPACK self-confidence perceptions.*

Keywords: *mixed method, pre-service teachers, scientific digital story, technological pedagogical content knowledge*

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Introduction

As a result of rapid developments in technology, digital transformation in the field of education has accelerated. In this period when digital technology becomes widespread and directs every aspect of life, the task of guiding students to use technology in a beneficial way is very important (Kocoglu, 2021). In order for the students called "New Millennium Learners" (Pedró, 2006) or "Digital Natives" (Prensky, 2001) to be successful both academically and socially, teachers should pay attention to use different methods/techniques in their teaching activities. Teachers are expected to be sufficiently equipped, especially in terms of effective use of technological tools. The International Educational Technologies Society (ISTE; 2015) tried to draw the framework of innovation in education and some standards were determined. The framework especially emphasized (a) setting professional learning goals by applying technology together with pedagogical approaches, (b) developing themselves according to their interests by participating in national and international learning networks, (c) creating a technology-enhanced teaching and learning vision, (d) striving to meet the needs of students and ensure equal access to educational technologies, (e) increasing students' curiosity about online resources and enable them to look critically, and (f) creating a learning culture that improves digital literacy (ISTE, 2015).

Approaches to improve teacher competence in technology integration argue that technological knowledge alone is not sufficient and that we should focus on the fundamental connections between technology, pedagogy, and content knowledge (Mishra & Koehler, 2006). Today, especially in the field of science education, the integration of education and technology comes to the fore (Turk & Seckin-Kapucu, 2021). Jacobs (2010) stated that the teaching tools to be designed for 21st century skills should have visual and organizational features that allow students to learn concretely. Wellington and Osborne (2001) stated that different types of materials (visual presentations, pictures,

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animated materials, etc.) can be used to communicate well with students, especially in science education. At this point, the use of digital stories in the teaching process draws attention. Robin (2006, 2008) classified digital stories as personal, historical, and scientific. Teachers can use digital stories to present information to their students, from math and science, to arts, technology, and medical education (Robin, 2008). In this context, the use of "scientific digital story" in science education emerges as one of the effective methods (Calik & Seckin-Kapucu, 2021).

Research Problem

In the 21st century, it is of great importance to use digital learning objects in educational environments and to integrate learning materials such as interactive videos, animations, simulations, educational films, digital stories into lessons as active learning tools (Koyunlu-Unlu & Dokme 2020; Topal et al., 2020). This research focused on digital stories from these learning tools. Digital stories can be created by combining music, video, audio, and pictures with a story or dialogue written using Web 2.0 technologies. Storytelling is the foundation of the digital story. The difference of digital stories from normal storytelling is that the story is supported by visual and auditory materials in the digital environment (Seckin-Kapucu & Yurtseven-Avci, 2020). The creation phases of digital stories need to be planned correctly. Digital story creation phases can be listed as (1) writing, (2) scripting, (3) creating storyboard, (4) locating multimedia, (5) creating the digital story, and (6) sharing (Jakes & Brennan, 2005). The digital story creation process requires content knowledge and pedagogy knowledge as well as technology knowledge. In this respect, teachers' self-confidence in TPACK is of great importance in creating a digital story.

TPACK is seen as an important approach that supports, improves, and facilitates technology integration in education (McGraw-Hill, 2018; Santos & Castro, 2021). Mishra and Koehler (2006), mentioning the importance of teachers' confidence in integrating technology into teaching, proposed a new conceptual framework by adding "technology" to Shulman's "pedagogical content knowledge" formula. TPACK generally consists of three general knowledge types (Technological Knowledge, Pedagogical Knowledge, Content Knowledge) and other knowledge (Technological Pedagogical Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge, Technological Pedagogical Content Knowledge) (Kiray et al., 2018; Kartal & Dilek, 2021). This understanding forms the basis of an effective teaching process with technology. The pedagogical techniques that are used to teach the content knowledge and the information necessary for students to use technologies that will help them construct new concepts are integrated by expert teachers (Koehler & Mishra, 2008). With the acceleration of digitalization, the technology dimension of TPACK is developing day by day and its importance is increasing.

Technology literacy has become one of the main aims of education today. In order for teachers to achieve this goal, they must first be technology literate and be able to combine their technological knowledge with their content and pedagogical knowledge (Koehler & Mishra, 2008; Mishra & Koehler, 2006). Primary school teachers in Turkey are obliged to teach more than one course (science, mathematics, social studies, life studies, etc.) from the first to the fifth grade. Primary school teachers are also faced with the necessity of integrating these courses with technology for the new generation who grow up with technology. In this context, this research aimed that the pre-service primary school teachers create scientific digital stories for the subjects and objectives in the Ministry of National Education (MoNE; 2018) science curriculum in Turkey, based on the "Technological Pedagogical Content Knowledge" approach, and the effects of this process on their self-confidence in technological pedagogical content knowledge intended to be examined. For this purpose, researchers expect that pre-service teachers' self-confidence in TPACK has improved in the process of creating digital stories. In Table 1, the association between the technology-related components of TPACK and the digital story creation process is presented.

Table 1
Components of TPACK and Application Examples in the Research

Components of TPACK	Explanation	Components of creating digital story process
TK	It is the knowledge about various technologies ranging from traditional technologies such as pen, paper, books to digital technologies such as internet, digital video, smart board, and software programs (Kiray et al., 2018; Koehler & Mishra, 2006).	Using Web 2.0 tools such as Powtoon, Storyboard-That, Pixton,

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Components of TPACK	Explanation	Components of creating digital story process
TPK	It is about how teachers can use and evaluate their technological knowledge in a pedagogically meaningful way in the classroom (Koehler & Mishra, 2008; Mishra & Koehler, 2006)	Deciding whether the digital stories created in the computer are suitable for the level of the student, the principles of material development, and different teaching strategies, methods, and techniques.
TCK	It is the knowledge that teachers change the way students understand and apply concepts related to a content/subject using technology (Mishra & Koehler, 2006).	Placing the scientific scenarios written according to the learning outcomes in the curriculum on the storyboard by blending them with visual and auditory elements and making use of technology.
TPCK	It is the knowledge of integrating technology in a way that helps students build their existing knowledge and new knowledge by making use of pedagogical techniques to teach content knowledge (Koehler & Mishra, 2008).	Creating a digital story by integrating content knowledge of science course subjects with Web 2.0 tools such as Powtoon etc. and presenting the created story with various teaching strategies, methods, and techniques.

