Journal of Qualitative Research in Education
Eğitimde Nitel Araştırmalar Dergisi

Creating Digital Storytelling as Digital Materials in Mathematics Education*

Emine Özgür Şen[1]

To cite this article:

Şen, E. Ö. (2024). Creating Digital Storytelling as Digital Materials in Mathematics Education. *Journal of Qualitative Research in Education,* 55-81. Doi: 10.14689/enad.40.1965

Abstract: The digitalization of stories through technology-supported software has created the concept of digital stories. In recent years, researchers have been making efforts to investigate the effects of digital stories that have started to be used as digital materials in education. This study aims to evaluate the digital stories created by preservice mathematics teachers for mathematics courses, their experiences in the process of creating digital stories, and their views on the use of digital storytelling as digital materials in mathematics courses. This qualitatively designed study was conducted with the participation of 49 preservice elementary mathematics teachers and lasted 7 weeks. It was found that the digital stories created by the participating preservice teachers were moderately acceptable. Participants characterized digital storytelling as materials that are interesting, support teaching, and provide visual richness. They also stated that they intended to use digital storytelling when they begin working as teachers. However, due to the time-consuming nature of the process, most participants stated that they would use ready-made digital stories instead of creating them themselves. Additionally, the results of this study provide information about the experiences of preservice teachers regarding the process of creating digital storytelling.

Keywords: Digital storytelling, Digital materials, Teacher education, Mathematics education.

About the Article

Received: May. 05, 2024

Revised: Sep. 13, 2024

Accepted: Oct. 29, 2024

Article Type:

Research

[1] * Part of this research was orally presented in International Symposium of Turkish Computer and Mathematics Education (TURKBILMAT-6) (Ankara, 28-30 October 2023).

[1] Assoc. Prof. Dr., Yozgat Bozok University, Faculty of Education, senozgur@yahoo.com

Introduction

Technological developments make it possible to use digital materials in educational environments. Digital materials provide educators and students with opportunities to improve their knowledge and skills, thus increasing educational standards (Smeda et al., 2014). Particularly since the outbreak of COVID-19, the contribution of digital materials to education has become increasingly important, and people have become more conscious about the use of digital materials. The range of digital materials is considerably wide (Schneider et al., 2022). One type of digital material used in education is digital storytelling (DS). Although DS are mostly associated with arts and humanities, they can also be used as effective teaching materials in quantitative courses such as mathematics (Sadik, 2008; Wu & Chen, 2020).

Digital Storytelling

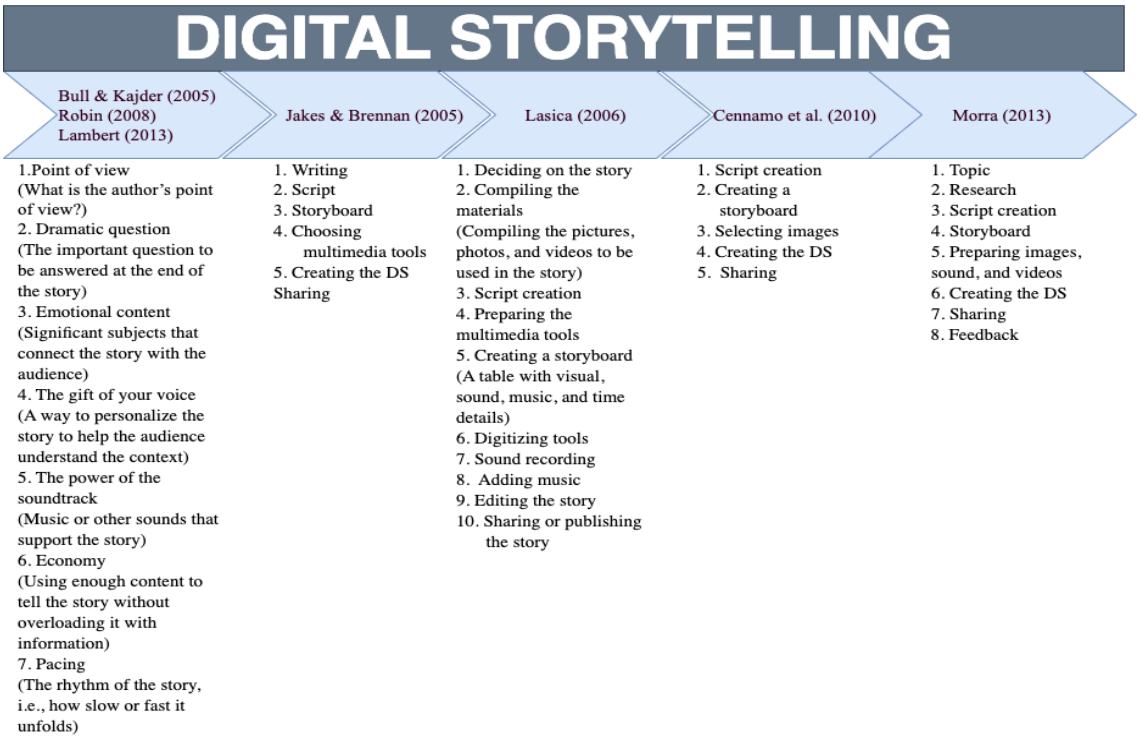
DS entails the presentation of a story on a certain topic in a digital environment (Çetin, 2021; Kobayashi, 2012) or, in other words, the enrichment of a story through the use of multimedia tools (Yilmaz & Durak, 2018). The concept of digital storytelling (DS) is based on combining the art of storytelling with various digital multimedia resources, such as images, audio, and video. DS combine text, audio, video, graphics, and music to present information about a particular topic using technology (Chung, 2007; Robin, 2006, 2008; O'Byrne et al., 2018). DS can also be described as tools for individuals to convey their feelings and thoughts (Kocaman-Karoglu, 2016; Ng, 2015) or to convey complex concepts through both linguistic and non-linguistic means (Kim & Li, 2021; Kim et al., 2021).

Digital storytelling (DS) is based on the traditional concept of storytelling, bearing both similarities and differences to it. Similar to traditional stories, DS are created around a chosen theme or topic. They focus on a specific point of view. They can be written to tell about a personal event, to relate a historical event, or to provide information on a particular topic (Robin, 2006, 2008). DS involve traditional story-making processes such as choosing a topic, conducting research, writing a script and turning it into an interesting story, brainstorming, and creativity (O'Byrne et al., 2018; Saritepeci, 2021; Robin, 2008). The difference between DS and traditional stories is that DS are supported by various digital multimedia tools (O'Byrne et al., 2018). DS can be created at a basic level without using any additional technology, or they can be enriched by using different applications and software (Yilmaz & Sığirtmaç, 2023). The latter typically involves the combination of narratives in short video format of 2-6 minutes (Jakes & Brennan, 2005; McLellan, 2007; Ng, 2015; Kim et al., 2021; Kocaman-Karoglu, 2016), usually consisting of 20-25 images, with still images and occasionally animated images and music (McLellan, 2007). The short and concise structure of DS eliminates the text and word complexity of traditional stories (Kim et al., 2021). It is important to choose the appropriate technological tools according to the subject content of DS (Yilmaz & Durak, 2018). Many digital tools are used for creating DS. PowToon, Slidely, Storybird, Puppet Pals, Movie Maker, PowerPoint, Tellagami, StoryJumper, iMovie, and GoAnimate are

among the most popular ones. These tools offer many options to users who want to create DS, such as recording their own voices and music, using ready-made visuals as well as pre-existing visuals of their choice, and drawing (Büyükkarcı & Müldür, 2022). DS can be uploaded to websites or printed (Robin, 2008). Sharing the final product of the creative process offers the opportunity to communicate with peers, colleagues, administrators, and parents (Kim et al., 2021). Moreover, digital tools are inexpensive and widely accessible, which makes DS both personal and universal at the same time. Therefore, DS are powerful learning and communication tools (Chang & Chu, 2022; Sadik, 2008; McLellan, 2007).

There is no clear theoretical framework for DS used to enhance technology effectiveness in the classroom (Robin, 2008; Smeda et al., 2010). In general, the process of creating DS consists of two dimensions. The first dimension is the creation of the story within a given context and the script-writing stage, and the second dimension is the stage of using technology integration within the framework of the established script (Saritepeci, 2021; Wang & Zhan, 2010; Büyükkarcı & Müldür, 2022). In the literature, different researchers have categorized the DS creation process within different dimensions (Figure 1). Robin (2008) focused on seven elements identified by the Center for Digital Storytelling (2005). These elements constitute the seven elements of DS, which are considered the starting point for working on a DS. Cennamo et al. (2010) described the process of DS creation in five stages. Lasica (2006), on the other hand, outlined a ten-stage process by describing the elements of a DS in a broader scope. When the stages of DS creation are examined, it is seen that the most basic elements of DS are having a point of view and a purpose for the story; writing a script suitable for the story; selecting audio, video, and music suitable for the script; and creating and sharing the DS.

Figure 1. Stages of creating a DS



Digital Storytelling in Education

DS are used in almost every aspect of life, from health to museums and from commerce to human resources. Perhaps one of the most important areas where DS are used the most is education. It is possible to see the use of DS at every level of education, from preschool to university, and in many disciplines (Ciğerci & Yıldırım, 2023; Nunvářová et al., 2022; Wu & Chen, 2020). Wang and Zhan (2010) emphasized that DS are becoming powerful learning materials in educational settings and an effective way to draw the attention of both teachers and students. DS have the potential to transform and improve students' learning (O'Byrne et al., 2018; Korukluoğlu & Toy, 2022); they are effective learning tools (Chung, 2007; Dreon et al., 2015) and constitute a new learning method (Nunvářová et al., 2022; Yilmaz & Durak, 2018). In particular, using technology-supported DS can be a unique way to teach difficult and complex concepts. DS offer opportunities to readers who have difficulty comprehending the material to be learned to visually make sense of or imagine it (Bull & Kajder, 2005; Kajder & Swenson, 2004).

DS created by combining human creativity with technology are characterized as student-centered interactive learning and materials that can transfer learning to technology-rich environments (Smeda et al., 2014). Therefore, DS offer teachers and students opportunities to use technology effectively (Robin, 2006, 2008). Barrett (2006) stated that DS facilitates four main student-centered learning strategies: engagement, deep

learning, project-based learning, and technology integration. In addition, there is a prevailing view that DS used in education are tools that encourage individuals to develop skills of information-gathering, problem-solving, and critical thinking together with aesthetic awareness (Chung, 2007; Çetin, 2021; Kim et al., 2021; McLellan, 2007; Yilmaz & Durak 2018; Walters et al., 2018). The DS used in learning environments contribute to the development of students' skills such as using technology (Korukluoğlu & Toy, 2022; Smeda et al., 2014), learning based on collaboration and peer communication, and taking personal initiative (McLellan, 2007; Yilmaz & Durak 2018). Furthermore, DS created with digital technologies offers open-ended and creative learning experiences for both teachers and students (Yang & Wu, 2012). DS are materials that have the potential to increase students' engagement in lessons and provide better learning outcomes (Smeda et al., 2014). They also support learning by contributing to the concretization of content (Yilmaz & Siğirtmaç, 2023). Churchill (2020) emphasized that DS are digital materials that provide students with opportunities to conduct research, collect data, and analyze and present their findings. While DS enable students to learn about a topic, they also give students opportunities to think and learn about their own lives (Kim & Li, 2021).

Literature Review

Studies have shown that DS used as learning materials contribute positively to the educational development of students and that they can be used to improve motivation (Başar, 2022; Hung et al., 2012; Kim & Li, 2021; Niemi et al., 2018; Korukluoğlu & Toy, 2022), creativity (Demirbaş & Şahin, 2023; Kim & Li, 2021; Özen & Duran, 2021), identity development (Kim et al., 2021), academic achievement (Başar, 2022; Korukluoğlu & Toy, 2022; Hung et al., 2012), class participation (Özen & Duran, 2021; Saritepeci, 2021), peer communication (Korukluoğlu & Toy, 2022), technological competence (Heo, 2009; Shinas & Wen, 2022), and problem-solving (Korukluoğlu & Toy, 2022; Hung et al., 2012). There are studies in the literature on the use of DS in mathematics education. For instance, Niemi et al. (2018) explored how DS are perceived by middle school students. They concluded that DS used in mathematics courses contributed to students' collaborative learning, the ability to generate new ideas, success in group work, and the ability to relate mathematics to daily life. Istenic-Starčič et al. (2016) found that DS increased students' mathematical problem-solving competencies, while Yilmaz and Siğirtmaç (2023) found that preservice teachers considered DS as a more important type of material than printed course materials because they provide both auditory and visual richness. Islim et al. (2018) showed that preservice teachers believed that DS are effective materials that can be used in mathematics courses. Kim et al. (2021) indicated that DS provide teachers and students with the opportunity to feel more confident and express their thoughts more easily. Çetin (2021) revealed that DS contribute positively to learning environments but also found that preservice teachers had difficulties in creating DS. Similarly, Özpınar (2017) found that preservice teachers mostly encountered technical issues in the process of creating DS and had difficulty in creating stories. The study emphasized that the creation of DS should be learned during the teaching process. Aldemir-Engin (2022) reported that preservice mathematics

teachers ignored the step of dramatic questions while creating their DS, did not use music, and experienced difficulties in making audio recordings and adding sound to their stories. Büyükkarcı and Müldür (2022) conducted their research with preservice mathematics teachers and showed that the actions and strategies used by preservice teachers in the process of creating DS were quite limited and that they did not complete the stages of DS creation in their entirety.