Research Focus

In today's conditions, teachers are expected to set learning goals by applying technology together with pedagogical approaches, to create a technology-enhanced teaching vision, to make efforts for students to have equal access to educational technologies, to increase students' curiosity about online resources and to enable them look critically, and to create a learning culture that improves digital literacy (ISTE, 2015). One of the main aims of primary education is to raise technology literate individuals. Teachers' raising individuals with this characteristic primarily depends on their being technology literate and combining their technological knowledge with their content and pedagogical knowledge. Approaches to improve teacher competence in technology integration argue that technological knowledge alone is not sufficient and that it should focus on the fundamental connections between technology, pedagogy, and content knowledge (Mishra & Koehler, 2006). Literature emphasized that teacher can use technology effectively in the technology integration process and that technology should be made a part of the curriculum, and students' learning is enriched in this way (Mazman & Usluel, 2011, p. 65). In science education, it is recommended to use different materials (visual presentations, pictures, animated materials, etc.) to communicate well with students (Wellington & Osborne, 2001). In this context, the use of "scientific digital story" in science education emerges as one of the effective methods. Teachers can use digital stories to present information to their students, from mathematics, science, art, technology, and medical education (Robin, 2008). Considering that teachers gain their knowledge and experience during their education in college, it is necessary for pre-service teachers to receive training on digital storytelling to experience this practice (Shelton et al., 2017). It is important for the pre-service teachers to become competent in creating and presenting the digital story after the phases of creating a digital story: developing a story idea, writing, and editing the story, creating a storyboard, and choosing the multimedia components (Frazel, 2010). At the same time, taking the trainings that include the software used in digital storytelling and the use of Web 2.0 tools will help pre-service teachers in creating digital stories. In line with these considerations, in this study, researchers aimed to examine the experiences of pre-service primary school teachers in creating scientific digital stories for the subjects and objectives in the MoNE (2018) science curriculum in the context of the "Technological Pedagogical Content Knowledge" approach.

Research Aim and Research Questions

In this study, it became important to prepare digital stories developed by pre-service primary school teachers for the science curriculum and to determine the effects of this process on the pre-service teachers' self-confidence in TPACK, especially regarding the TK, TPK, TCK, and TPCK dimensions. As researchers aimed to examine the experiences of pre-service primary school teachers in creating scientific digital stories in the context of their self-confidence in TPACK in this study, the research questions were determined as follows:

1. Does the digital story creation experience of the pre-service primary school teachers make a statistically significant difference on their self-confidence mean scores in TPACK?

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2. Does the pre-service primary school teachers' experience of creating digital stories make a statistically significant difference between the mean scores obtained from the sub-dimensions of the TPACK confidence scale?
3. What are the opinions of the pre-service primary school teachers about the use of digital stories in science education?

Research Methodology

General Background

Mixed methods research is pragmatic research that uses both quantitative and qualitative data together (Erdogan & Stuessy, 2022). The mixed method has different designs, one of which is the convergent parallel design. The most distinctive feature of the convergent parallel mixed design is that quantitative and qualitative data are collected simultaneously but analyzed separately (Creswell, 2014). Therefore, in this research, the convergent parallel mixed method, in which quantitative and qualitative data were used together, giving the opportunity to examine the research problem in depth, was used. In this research, the data collected by quantitative methods needed to be supported by the data collected from qualitative methods through interviews to illuminate the subjective meaning that could be missed during the quantitative data collection.

Participants

This research was carried out with the pre-service primary school teachers studying at a state university in Turkey during the fall semester of 2019-2020. The research was carried out with a total of 24 pre-service teachers, 10 females (41.7%) and 14 males (58.3%) enrolled in the "Integration of Technology Based Applications in Education" course in the undergraduate education program of Primary Education Department. Integration of Technology Based Applications in Education course is an elective course and all of the students who chose this course were included in the research. Until this application, the participants had only taken Computer I course (a course with basic Office applications such as Word, Excel, PowerPoint). There is no course in the official program covering Web 2.0 applications. Before the application, the participants were informed about the application to be made. Consent form was filled by the participants so that they could participate in the experimental application. All of the students who chose the course volunteered to participate in the experimental application.

Instrument and Procedures

The research was carried out in the computer laboratory classroom for 2 hours a week and lasted for 14 weeks in the fall semester of 2019-2020. All pre-service teachers who participated in the research were informed about the research and the voluntary participation form was signed and collected. Before the applications started, the "Technological Pedagogical Content Knowledge Confidence Scale" was applied to the pre-service teachers in the classroom environment as a pre-test.

The association between the components of the digital story and the components of TPACK is presented in Table 2, with reference to the digital story creation processes of the pre-service teachers during the research and the digital story creation phases of Frazel (2010) and Ohler (2013).

Table 2
The Digital Story Creation Process of Pre-Service Teachers and the TPACK Relationship

Time	Phases	What's done in practice	Relevance to TPACK
Week 1	Pre-application	The concept of "story" was explained. Group work was done in the classroom with scientific stories developed by Gölcük (2017). They identified the elements in these stories (number of characters and their features, setting, etc.) and wrote the appropriate dramatic questions. They designed a scene suitable for the story and chose the music.	PK (Pedagogical Knowledge)

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Time	Phases	What's done in practice	Relevance to TPACK
	1. Preparation and Planning:		
Week 2	a. Deciding what kind of story to prepare (Frazel, 2010)	Each pre-service teacher determined a subject and outcome from a unit in the MoNE (2018) science curriculum. For example: A story called "Shining Friendships" was written for the objective of "Recognizes the circuit elements that make up a simple electrical circuit with their functions."	CK (Content Knowledge)
Week 3	b. Writing the dramatic question.	A dramatic question was written for each story. For example: "How do we meet the lighting needs from past to present?"	
Week 4	c. Writing a screenplay (Frazel, 2010)	Scientific scenarios suitable for the curriculum were written and necessary corrections were made by bilingual experts.	PCK (Pedagogical Content Knowledge)
Week 5	d. Getting peer opinion and changing the scenario if necessary (Ohler, 2013)	All stories were read in class and opinions were taken.	
Week 6	e. Preparing a Story Board	"The Digital Storyboard" template was shared with the participants and explanations were made. Participants prepared a digital storyboard about the topic they determined.	TCK (Technological Content Knowledge)
Week 7	f. Determining a digital story evaluation rubric	The "Digital Story Evaluation Rubric" developed by Çıralı-Sarıca and Koçak-Usluel (2016) was introduced, and information was given about the criteria.	TPK (Technological Pedagogical Knowledge)
	2. Before Production:		
Week 8	a. Identifying the necessary elements (visual, sound, text, music) in the digital story (Ohler, 2013).	All visuals, texts, and music, as well as the science subject they will use in their digital stories, were determined by the pre-service teachers.	TCK (Technological Content Knowledge)
Week 9	b. Creating visual content to be used in the story	For their stories, pre-service teachers completed the drawing of both their characters and all their scenes using Web 2.0 tools Pixtoon / StoryboardThat/Toondoo and Microsoft Paint.	TK (Technological Knowledge)
	3. Production:		
Week 10 and 11	Creating the digital story through the appropriate program / software/application (Ohler, 2013).	They created their digital stories using Microsft Photo Story, StoryboardThat, and Powtoon programs. They used stories and visuals suitable for the development level of the group (primary school students) to be applied in the digital story creation process. They paid attention to use scientific knowledge correctly.	TPCK
	4. Presentation:		
Week 12	a. Presenting the prepared digital stories (Frazel, 2010).	At the end of the semester, all digital stories were presented in the classroom.	TPCK
Week 13	b. Receiving feedback after peer review and rearranging if necessary (Ohler, 2013).	Participants first evaluated their own digital stories and the application process, and then expressed their opinions about the use of content knowledge, pedagogy knowledge and technology knowledge of other friends' stories.	TPCK
	5. Sharing:		
Week 14	a. Deciding where and with whom the finalized digital stories will be shared. (Ohler, 2013).	They recorded their stories in mp4 format and shared it with researchers on their personal YouTube channels. They signed the "Voluntary Consent Form" and submitted it to the researchers so that the digital stories they prepared could be used and published within the scope of this research.	TK (Technological Knowledge)

Data Sources

In order to collect data in the research, TPACK confidence scale and semi-structured interview form were used.

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Technological Pedagogical Content Knowledge Confidence Scale. In the study, "Technological Pedagogical Content Knowledge Confidence Scale" developed by Graham et al. (2009) and adapted to Turkish by Timur and Taşar (2011), was used as pre-test and post-test. TPACK Confidence scale is a scale with four dimensions consisting of combinations of technology, pedagogy, and content knowledge. The scale has 8 items in the Technological Pedagogical Content Knowledge (TPCK) dimension (items 1-8), 7 items in the Technological Pedagogical Knowledge (TPK) dimension (items 9-15), 5 items in the Technological Content Knowledge (TCK) dimension (items 16-20), and 11 items in the Technological Knowledge (TK) dimension (items 21-31) with a total of 31 items. While the highest score that pre-service teachers could get from the scale, which is adapted as a 5-point Likert type, was 186, the lowest score was 26. The internal consistency coefficients of the Cronbach's Alpha reliability values for the sub-dimensions of the scale range from .786 to .925, and .919 for the overall scale. These values make consistent measurements within themselves, and the internal consistency is highly reliable (Kalaycı, 2010).

Semi-Structured Interview Form. In preparation for the interviews, a semi-structured interview form was prepared, and this form was used as a guide by the interviewer (See Appendix 3). 4 of the 24 volunteer pre-service teachers participating in the research were randomly chosen and their opinions regarding the digital stories they prepared were taken. The interviews, which lasted approximately 20-25 minutes, were conducted online. Researchers and an experienced expert working on qualitative research made separate coding on the data obtained from the interviews, and the consistency rate was calculated by comparing the coding. The resulting codes were divided into similar and divergent codes. According to the Miles and Huberman (1994) formula, the reliability between the coders was calculated as 88%. The fact that the Miles-Huberman reliability formula value is more than 70% indicates that researchers' coding is reliable. There was also a consistency between the codes and themes determined by the researchers.

Data Analysis

The SPSS 22.0 package program was used to analyze the quantitative data obtained from the Technological Pedagogical Content Knowledge Confidence Scale. Shapiro-Wilk test was used with skewness values to determine whether the study group showed a normal distribution after data entry. According to the results, *p* value was larger than .05 and the skewness value was between -1 and +1 (Skewness = 0.36). Accordingly, the study group had a normal distribution, and parametric tests were used in the analysis of the data. The paired-samples *t*-test was used to test whether the pretest and posttest average scores of the pre-service teachers' digital story-making experiences regarding the self-confidence in TPACK and the sub-dimensions of the TPACK differ.

Research Results

Quantitative Results

Self-confidence of Primary School Teacher Candidates about TPACK

The findings regarding the pretest-posttest average scores of the pre-service teachers' scientific digital story-making experiences regarding their self-confidence in TPACK are given in Table 3.

Table 3
Pre-test-Post-test Average Scores of the Pre-service Primary School Teachers' Self-confidence in TPACK

Dimensions	Tests	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
TK	Pre-test	24	42.21	8.582	-3.005	23	.006
	Post-test	24	48.79	5.485			
TCK	Pre-test	24	16.46	4.836	-2.029	23	.054
	Post-test	24	19.21	3.945			

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Dimensions	Tests	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
TPK	Pre-test	24	26.33	5.577	-1.852	23	.077
	Post-test	24	28.71	3.641			
TPCK	Pre-test	24	27.25	6.152	-2.050	23	.052
	Post-test	24	30.54	5.013			
Total Score	Pre-test	24	112.25	20.484	-2.815	23	.010
	Post-test	24	127.25	14.959			

Note: In this research, TPCK was used as a sub-dimension of the scale, and TPACK was preferred when mentioning about the total score obtained from the scale.

According to Table 3, there is a significant difference between the pre-test and post-test mean scores of pre-service teachers' scientific digital story-making experiences in only the TK sub-dimension of the TPACK Confidence scale [$t(23)=-3.005$, $p<.05$]. There was no significant difference between the pretest-posttest mean scores in the other sub-dimensions [$t(23)=-2.050$, $p>.05$; $t(23)=-1.852$, $p>.05$; $t(23)=-2.029$, $p>.05$]. In terms of the total score obtained from the scale, there was a significant difference between the pre-test and post-test mean scores [$t(23)=-2.815$, $p<.05$]. While the average of the pre-test scores before the application was $\bar{X}=112.25$; after the application, the average of the post-test scores increased to $\bar{X}=127.25$. This finding shows that practice has a positive effect on the pre-service teachers' self-confidence in TPACK and it is due to the TK sub-dimension.