Aim of the Study

In the context of Turkish education, the mathematics curriculum gives importance to technology-supported mathematics teaching (Ministry of National Education [MoNE], 2018). Therefore, mathematics teachers are expected to use technology effectively. However, studies show that the level of mathematics teachers' use of technology for teaching purposes is not sufficient (Birgin et al., 2020) and that teachers have some deficiencies in developing digital course materials (Birgin et al., 2020; Turgut & Aslan, 2021; Walters et al., 2018). In the literature, it is emphasized that DS can be effective teaching tools for mathematics courses (Batur & Çakıroğlu, 2023), but the studies to date on the process of creating DS in mathematics education are not sufficient (Chang & Chu, 2022; Wu & Chen, 2020). It has been stated that the findings of studies conducted with limited sample groups cannot be generalized (Büyükkarcı & Müldür, 2022; Islim et al, 2018; Kocaman-Karoglu, 2016) and that such studies should be repeated with different sample groups (Yilmaz & Durak, 2018; Istenic-Starčič et al., 2016; Mojtahedzadeh et al., 2021). Furthermore, it is emphasized that little is known about the effects of DS (Stenhouse & Schafer, 2019) and that preservice teachers should work in cooperation in the process of creating DS as digital materials (Çetin, 2021). For these reasons, further research on DS is worth pursuing (Chang & Chu, 2022). There is a gap in the literature in terms of studies investigating the experiences of preservice teachers with the use of DS as digital materials in mathematics courses. It is thought that the opinions of preservice teachers who will be mathematics teachers in the future about the use of DS as digital materials in mathematics courses are important. Thus, the present study is expected to provide a contribution to the literature in terms of preservice teachers' experiences in creating DS and present insights into the use of DS as digital materials in mathematics courses.

This study aims to evaluate the DS created by preservice elementary mathematics teachers as digital teaching materials and to examine their views on the process. In this context, the study seeks answers to the following questions:

1.What is the general framework of the DS created by preservice teachers for mathematics teaching?

2.What are the opinions of preservice teachers about creating DS?

3.What are the opinions of preservice teachers about the use of DS as digital teaching materials in mathematics courses?

Method

The study was designed as a case study, employing a qualitative research method. Qualitative research focuses on how people experience phenomena and how they interpret, perceive, and construct what they experience (Merriam & Tisdell, 2015).

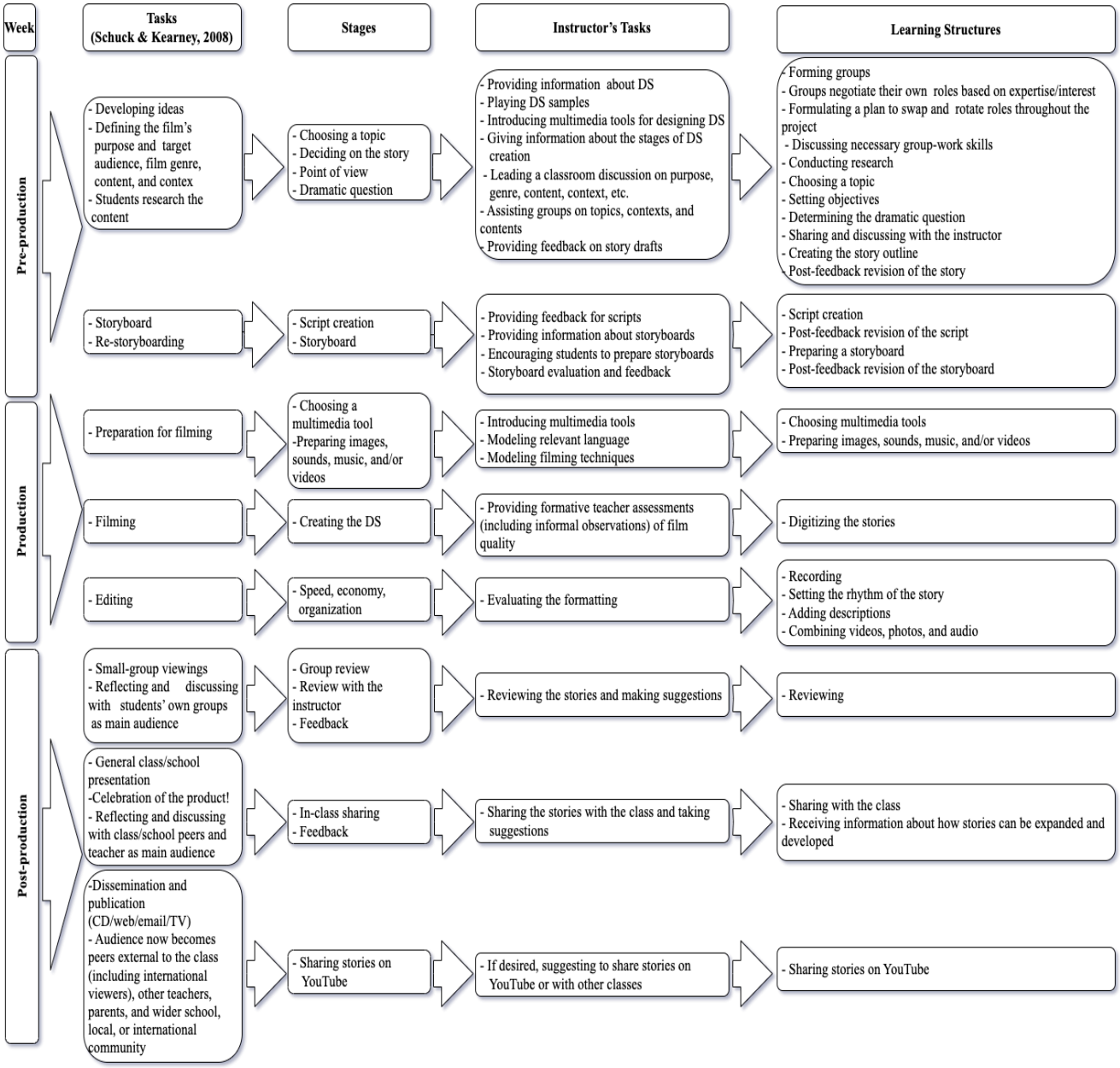
Participants of the Study

Forty-nine undergraduate preservice teachers enrolled in the Department of Elementary Mathematics Teaching at a university in the central region of Turkey participated in this study. While 78% (n=38) of the participants were female, 22% (n=11) were male. Convenience sampling from the purposeful sampling method was used to select the participants. The participants were between the ages of 19 and 24 (Mean=21.49, SD=0.12) years and they stated that they had no experience in creating DS before the implementation of this study. The data of the study was collected in the spring semester of 2022-2023.

Data Collection Process

This study was conducted within the scope of a course on computer-assisted mathematics teaching, which is an elective course in the Department of Elementary Mathematics Teaching. The computer-assisted mathematics teaching course is an applied course that meets for 2 hours a week. The study lasted 7 weeks. At the beginning of the study, preservice teachers attended a seminar lasting 2 lesson hours. Information about what a DS is, how and for what purpose DS are used in education, what DS multimedia tools exist, and examples of DS were given using in-class discussion and brainstorming methods. Afterwards, the participants were asked to form their own groups. A total of 21 groups were formed, comprising 3 people who wanted to work individually, 8 groups of two people, and 10 groups of three people. The study was conducted within the pedagogical framework proposed by Schuck and Kearney (2008) for video production and a design framework including the DS stages of Lambert (2013), Robin (2008), Bull and Kajder (2005), Lasica (2006), and Morra (2013). Each stage of the process proposed by Schuck and Kearney (2008) includes suggestions for teaching strategies and peer support. Thus, feedback was provided to ensure that the participating preservice teachers completed each stage of preparing digital teaching materials. Detailed information about the pre-production, production, and post-production practices of the study is presented in Figure 2.

Figure 2. Implementation process of the study



In the pre-production stage, the groups first examined the 2018 mathematics curriculum of the MoNE and decided on the grade levels and outcomes of the DS they would create. There were no limitations regarding the topics or levels of the DS. After conducting their research, the groups shared information in the classroom about how they would create their story environment, and they received feedback. They created their stories and scripts. Errors in mathematical definitions, editing mistakes, spelling mistakes, and other similar problems were corrected with cooperation among group members and the instructor. Some groups shared their stories with other groups and received their opinions. The groups created storyboards (Chung, 2007), which are visualizations of how a story will

be displayed. In the production stage, the groups selected a software program to use and created their DS. The majority of the groups preferred to use Powtoon, although some groups used Plotagon, Sony Vegas, and Canva, as well. After the production stage, the groups shared their DS with all participants in the computer lab. The topics of the DS included fractions (n=5), polygons (n=4), highest common factors/lowest common multiples (n=3), percentages (n=2), patterns and decorations (n=2), equations (n=2), natural numbers (n=1), integers (n=1), ratios/proportions (n=1), and the history of mathematics (n=1). The time duration of the created DS varied between 1.30 and 6.02 minutes, with an average duration of 3.32 minutes.

Data Collection Tools

Four different data collection tools were used in this study. The first was the Graded Assessment Scale for DS (GASDS), developed by Özcan, Kukul, and Karataş (2016). This scale was used to evaluate the DS created by the preservice teachers. The scale consists of three main themes with 14 sub-themes: 1) planning (dramatic question, purpose of the story, creating a storyboard, originality/appeal), 2) production (length of the story, economy, use of language and grammar, copyright and ethics, sound, music, multimedia quality, multimedia synchronization, editing), and 3) sharing/presentation/feedback (sharing for feedback). Scale items such as story length, copyright and ethics, and sharing for feedback are rated between 0 and 3 as poor to excellent; other scale items are rated between 0 and 3 as bad, poor, good, or excellent, respectively. The maximum score that can be obtained from the scale is 42, and the minimum possible score is 14.

The stories and storyboards that the groups prepared constituted the second data collection tool of the study, while the reports written by the groups constituted the third. During the implementation of the study, each group wrote a report about the process. In their reports, they recorded all the data related to the pre-production, production, and post-production stages as well as their feelings and thoughts about the process.

The final data collection tool used in this study was a focus group interview form. In preparing that form, the relevant literature was first reviewed, and then focus interview questions were formulated. In this context, two experts in the fields of mathematics education and educational sciences were consulted. In addition, a pilot study was conducted with two students. Based on the feedback from the students and experts, the focus interview form was finalized by removing or reorganizing questions that were difficult to understand, complex, or incompatible with the study. After the implementation process was over, a total of 8 focus group interviews were conducted in groups of 5 in the researcher's office. All participants verbally confirmed that they were participating in the interviews based on principles of voluntariness and willingness. The participants were assured that their names would be kept confidential and the data would not be shared with anyone. Interviews were audio-recorded with the permission of the participants. The interviews lasted approximately 15-20 minutes. The questions in the 9-item focus group interview form were as follows:

1.What do you think a DS is, and how would you define it?

2.What were your favorite aspects of creating a DS? Can you describe them?

3.What were the most difficult aspects of creating a DS? Can you describe them?

4.What do you think about the use of DS in mathematics courses as digital teaching materials?

5.What are the advantages and disadvantages of using DS as digital teaching materials in mathematics education?

6.Would you use DS as digital teaching materials when you become a teacher? Please explain why or why not.

7.What are your thoughts about the skills you gained from the DS creation process?

8.What would you take into consideration if you were going to create a DS as digital teaching material again? What would be your suggestions?

9.Is there anything else you would like to add?

Data Analysis

The groups' DS were evaluated separately by three field experts. Pearson correlation analysis was used to verify the validity of the experts' evaluation scores. Qualitative data were analyzed by the content analysis method. In this context, the interviews recorded as audio files were transcribed into written text. The names of the students were kept confidential, and the students were given pseudonyms in the form of P1, P2, ..., P49. After the hard copies of the written texts and the reports were read three times by two researchers, the coding stage began. The coding and categorization stages were carried out with the NVivo 9 software program. During the analysis, the codes and categories created by two different researchers were compared; codes that did not match were placed within appropriate categories or eliminated. This process continued until the inter-coder reliability score was 100%.