Qualitative Results

Detailed information about the digital stories prepared by the pre-service teachers is presented in Appendix 1. In addition, there are sample scenes and story texts from the digital stories in Appendix 2. Links to the scientific digital stories that 2 pre-service teachers uploaded to their personal YouTube channel were also provided. In general, pre-service teachers created their digital stories about the *sense organs, the natural and artificial environment, the importance of our environment being clean, the movements of the Earth, the Sun and the Moon, the shape of the Earth, the states of matter, light and sound, force, and nutrients*. At the same time, pre-service teachers made applications in internship schools with the digital stories they prepared. 4 of the 24 pre-service teachers who participated in the research were randomly selected and their opinions were consulted.

In terms of Technological Knowledge (TK)

In the quantitative findings of the study, there was a significant difference in the self-confidence of the pre-service teachers, especially in terms of TK. Similarly, positive opinions especially in terms of TK draw attention in qualitative findings. All of the pre-service teachers stated that their technology knowledge proficiency has improved thanks to the digital story creation process. During this period of self-assessment, they especially faced difficulties in "*finding and using appropriate Web 2.0 tools*", "*having language problems while using programs*" (due to the fact that programs are usually in English), "*utilizing programs with different interfaces*", "*limitations of programs because they charge fees*" and mentioned the contributions of this process to them. The opinions of some pre-service teachers on this subject are as follows:

> ***T4:*** *When we looked at the technological knowledge while creating the story, yes, I had this. I started to use the computer programs (Word, PowerPoint, Excel) in my primary school years. I was fast. But what I have, more precisely, what we lack is that we were lacking in digital education... I realized that I knew very traditional programs. I am always grateful to my teacher for this. ... In terms of technology, I have developed myself a lot in terms of programs (software used in the digital story) and I am still developing it. … As a limitation, of course, this is technology… There may be problems with the computers we use, important points of some programs may be that they charge fees, etc.*

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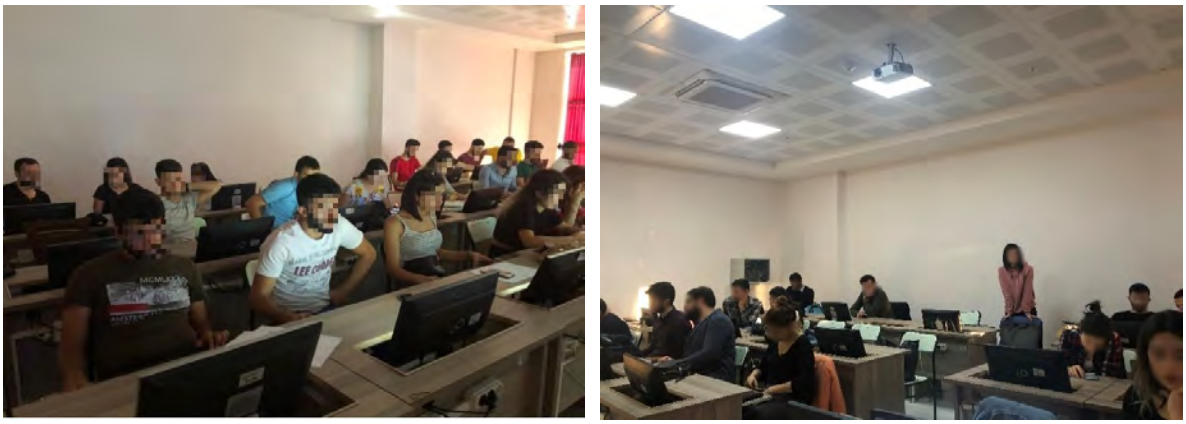
Figure 1
Pre-service Teachers Using Web 2.0 Tools and Digital Story Programs in the Computer Lab



Another pre-service teacher stated her opinion as follows:

> **T2:** *...The process definitely improved my technology knowledge. I realized how simple and superficial I used technology. I saw the multiple richness offered by technology and how useful they can be in teaching with the theory of multiple intelligences.*

In terms of Technological Pedagogical Knowledge (TPK)

Although there was no statistically significant difference in the quantitative analysis regarding the TPK, the qualitative findings obtained from the pre-service teachers showed that the digital story creation process also has positive effects in the TPK dimension. Pre-service teachers stated that the process of creating digital stories improved creativity and cooperation; individual differences were addressed with digital stories; different strategies, methods and techniques were needed in the process of developing and using digital stories; and it had a positive effect on classroom management and student motivation. Opinions of T2 and T4 on this subject are given below.

> ***T2:*** *What I can say about the digital stories is that, first, creativity was the biggest opportunity because in this process, creating a story scenario, creating visuals, using which sound and which tone, these phases are all parts that develop creativity. Thanks to the digital story, both visual elements and sound elements are used, so it appeals to individual differences. It is more professional than traditional methods. It also enhances collaboration. Since we use many phases at the same time on a single screen, it accelerates the practicality of executing the process and provides coordination.*

> ***T4:*** *Digital story is defined as the combination of traditional storytelling and multimedia technologies, and based on this, I think it is appropriate for using digital story creation in science lessons. Since it is a very comprehensive study, the person doing the study needs to use many methods and techniques. This has a positive effect on what we call individual difference in the classroom. It is much easier to provide classroom management as it attracts the attention of children auditory and visually. In general, I can say that this method (digital story) positively affects students' motivation and creative thinking skills.*

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Figure 2
The Image of Pre-service Teachers Teaching Students with Digital Stories in the Schools where they Did Internship (TPK)

In Terms of Technological Content Knowledge (TCK)

Although there was no statistically significant difference in the quantitative analysis regarding the TCK, the pre-service teachers stated that digital stories should be used in teaching some science subjects, and they stated that digital storytellers should have science content knowledge.

> ***T4:*** *Frankly, since it is a somewhat arduous process, I find it appropriate to use this in some subjects, not at every stage, where we say it would be good if we used it.*

> ***T1:*** *Science is a very comprehensive course. I think that the person who created (the digital story) should have a good understanding of the subject, pay attention to the concepts, and know the content well.*

> ***T3:*** *It is very efficient for non-applied objectives such as "Explains the relationship between living life and nutrient contents." While explaining more abstract topics such as protein, vitamins, and carbohydrates to students, the digital stories can make it easier for them to both watch and learn, like they watch a movie, rather than lectures or question and answer methods.*

Figure 3
Screenshot of One of the Scientific Digital Stories Regarding the TCK Prepared by Pre-service Teachers Using Powtoon and Pixton Programs

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In Terms of Technological Pedagogical Content Knowledge (TPCK)

In the quantitative dimension of the study, there was no statistically significant difference in the quantitative analysis regarding the TPCK. However, the findings obtained from pre-service teachers show that the digital story creation process had a positive effect on the TPCK sub-dimension.