Validity and Reliability

It is necessary to meet the criteria of credibility and transferability to ensure validity in qualitative research and to collect evidence of reliability to ensure that the conclusions drawn from the findings are reliable. The following methods are used in order to ensure validity criteria: long-term interaction, in-depth data collection, triangulation, expert opinion, participant confirmation, detailed description, and purposeful sampling (Creswell, 2020). Throughout the process, the researcher and the preservice teachers were in constant communication. The researcher provided guidance to the preservice teachers. The participants could easily reach the researcher at every stage of the research process and receive feedback. It was also aimed at collecting diversified and in-depth data by using more than one data collection tool. Before the study began, the

participants were informed about the study and asked for their consent to participate. In order to increase the validity and reliability, expert opinions were obtained and direct quotations from participants were included. The study was initiated only after the necessary ethics committee permissions were obtained.

Findings

1. General framework of DS

The experts evaluated the DS created by the groups according to the GASDS (Table 1). The scores of the groups ranged between 16.3 and 37.3 and the average score was 27.6. 12 (57%) groups scored above the average score, 9 (43%) groups scored below the average, and 1 group scored below half of the maximum score that can be obtained from this scale. With the exception of that final group, all groups can be considered to have completed the DS preparation process at an intermediate level or above.

Pearson correlation analysis was used to ensure the validity of the scores (Table 2). Table 2 shows that there was a significant and positive relationship between Expert 1 and Expert 2 ($r=.817$, $p<.01$), between Expert 2 and Expert 3 ($r=.536$, $p<.01$), and between Expert 1 and Expert 3 ($r=.786$, $p<.01$).

Table 1: GASDS scores according to experts

	expert 1	expert 2	expert 3	Mean
Group 1	22	28	25	25.0
Group 2	35	30	29	31.3
Group 3	29	33	26	29.3
Group 4	36	29	34	33.0
Group 5	24	28	21	24.3
Group 6	26	28	23	25.6
Group 7	38	34	35	35.6
Group 8	31	35	27	31.0
Group 9	34	30	36	33.3
Group 10	35	29	31	31.6
Group 11	29	33	25	29.0
Group 12	21	24	19	21.3
Group 13	21	25	20	22.0
Group 14	18	23	24	21.6
Group 15	40	34	38	37.3
Group 16	12	17	20	16.3
Group 17	29	26	32	29.0
Group 18	29	32	28	29.6
Group 19	24	27	22	24.3
Group 20	22	26	33	27.0
Group 21	23	26	18	22.3

Table 2: Pearson correlation test results

		R		P
n		expert 1	expert 2	
expert 1	21			
expert 2	21	.817**		.000
expert 3	21	.786**	.536*	.000

2. Definitions of a DS

The participants' definitions of a DS emphasized the transfer of traditional stories to a digital environment, story creation through software programs, and materials that appeal to the senses (Table 3).

Table 3: Participants' definitions of a DS

Categories	%
Digitizing traditional stories	40
Material that appeals to the senses	35
Creating a story through a software program	30
Transferring knowledge through animation	22
Teaching material	22
Educational digital content	20
A Story in a virtual environment	12
Movie-style digital video	8

P32 defined DS as *"Stories supported by animated visuals, animations, sound, and music. These stories are created with the help of technological devices and applications. The presentation of the story is also done on smart devices and online platforms."* P16 defined DS as *"Transforming a verbally written story into a material that appeals to more senses with visual scenes and voiceovers."*

3. Experiences related to the DS creation process

Participants expressed their opinions about the situations they liked and found difficult during the DS creation process (Figure 3).

Figure 3. What the participants liked and found difficult in the DS creation process

a)Likes

In describing what they liked about the process of creating a DS, 61% of the participants stated that their favorite aspect was doing voiceovers using their own voices. P22 stated: *"It was a lot of fun because we did the voiceover part ourselves. Instead of using ready-made voices, we created a more original DS."* In the words of P12: *"The part I enjoyed the most was that I was able to use my own appearance and my own voice in the DS. I was the writer, screenwriter, director, and actor of that DS. In short, I was happy to voice and create my own character and to have something from me in the story."* P4 said: *"I enjoyed the part of creating speech bubbles and writing a script the most. While explaining the subject, I enjoyed it, as if I was explaining it to a student."* Regarding the multimedia tool they used, 49% of the participants stated that they liked that it offered rich contents, 29% liked that it had a simple interface, 34% liked that it allowed them to choose characters, and 23% liked that it allowed them to upload content. P35 said: "It was quite fun to create the characters. We made them ourselves, from the shape of their jaw to the color of their socks."

Furthermore, 57% of the participants stated that creating a DS through group work contributed positively to their personal skills. While 51% stated that it contributed positively to their communication skills, 34% stated that it contributed positively to their problem-solving skills. P1 said: *"Since we worked as a group, different ideas emerged and we tried to make a common decision. The division of labor enabled us to finish the work in a planned and timely manner."* In the words of P9: *"Most importantly, I think it contributed to our problem-solving skills, because we had to fictionalize an event and produce practical solutions to the problems created by the program, and it enabled us to deal with the problems we encountered."*

Additionally, 20% of the participants stated that creating a DS increased their self-confidence. Some participants who initially did not think that they could create a DS said that they were happy to create digital materials successfully and that it increased their self-confidence. P22 said: *"Being able to create something mathematical in a digital environment gave me the confidence to create my own materials when I become a teacher, although I was not afraid of such practices before this course."*

Finally, 49% of the participants stated that creating a DS improved their skills in technology. P16 said: *"I learned that I can create content for mathematics courses. I realized that I can easily use most of the apps while preparing digital content."* 35% of the participants stated that writing a script was a positive aspect of creating a DS and 16% noted that they enjoyed adding originality to their stories.

b) Difficulties

Along with the aspects they liked, participants also provided information about some of the difficulties they faced. Most significantly, 56% of the participants stated that the necessity of paid subscriptions made the DS creation process difficult. The content, time, and sharing limitations that paid software set for users who used the free options of the software made the process of creating DS more difficult. Some participants reported that they even had to find different ways to download the videos. P33 said: *"Some of the features were with charges. We had to shorten the dialogues because only a short duration of like three minutes was free."* In the words of P36: *"The most difficult part was finding a background and adding characters, because the [free] backgrounds in the app were not what we wanted. Characters couldn't be added, because that option had a fee. We had to search for them all ourselves, download them, return to the app, and add them."* Furthermore, 25% of the participants stated that they had difficulty because the free parts of the software program had insufficient content.

50% of the participants stated that they had difficulty in adjusting the synchronization of sound, image, dialogue, and duration. P28 said: *"We used paid software and it gave us the right to use it for free just for a certain period of time. Since we recorded and added the sounds all at once, not scene by scene, there were scene and sound mismatches. It was quite difficult to adjust them."* P4 explained: *"We had difficulty in adjusting the sound*

and duration." Finally, in the words of P18: *"We had difficulty in adjusting the transition time of visuals and dialogues."*

Among other difficulties described by the participants, 22% stated that they had many problems when they first started using the software. P34 explained: *"We had difficulty in the process of learning the program while creating a DS. We were using a software program that we didn't know and had no experience with."* Similarly, P3 said: *"We had a lot of difficulty in using the software program because we were working on an app that we had never used before."*

While 37% of the participants stated that one of the most difficult aspects of creating a DS was doing voiceovers, 15% also stated that it was difficult to write a script, 2% had difficulty adding originality to the story, and 2% struggled in establishing a connection with daily life. For example, P10 stated: *"We had difficulty in determining the topic and preparing a script. The reason for this was the effort to choose the most appropriate topic that we could adapt to a DS from among many topics." In the words of P9: "I can say that we had difficulty in the script-writing process. We tried so hard to write a different story, to establish a connection with daily life and to add originality to the story."*

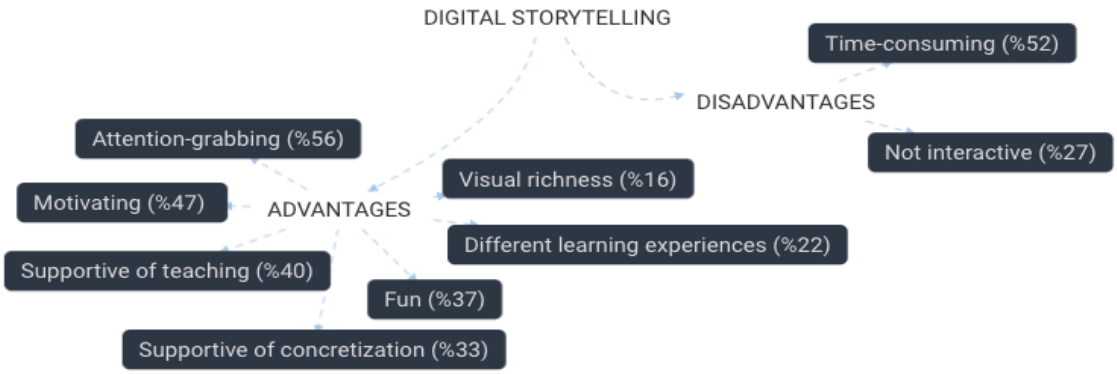
Furthermore, 12% of the participants stated that they had difficulty in creating backgrounds, 10% in adding sound effects, 8% in making speech bubbles, 8% in choosing a scene, and 8% in creating background music, while 20% of the participants reported difficulties due to technological deficiencies, such as not having a personal computer or having trouble with the internet.

4. DS as digital materials

While 86% of the participants stated that they would like to use DS as digital materials when they start working as mathematics teachers, 37% of the participants specified that they would prefer to use ready-made DS instead of creating them themselves. On the other hand, 14% of the participants stated that using DS was unnecessary and a waste of time.

Participants were asked to express their opinions about the advantages and disadvantages of using DS as digital materials in mathematics courses (Figure 4).

Figure 4. Advantages and disadvantages feature of using DS as digital teaching materials



a) Advantages

Among the advantages of DS, 56% of the participants stated that they are interesting course materials, 47% stated that DS can be used as motivational tools, 40% stated that DS can be used as materials to support teaching, 37% stated that DS can be fun materials for students, and 16% stated that they offer visual richness. Finally, 22% of the participants felt that DS can offer different learning experiences to students. P37 explained: *"We knew how to use various geometry software programs, but we've seen that DS can be used as teaching materials as well."* P14 stated: *"I never thought that DS could be used for a mathematics course before."* In the words of P18: *"I never thought that mathematics and mathematical concepts could be explained with stories other than daily-life questions. It broadened my perspective and made me look at teaching concepts from a different point of view."*

b) Disadvantages

As the most commonly described disadvantage, 52% of the participants stated that the time it takes to create a DS is an important obstacle to their use as digital materials. P2 shared the following opinion: *"When I start to work as a teacher, I would like to use DS in my courses. However, the preparation process is a laborious one that takes a lot of time, so I would use ready-made DS instead of creating them myself."* Furthermore, 27% of the participants stated that DS are not interactive materials. For this reason, they said, DS may not attract the interest of all students or they may be boring materials for some students.

5. Suggestions for creating DS

While 42% of the participants stated that the purpose should be clearly determined before starting to create a DS, 24% said that the integrity of the story and the perception of reality should not be disturbed. As other suggestions, 32% of the participants emphasized that it is necessary to research the features of the software to be used before

beginning to create a DS, 15% of the participants said that they would have preferred software with a Turkish-language interface, 18% felt that more attention should be paid to voiceovers, and 12% emphasized that there should be more animated visuals.

Results and Discussion

In this study, the DS developed by preservice mathematics teachers as digital teaching materials were evaluated. In line with the findings obtained from focus group interviews and reports, the participants' experiences related to the DS creation process and their views on the use of DS as digital teaching materials in mathematics courses were examined.

A total of 21 DS were created in this study. The average score of the DS as evaluated by experts was 27.6, and 57% of the groups scored above the average score. This shows that the DS created by the groups were moderately acceptable. However, the score of one group was very low. This result differs from the findings of the study conducted by Çetin (2021), as the DS (75%) created by the preservice computer science teachers who participated in that study were highly successful. It is thought that this difference may be related to the participants' specific fields of education. In Korukluoğlu and Toy's (2022) study, it was determined that the students performed well in the DS preparation process and at a moderate level in the DS creation process.

The definitions of a DS provided by the preservice teachers who participated in this study were dominated by expressions of transferring traditional stories to a digital environment and creating stories using software. The participants characterized DS as teaching materials and defined them as materials that appeal to the senses. Nunvářová et al. (2022) stated that there is no single definition of a DS because there are different possible versions of DS. Although there are different definitions of DS, these definitions are generally centered around the idea of integrating information-sharing and storytelling into technology (Yilmaz & Durak, 2018).