> ***T2:*** *The thing I like most about digital stories is that they are very educational, and I think they should be applied for every lesson and objective. I think it is very effective especially in attracting students' attention and giving the desired message. It will also definitely improve students' ICT skills. While preparing these stories, I realized that I could have more control over technology. From a pedagogical point of view, it will be an instructive application that will easily attract the attention of students and make the lesson more enjoyable. It will be very difficult to prepare for every lesson, as it takes a process and effort to prepare rather than being limited. It intrigues me, and frankly, it makes me more involved and interested. It has a very interesting effect. Lecture and memorization do not work in all lessons, especially in science lessons, more visual and observation-based things should be used in these lessons.*

Figure 4
Image of Teaching a Science Subject with a Digital Story (TPCK)

Discussion

In this research, the effect of digital stories created by pre-service primary school teachers on their self-confidence in TPACK, especially for TK, TPK, TCK, and TPCK sub-dimensions, were examined. According to the results of the research, the digital stories created according to the science curriculum objectives have a positive effect on the TPACK confidence of the pre-service primary school teachers. The quantitative results of the research revealed that such stories have led to the development of pre-service primary school teachers' technological knowledge (TK). The development of pre-service primary school teachers' ability to use technology also led to an increase in the total score of TPACK. The fact that digital stories increase pre-service teachers' self-confidence in technology knowledge has also been supported by some studies in the literature. Dogan (2012), Eguz (2020), and Seckin-Kapucu and Yurtseven-Avci (2020) stated that digital stories increase students' ability to use technology. Sancar-Tokmak et al. (2014) found that digital stories they made with pre-service science teachers increased the technological knowledge dimension of TPACK and accordingly the TPACK total score. Sancar-Tokmak and Yanpar-Yelken (2015) stated that the use of digital stories had a positive effect on pre-service teachers' self-confidence in TPACK, and especially their technological pedagogical knowledge and technological knowledge scores improved significantly. In the literature, it has been determined that the technology use skills of teachers and preservice teachers have increased (Brown & Warschauer 2006; Ersanlı, 2016; Graham et al., 2009; Kildan & Incikabi, 2015; Sancar-Tokmak, 2015). Heo (2009) found that digital stories increase pre-service teachers' educational technology competencies and self-confidence. These findings support Graham et al. (2009)'s idea that self-confidence in Technology Knowledge

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(TK) is the basis for improving self-confidence in the other three types of knowledge. Erdoğdu and Çakır (2020) stated in their study that they investigated the digital story creation experiences of pre-service teachers and stated that the pre-service teachers were confident in the use of digital story creation, and they found themselves sufficient in this regard. Alabbasi (2018) emphasized that creating digital stories gave teachers a positive perception of technology integration. In the study of Dewi (2016), primary school teachers who integrated digital stories into the lesson plan improved their TPACK levels and teachers had positive opinions about these practices.

According to the qualitative results of this research, the use of digital stories in science education had a positive effect on the dimensions of TK, TCK, TPK and TPCK of pre-service primary school teachers. When the literature is examined, similar findings related to the positive contributions of the use of digital stories to the TPACK self-confidence were found. Wang (2016) found that there was a statistically significant difference in favor of the experimental group in terms of TK, TCK, TPK, TPCK and TPACK total score dimensions of the TPACK scale in the experimental group in which digital stories were used. Clark (2017) revealed that developing digital stories contributes to teachers' improvement in all sub-dimensions of TPACK.

Both quantitative and qualitative results of this research showed that digital stories had a positive effect on TK and TPACK total scores. For this reason, in order for teachers to realize effective technology integration, they need to understand how to shape the teaching practices in which the components of TPACK are embedded. In this way, their self-confidence in TPACK will also improve (Voogt & McKenney, 2017). According to the results obtained in the TPK sub-title of the qualitative dimension, designing and applying digital stories contributes to the development of pre-service teachers' pedagogical knowledge such as creativity, cooperation, motivation, classroom management and taking into account individual differences. The literature indicates that the use of digital stories improves creativity (Ohler, 2008; Wu & Yang, 2008) and collaboration (Robin, 2006; Sadik, 2008); individual differences are addressed with digital stories (Sylvester & Greenidge, 2009; Yüksel, 2011); different strategies, methods and techniques are needed in the process of creating and using digital stories; and it has a positive effect on classroom management and student motivation (Morgan, 2014; Smeda et al., 2014; Turan & Sezginsoy Şeker, 2018; Ware & Warschauer, 2005; Yang & Wu, 2012). According to the results obtained in the TCK sub-title of the qualitative dimension, pre-service teachers stated that digital stories should be used in teaching some science subjects and they stated that digital storytellers should have knowledge of science. This result contains similar results with the study of Pekmezci (2014), Ulum and Ercan-Yalman (2018). Kiray et al. (2018) revealed that science teachers' content knowledge directly affects their technological content knowledge. These findings reveal that content knowledge is important in digital story development. Since the science curriculum is designed with the wide-area design approach, the self-efficacy perceptions of science teachers towards physics, chemistry, biology, astronomy, and earth sciences that make up the science lesson differ. Teachers feel strong in some of these areas and weak in others. Teachers have difficulties in teaching the areas where they feel inadequate (Sari & Kiray, 2021). For this reason, it is important for science teachers and pre-service teachers to pay attention to the content knowledge in the use of digital stories.

In addition to the positive effect of using digital stories on the pre-service primary school teachers' self-confidence in TPACK, in the qualitative findings, they stated that they had some problems in TCK and TK dimensions (not being able to find images due to copyright, not being able to create a scenario suitable for the outcome, difficulty in vocalizing, long duration, difficulty in using/finding a computer/program, and not being able to find suitable background music, etc.). The difficulties faced by pre-service primary school teachers in the digital story creation process were paralleled by Sancar-Tokmak et al. (2014) and Kildan and Incikabi (2015).

Conclusions and Implications

The quantitative findings of this study revealed that developing digital stories and using digital stories in lessons resulted in a statistically significant increase in the TK and TPACK total scores of pre-service teachers. Although there was no statistically significant difference in the dimensions of TCK, TPK, and TPCK in quantitative findings, qualitative findings revealed a positive development in these dimensions. The qualitative findings of the study also showed that digital story development and application studies contributed positively to the development of pre-service primary school teachers' pedagogical knowledge such as creativity, cooperation, motivation, classroom management, and taking into account individual differences.