One of the essential stages of DS preparation is the creation of the content. While most of the participating preservice teachers stated that they were satisfied with being able to add originality to the script and the story, some participants had difficulty in preparing the script, adding originality to the story, and establishing a connection between the story and daily life. The related literature indicates that preservice teachers often have difficulties in selecting a topic, planning the story, and writing the script among the stages of DS preparation (Çetin, 2021; Özpınar, 2017). Ciğerci and Yıldırım (2023) stated that individuals who are successful in story-writing are more successful in creating DS. If the person who writes the story is satisfied with the story, the other stages progress more easily. In this regard, one may argue that preservice teachers need support in writing stories or preparing scripts.

The participants of the present study had no previous experience in preparing DS. One of the positive results of this study is that some preservice teachers who did not initially believe that they could prepare digital content regained their self-confidence in the course of creating and sharing DS. Sarıtepeci (2021) stated that DS used in learning environments increase students' self-confidence and provide opportunities for them to discover their interests and abilities. Creating a DS is not as complex a process as teachers and students typically think (Kobayashi, 2012). Preservice teachers similarly need to realize that using software that they perceive as complex is not as complicated as they think.

The participating preservice teachers developed their technological competencies while creating DS. In the literature, there are studies emphasizing that digital materials improve students' technological competencies (Niemi et al., 2018; Nunvářová et al., 2022; Kobayashi, 2012; Korukluoğlu & Toy, 2022; Özpınar, 2017; Sadik, 2008; Saritepeci, 2021; Smeda et al., 2014; Shinas & Wen, 2022). If appropriate environments are provided, students can use technology effectively (Sadik, 2008). As other outcomes of the present study, the preservice teachers developed skills related to communication, group work, and research while creating their DS. There are studies in the literature showing that DS contribute positively to various skills of students. Istenic-Starčič et al. (2016) showed that preservice teachers who created DS moved from being passive recipients to active producers. Niemi et al. (2018) found that DS encouraged students to learn new technologies and contributed to the development of mathematical literacy and 21st-century skills. The study by Korukluoğlu and Toy (2022) showed that creating and presenting their own stories contributed to students' abilities to work collaboratively. In addition, it was stated that creating DS allowed the students to conduct more research on subjects they were curious about.

In this study, the preservice teachers stated that DS support the teaching of mathematics and contribute to it through concretization. Previous studies similarly indicated that DS have the potential to contribute to teaching through concretization and support meaningful learning (Başar, 2022; Korukluoğlu & Toy, 2022; Robin, 2008; Saritepeci, 2021; Smeda et al., 2010, 2014; Yilmaz & Sığirtmaç, 2023). Some students need concretization to make sense of mathematics. Explaining abstract concepts with the help of digital content facilitates the teaching process and helps students make sense of mathematics. Goral and Gnadinger (2006) noted that some children have difficulty understanding concepts even with the help of manipulative tools. The fact that stories appeal to students' imaginations and emotions facilitates learning. Thus, the use of DS in mathematics teaching can be considered as a way to help students make sense of abstract concepts.

Moreover, DS are interesting and entertaining digital materials that can be used as motivational tools at the beginning of a course and provide students with different learning experiences in mathematics courses. Similarly, previous studies indicated that DS are interesting and fun digital learning materials (Korukluoğlu & Toy, 2022; Özen & Duran, 2021; Özüdoğru & Çakır, 2020). Yilmaz and Sığırtmaç (2023) emphasized that

DS appeal to the visual and auditory senses, enrich learning environments, and, therefore, are materials that attract children's attention.

The present study shows that DS are digital materials that can be used in mathematics courses. The majority of the participants stated that they would like to use DS in their classes when they become teachers. Similarly, Smeda et al. (2014) showed that teachers have positive attitudes toward using DS as teaching materials in their classes. Furthermore, it was found that teachers who used DS in their classrooms fulfilled their mentoring responsibilities better and carried out the learning process effectively. However, it takes time to create a DS. According to the participants of the present study, the primary disadvantage of creating a DS is that it is time-consuming. Nunvářová et al. (2022) stated that due to the time-consuming nature of creating DS, they are not widely used in practice. Similarly, it has been emphasized in various studies that one of the negative aspects of creating a DS is that the preparation process takes time (Islim et al., 2018; Yilmaz & Siğirtmaç, 2023; Özpınar, 2017; Özüdoğru & Çakır, 2020; Sadik, 2008; Turgut & Aslan, 2021). The fact that it takes time to create a DS suggests that preservice teachers may prefer using ready-made digital materials when they start working. This finding differs from the results of some studies in the literature (Islim et al., 2018; Özpınar, 2017). In a study conducted by Islim et al. (2018), it was found that preservice teachers were willing to prepare their own DS when they started working. Similarly, Kobayashi (2012) found that preservice teachers had positive feelings about DS and intended to use them with their students. However, Nunvářová et al. (2022) reported that although students were satisfied with DS, they preferred traditional learning methods. This finding further supports the conclusion that preservice teachers may prefer to use ready-made DS instead of their own DS when they start working because the preparation process is laborious and time-consuming. When teachers do not have the competence and time to create their own digital materials, they tend to use ready-made materials. However, they often face difficulties in finding ready-made materials suitable for the subject and grade level (Turgut & Aslan, 2021).

Another stage of creating a DS is technology integration. It was observed in this study that preservice teachers had difficulties in technological integration. The participants faced challenges due to the use of multimedia tools. These findings are in line with the relevant literature. Özüdoğru and Çakır (2020) stated that preservice teachers had problems using software. Walters et al. (2018) emphasized that preservice teachers raised in the digital age use the communication and entertainment functions of technology and are not familiar with the educational implementations of hardware and software. The participating preservice teachers had difficulties in various stages of the DS creation process, struggling with issues such as voiceovers, synchronization, limited available content, and the need to decode the language of the software. Korukluoğlu and Toy (2022) also found that teachers had difficulties in technical areas such as voiceovers, music, and the use of interesting and original multimedia tools in the creation of DS. However, the biggest difficulty can be said to be the limitations of paid software. For this reason, the participants of the present study stated that it is necessary to know the features of the software program in advance and create a DS accordingly. Similarly,

Büyükkarcı and Müldür (2022) stated that the limited free features of software programs negatively affected the DS creation process.