The qualitative findings of the study showed that along with the positive aspects of the use of digital stories, some difficulties were encountered in practice. In addition to technological difficulties such as difficulties encountered in vocalizing digital stories, difficulties in using/finding computers/software, and difficulties in using

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digital story development software in the process of creating digital stories, the pre-service teachers experienced problems such as not being able to find images due to copyright, difficulties in creating scenarios suitable for the objectives, the length of the process of creating digital stories, and the difficulties encountered in finding suitable background music.

In the light of these results of the research, although there are some difficulties in developing digital stories, such stories can be used in teacher training programs because they are effective in improving pre-service teachers' TPACK self-confidence. Finally, it can be recommended that teachers increase the effectiveness of their lessons by using digital stories in their lessons.

Limitations

This research is limited to the TPACK confidence scores of pre-service teachers studying at a state university in Turkey in the 2019-2020 fall semester and their views on digital story creation.

Declaration of Interest

Authors declare no competing interest.

References

Alabbasi, D. (2018). The design and application of a digital storytelling process model to enhance teachers' understanding of TPACK and foster positive attitudes toward teaching with technologies. *International Journal of Technology Enhanced Learning, 10*(4), 309-328 https://doi.org/10.1504/IJTEL.2018.095142

Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: Students' experiences in learning to integrate technology in instruction. *Journal of Technology and Teacher Education, 14*(3), 599–621.

Calik, I., & Seckin-Kapucu, M. (2021). The effect of digital story-supported science practices on the scientific attitudes of 7th-grade students. *The Eurasia Proceedings of Educational and Social Sciences, 21*, 1-14. https://doi.org/10.55549/epess.1040437

Clarke, A. M. (2017). A place for digital storytelling in teacher pedagogy. *Universal Journal of Educational Research, 5*(11), 2045-2055. https://doi.org/10.13189/ujer.2017.051121

Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Çıralı-Sarıca, H., & Koçak-Usluel, Y. (2016). Digital storytelling in the educational context: A rubric development study. *Educational Technology Theory and Practice*, *6*(2), 65-84. https://doi.org/10.17943/etku.12600

Dewi, F. (2016). Digital storytelling project: An alternative to develop English teachers' technological pedagogical and content knowledge (TPACK). *SPaCE Edu Journal, 2*(1), 16–40.

Doğan, M. (2012). Prospective Turkish primary teachers' views about the use of computers in mathematics education. *Journal of Mathematics Teacher Education, 15*, 329-341. https://doi.org/10.1007/s10857-012-9214-3

Eguz, S. (2020). The use of digital storytelling in the education of social studies teacher candidates. *The Eurasia Proceedings of Educational and Social Sciences, 18*, 55-58. http://www.epess.net/en/pub/issue/58018/831234

Erdogan, N., & Stuessy, C. L. (2022). Applying an ecology metaphor in a mixed methods analysis of high school science program infrastructure. *Journal of Education in Science, Environment and Health, 8*(1), 86-97. https://doi.org/10.21891/jeseh.1029468

Erdoğdu, F., & Çakır, Ö. (2020, December 12-13). *Digital story development: A study with pre-service mathematics teachers.* Paper presented at the 9th International Scientific Research Congress-Social and Educational Sciences, Ankara, Turkey.

Ersanlı, C. Y. (2016). Improving technological pedagogical content knowledge (TPACK) of pre-service English language teachers. *International Education Studies, 9*(5), 18-27. https://doi.org/10.5539/ies.v9n5p18

Frazel, M. (2010). *Digital storytelling guide for educators.* Paper presented at the International Society for Technology in Education (ISTE).

Gölcük, A. (2017). *The effects of science education supported by scientific stories on students' creativity and affective characteristics* [Unpublished masters' thesis]. Hacettepe University.

Graham, C., Cox, S., & Velasquez, A. (2009). Teaching and measuring TPACK development in two preservice teacher preparation programs. In I. Gibson, R. Weber, K. McFerrin, R. Carlsen & D. Willis (Eds.), *Proceedings of SITE 2009--Society for Information Technology & Teacher Education International Conference* (pp. 4081-4086). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/p/31297

Graham, R. C., Burgoyne, N., Cantrell, P., Smith, L., St Clair, L., & Harris, R. (2009). Measuring the TPACK confidence of in-service science teachers. *TechTrends, 53*(5), 70-79. https://doi.org/10.1007/s11528-009-0328-0

Heo, M. (2009). Digital storytelling: An empirical study of the impact of digital storytelling on pre-service teachers' self-efficacy and dispositions towards educational technology. *Journal of Educational Multimedia and Hypermedia, 18*(4), 405-428.

ISTE (International Society for Technology in Education). (2015). *About ISTE*. https://www.iste.org/about/about-iste

Jacobs, H. H. (2010). *Curriculum 21: Essential education for a changing world*. ASC.

https://doi.org/10.33225/jbse/22.21.207

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Jakes, D. S., & Brennan, J. (2005). *Capturing stories, capturing lives: An introduction to digital storytelling.* http://www.jakesonline.org/dstory_ice.pdf

Kalaycı, Ş. (2010). *SPSS Applied multivariate statistics techniques.* Asil Yayın Dağıtım.

Kartal, T., & Dilek, I. (2021). Preservice science teachers' TPACK development in a technology-enhanced science teaching method course. *Journal of Education in Science, Environment and Health, 7*(4), 339-353. https://doi.org/10.21891/jeseh.994458

Kiray, S. A., Celik, I., & Colakoglu, M. H. (2018). TPACK Self-Efficacy perceptions of science teachers: A structural equation modeling study. *Education and Science, 43*(195), 253-268. http://dx.doi.org/10.15390/EB.2018.7538

Kildan, A. O., & Incikabi, L. (2015). Effects on the technological pedagogical content knowledge of early childhood teacher candidates using digital storytelling to teach mathematics. *Education, 3-13, 43*(3), 238-248. https://doi.org/10.1080/03004279.2013.804852

Kocoglu, E. (2021). The effect of digital learning environments on the learning teaching process. *The Eurasia Proceedings of Educational and Social Sciences, 20*, 96-100. https://doi.org/10.55549/epess.1038715

Koehler, M., & Mishra, P. (2008). Introducing TPACK. In AACTE Committee on Innovation and Technology (Eds.), *The handbook of technological pedagogical content knowledge for teaching and teacher educators* (pp. 3-29). Lawrence Erlbaum Associates, Publishers.

Koyunlu-Unlu, Z., & Dokme, I. (2020). The effect of technology-supported inquiry-based learning in science education: Action research. *Journal of Education in Science, Environment and Health, 6*(2), 120-133. https://doi.org/10.21891/jeseh.632375

Mazman, S. G., & Usluel, Y. K. (2011). ICT integration into learning-teaching process: Models and indicators. *Educational Technology Theory and Practice, 1*(1), 62-79. https://dergipark.org.tr/tr/pub/etku/issue/6274/84241

McGraw-Hill Education. (2018). *What is TPACK theory and how can it be used in the classroom?* https://www.mheducation.ca/blog/what-is-tpack-theory-and-how-can-it-be-used-in-the-classroom/

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

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

MoNE (Ministry of National Education) (2018). *Turkish Science Curriculum*. https://mufredat.meb.gov.tr/Dosyalar/201812312311937FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf

Morgan, H. (2014). Using digital story projects to help students improve in reading and writing. *Reading Improvement, 51*(1), 20-26.

Ohler, J. (2008). *Digital storytelling in the classroom: New media pathways to literacy, learning, and creativity.* Corwin Press.

Ohler, J. (2013). *Digital storytelling in the classroom. New media pathways to literacy, learning, and creativity* (2nd ed.). Sage Publications.

Pedró, F. (2006). *The new millennium learners: Challenging our views on ICT and learning.* Inter-American Development Bank.

Pekmezci, S. (2014). *Effects of short stories reinforced with information technology on students' success, their self-efficacy and their attitudes towards science* [Unpublished masters' thesis]. Pamukkale University.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon, 9*(5), 1-6.

Robin, B. R. (2006). *The educational uses of digital storytelling.* Paper presented in Society for Information Technology & Teacher Education International Conference (pp. 709-716). Association for the Advancement of Computing in Education (AACE).

Robin, B. R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory into Practice, 47*(3), 220-228. https://doi.org/10.1080/00405840802153916

Sadik, A. (2008). Digital Storytelling: A meaningful technology-integrated approach for engaged student learning. *Educational Technology Research and Development, 56*, 487-506. http://dx.doi.org/10.1007/s11423-008-9091-8

Sancar-Tokmak, H. (2015) Pre-service teachers' perceptions on TPACK development after designing educational games. *Asia-Pacific Journal of Teacher Education, 43*(5), 392-410, https://doi.org/10.1080/1359866X.2014.939611

Sancar-Tokmak, H., Surmeli, H., & Ozgelen, S. (2014). Preservice science teachers' perceptions of their TPACK development after creating digital stories. *International Journal of Environmental and Science Education, 9*(3), 247-264. https://doi.org/10.12973/ijese.2014.214a

Sancar-Tokmak, H., & Yanpar-Yelken, T. (2015) Effects of creating digital stories on foreign language education pre-service teachers' TPACK self-confidence. *Educational Studies, 41*(4), 444-461, https://doi.org/10.1080/03055698.2015.1043978

Santos, J. M., & Castro, R. D. (2021). Technological Pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Sciences & Humanities Open, 3*(1), 100-110. https://doi.org/10.1016/j.ssaho.2021.100110

Sari, B., & Kiray, S. A. (2021). Self-efficacy perceptions of science teachers regarding content knowledge. *MIER Journal of Educational Studies Trends and Practices, 11*(1), 85-102. https://doi.org/10.52634/mier/2021/v11/i1/1756

Seckin-Kapucu, M., & Yurtseven-Avci, Z. (2020). The digital story of science: Experiences of pre-service science teachers. *Journal of Education in Science, Environment and Health, 6*(2), 148-168. https://doi.org/10.21891/jeseh.689444

Shelton, C., Archambault, L., & Hale, A. (2017). Bringing digital storytelling to the elementary classroom: Video production for preservice teachers. *Journal of Digital Learning in Teacher Education, 33*(2), 58-68. https://doi.org/10.1080/21532974.2016.1276871

Smeda, N., Dakich, E., & Sharda, N. (2014). The effectiveness of digital storytelling in the classrooms: A comprehensive study. *Smart Learning Environments, 1*(1), 1-21. https://doi.org/10.1186/s40561-014-0006-3

Sylvester, R., & Greenidge, W. L. (2009). Digital storytelling: Extending the potential for struggling writers. *The Reading Teacher, 63*(4), 284-295. https://doi.org/10.1598/RT.63.4.3

Timur, B., & Taşar, M. F. (2011). The adaptation of the technological pedagogical content knowledge confidence survey into Turkish. *Gaziantep University Journal of Social Sciences, 10*(2), 839-856.

https://doi.org/10.33225/jbse/22.21.207

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Topal, M., Guven-Yildirim E., & Onder, A. N. (2020). Use of educational films in environmental education as a digital learning object. *Journal of Education in Science, Environment and Health, 6*(2), 134-147. https://doi.org/10.21891/jeseh.703492

Turan, T., & Sezginsoy-Şeker, B. (2018). The effect of digital stories on fifth-grade students' motivation. *Journal of Education and Future,* (13), 65-78.

Turk, H., & Seckin-Kapucu, M. (2021). Innovative technology applications in science educations: Digital holography. *Journal of Education in Science, Environment and Health, 7*(2), 156-170. https://doi.org/10.21891/jeseh.748662

Ulum, E., & Ercan Yalman, F. (2018). Examining the effects of preparing digital storytelling in science and technology course on the academically inadequate students spending much time on computers. *Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education, 12*(2), 306-335.

Voogt, J., & McKenney, S. (2017). TPACK in teacher education: Are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education, 26*(1), 69-83. https://doi.org/10.1080/1475939X.2016.1174730

Wang, A. Y. (2016). The impact of digital storytelling on the development of TPACK among student teachers in Taiwan. In Herring, M.C., Koehler, M.J. & Mishra, P. (Eds). *The handbook of technological pedagogical content knowledge (TPACK) for educators*, 297-308. Routledge Press.

Ware, P. D., & Warschauer, M. (2005). Hybrid literacy texts and practices in technology-intensive environments. *International Journal of Educational Research, 43*(7-8), 432-445. https://doi.org/10.1016/j.ijer.2006.07.008

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Open University Press.

Wu, W. C., & Yang, Y. T. (2008). *The impact of digital storytelling and of thinking styles on elementary school students' creative thinking, learning motivation, and academic achievement*. Paper presented in Society for Information Technology & Teacher Education International Conference (pp. 975-981). Association for the Advancement of Computing in Education (AACE).

Yang, Y. T. C., & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study. *Computers & Education, 59*(2), 339-352. https://doi.org/10.1016/j.compedu.2011.12.012

Yüksel, P. (2011). *Using digital storytelling in early childhood education a phenomenological study of teachers' experiences* [Unpublished doctoral dissertation]. Middle East Technical University. https://open.metu.edu.tr/handle/11511/21182

Appendix 1

Information on Digital Stories Prepared by Pre-service Teachers

Partici-pants	Story Title	Related science subject	Program used/application/hand drawing
P1	Emre's Disease	Maintaining the health of the sense organs	Pixton, Microsoft photostory 3
P2	Curious Elif and the Fireflies	Natural and artificial light sources	Pixton, Microsoft photostory 3
P3	Importance of the Eye	Importance of eye in sense organs	Pixton, Microsoft photostory 3
P4	Wise Laws	What is the importance of saving in preventing the depletion of resources?	Pixton, StoryboardThat, Microsoft photostory 3
P5	Two-Buddy Travelers	Natural and artificial light sources around us Light and sound	StoryboardThat, Microsoft photostory 3
P6	Legendary Cleanliness Şenköy	Environment Living environment, environmental cleaning, nature, garden Dramatic question: Does environmental pollution only harm people?	StoryboardThat, Microsoft photostory 3
P7	Summer Burn	Protecting the health of the sense organs-skin burn condition	Pixton, Microsoft photostory 3
P8	Beautiful Friendship of Sun and Earth	Events that occur as a result of the movements of the Earth	Pixton, Microsoft paint, Microsoft photos-tory 3
P9	Talking Foods	Nutrients	StoryboardThat, Microsoft photostory 3
P10	A Clean World for Everyone	Environmental cleaning, garbage, waste, nature, environmen-tal pollution	StoryboardThat, Microsoft photostory 3
P11	Büşra's One Day	Change of state of matter under the influence of heat	StoryboardThat, Microsoft photostory 3

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Partici-pants	Story Title	Related science subject	Program used/application/hand drawing
P12	Camping Adventure	Environmental cleaning	StoryboardThat, Microsoft photostory 3
P13	Snowman	Beings around us	StoryboardThat, Microsoft photostory 3
P14	Our Environment	Natural and artificial environment	StoryboardThat, Microsoft photostory 3
P15	Shining Friendships	Simple electrical circuit	Hand-drawn
P16	Amusement Park Excite-ment	Force Movement properties of beings; characterized as fast, slow, rotating, swinging, and changing direction.	Pixton, Powtoon
P17	Cherry Jam	Living and inanimate objects	StoryboardThat, Microsoft photostory 3
P18	All Around the World in Every Moment	States of matter as solid-liquid-gas	StoryboardThat, Microsoft photostory 3
P19	I Heard Your Voice I Found You	Sound	StoryboardThat, Microsoft photostory 3
P20	Jungle Adventure	Sense organs	StoryboardThat, Microsoft photostory 3
P21	Space Travel	Shape of the Earth	StoryboardThat, Microsoft photostory 3
P22	Journey of the Water Drop	States of water	Pixton, Mirsoft paint and photostory 3
P23	A Warm Winter's Tale	Heating-melting of matter	StoryboardThat, Microsoft photostory 3
P24	If the electricity is cut off	Lighting technologies from past to present, importance of lighting tools	Pixton, Microsoft photostory 3

Appendix 2

Sample Images from Applications
Sample images and story content of P16
Story Title: Amusement Park Excitement,
The related objective in the science program: "Movement properties of beings; characterized as fast, slow, rotating, swinging, and changing direction."
Programs used: Pixton, Powtoon

Scene 3	Scene 4
	

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Scene 3	Scene 4
Scene Description: Emine was very happy with her mother's offer to play. Her father also listens to Emine and her mother with pleasure.	**Scene Description:** The family has arrived at the amusement park. Emine excitedly comments on the carousel and is happy to think she has won the movie award-winning game. Her mother laughs and says she hasn't won yet.
Narration of the Story: Emine said "Yes". Her mother said, "Well, let's play a game with you. If you know what movements the toys do when we go to the amusement park, we will go to the movies with you next week". Emine was very happy about this. Because she had listened to the teacher very well.	**Narration of the Story:** In the meantime, they had arrived at the amusement park. The first thing that caught Emine's attention was a huge carousel. She turned to her mother excitedly and said, "Mother, this carousel is spinning. Didn't I know? Are we going to the movies?" Her mother replied with a laugh, "Wait, you haven't explained it all yet."

Appendix 3

Interview form

Dear Participant,
The purpose of the interview: To learn your experiences and feedbacks about the digital stories you have prepared for science teaching.
Introduction of the interview: You will be asked to answer various questions in order to identify the strengths and areas of development of the Digital Story application. You don't have to answer the questions. You can end the interview at any time.
Risks: Your participation in this interview does not involve any risk.
Confidentiality: Interviews will be held with all students participating in the application. The information obtained from the interviews will be separated from the personal information and brought together in the research article. These opinions will only be used as research data and will not be used or published for any other purpose.
Consent: I understand the purpose of this interview and how it will be conducted. By participating in this meeting, I agree to share my views on the digital story application. I know that I don't have to answer every question and that I can end the conversation at any time.

Semi-structured questions

1. Explain the process of creating a digital story according to the following headings.
   a. creating a story idea
   b. creating a storyboard
   c. writing a dramatic question
   d. character determination
   e. writing a script
   f. finding images
   g. writing the story text for each scene
   h. music and rhythm selection
   i. determining the people who will make the voice over
   j. finding Web 2.0 tools (programs)

2. a. According to which criteria did you determine your unit or subject?
   While creating your story text, did you start from a science subject that you dominate or from a subject that you do not know or are missing?
   b. How do you evaluate the story you wrote as a scientific story? -Content-Suitable for science curriculum etc.

3. Was your technological knowledge sufficient when creating the story? Has it improved? How did this process affect your knowledge of technology? What were the limitations and advantages of using technology (while using Web 2.0 tools)?

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4.

a) How would you evaluate the use of digital stories in science lessons from a pedagogical point of view (in terms of using appropriate methods-techniques, measurement/evaluation, classroom management and individual differences of students)?
b) Do you think you have succeeded in combining your pedagogical knowledge with the technology you use in preparing digital stories? Please explain.

5.

a) How would you evaluate the use of digital stories in science lessons from a content knowledge point of view?
b) Do you think you have succeeded in combining your content knowledge with the technology you use while developing a digital story? Please explain.

6.

a) What are your thoughts on creating digital stories by using technology, pedagogy and content knowledge for science subjects and teaching science subjects with these digital stories?
b) Do you think you can combine your technology, pedagogy and content knowledge while developing and applying digital stories? Please explain.

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