In this study, the preservice teachers had great difficulty in the voiceover process while creating their DS. At the same time, voiceovers were among their favorite aspects of the process. Although they stated that they faced many challenges while creating the DS, they also said that they found ways to deal with those difficulties. This shows that the participating preservice teachers improved their problem-solving and communication skills. These results are in line with the findings of studies in the literature. It has been emphasized in various studies that DS make positive contributions to students' problem-solving and communication skills (Büyükkarcı & Müldür, 2022; Çetin, 2021; Korukluoğlu & Toy, 2022; Hung et al., 2012; O'Byrne et al., 2018). Creating DS helps preservice teachers reach the desired results by generating their own solutions to the problems they encounter.

Conclusion and Suggestions

Based on the findings of this study, it can be concluded that preservice teachers have positive opinions about the use of DS as digital materials in mathematics courses. The fact that the preservice teachers realized that DS are digital materials that can be used in mathematics courses is one of the positive results of the study. Creating DS requires that story-writing and technology use be carried out together. In this sense, it can be said that preservice teachers need experience in both writing stories and using technology for instructional purposes. In the future, the effects of studies conducted by researchers working in different fields such as language, computer science, and mathematics in the process of creating DS could be investigated. Preservice teachers are generally acquiring the necessary competencies to produce digital contents to be used in mathematics education only through elective courses during the course of their education process. It is argued that DS, which are digital materials, should be integrated into course curricula (Kim & Li, 2021; Kobayashi, 2012; Yilmaz & Sığirtmaç, 2023). In order to use DS effectively in educational environments, preservice teachers should be given opportunities to develop digital materials with high-quality training before completing their undergraduate programs.

References

Aldemir-Engin, R. (2022). Evaluation of the digital stories prepared by preservice middle mathematics teachers and investigation of preservice teachers' views on digital story design process. *Kırşehir Eğitim Fakültesi Dergisi, 23*(1), 706-750. https://doi.org/10.29299/kefad.943463

Barrett, H. (2006). Researching and evaluating digital storytelling as a deep learning tool. In Society for information technology & teacher education international conference (pp. 647-654). Association for the Advancement of Computing in Education (AACE).

Başar, T. (2022). The effect of digital stories on 3rd graders' achievement, attitudes and motivation in science lesson. *Participatory Educational Research, 9*(5), 127-142. https://doi.org/10.17275/per.22.107.9.5

Batur, A., & Çakıroğlu, Ü. (2023). Implementing digital storytelling in statistics classrooms: Influences on aggregate reasoning. *Computers & Education*, *200*, 104810. https://doi.org/10.1016/j.compedu.2023.104810

Birgin, O., Uzun, K., & Mazman Akar, S. G. (2020). Investigation of Turkish mathematics teachers' proficiency perceptions in using information and communication technologies in teaching. *Education and Information Technologies*, *25*(1), 487-507. https://doi.org/10.1007/s10639-019-09977-1

Bull, G., & Kajder, S. (2005). Digital storytelling in the language arts classroom. *Learning & Leading with Technology*, *32*(4), 46-49.

Büyükkarcı, A., & Müldür, M. (2022). Digital storytelling for primary school mathematics teaching: Product and process evaluation. *Education and Information Technologies*, *27*(4), 5365-5396. https://doi.org/10.1007/s10639-021-10813-8

Cennamo, K., Ross, J., & Ertmer, P. (2010). Technology integration for meaningful classroom use. A standard-based approach. Belmont, CA: Wadsworth.

Center for Digital Storytelling (2005). http://www.storycenter.org/history.html

Chang, C. Y., & Chu, H. C. (2022). Mapping digital storytelling in interactive learning environments. *Sustainability, 14*(18), 11499. https://doi.org/10.3390/su141811499

Chung, S. K. (2007). Art education technology: digital storytelling. *Art Education, 60*(2), 17-22. https://doi.org/10.1080/00043125.2007.11651632

Churchill, N. (2020). Development of students' digital literacy skills through digital storytelling with mobile devices. *Educational Media International, 57*(3), 271-284. https://doi.org/10.1080/09523987.2020.1833680

Ciğerci, F. M., & Yıldırım, M. (2023). From Freytag pyramid story structure to digital storytelling: Adventures of pre-service teachers as story writers and digital story tellers. *Education and Information Technologies*, 1-24. https://doi.org/10.1007/s10639-023-12042-7

Creswell, J. W. (2020). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson Higher Ed.

Çetin, E. (2021). Digital storytelling in teacher education and its effect on the digital literacy of pre-service teachers. *Thinking Skills and Creativity*, *39*, 100760. https://doi.org/10.1016/j.tsc.2020.100760

Demirbaş, İ., & Şahin, A. (2023). The effect of digital stories on primary school students' creative writing skills. *Education and Information Technologies, 28*(7), 7997-8025. https://doi.org/10.1007/s10639-022-11440-7

Dreon, O., Kerper, R., M. & Landis, J. (2015). Digital storytelling: A tool for teaching and learning in the Youtube generation. *Middle School Journal,* 42(5), 4-10. https://doi.org/10.1080/00940771.2011.11461777

Goral, M. B., & Gnadinger, C. M. (2006). Using storytelling to teach mathematics concepts. *Australian Primary Mathematics Classroom*, *11*(1), 4-8.

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.

Hung, C.M., Hwang, G.J., & Huang, I. (2012). A project-based digital storytelling approach for ımproving students' learning motivation, problem-solving competence and learning achievement. *Educational Technology & Society*, *15* (4), 368–379.

Islim, O, F., Ozudogru, G. & Sevim-Cirak, N. (2018) The use of digital storytelling in elementary Math teachers' education. *Educational Media International, 55*(2), 107-122. https://doi.org/10.1080/09523987.2018.1484045

Istenic-Starčič, A., Cotic, M., Solomonides, I., & Volk, M. (2016). Engaging preservice primary and preprimary school teachers in digital storytelling for the teaching and learning of mathematics. *British Journal of Educational Technology*, *47*(1), 29-50. https://doi.org/10.1111/bjet.12253

Jakes, D. S., & J. Brennan, J. (2005). Capturing stories, capturing lives: An introduction to digital storytelling. http://id3432.securedata.net/jakesonline/dst_techforum.pdf

Kajder, S., & Swenson, J. A. (2004). Digital images in the language arts classroom. In the curriculum: Language arts. *Learning & Leading with Technology*, *31*(8).

Kim, D., & Li, M. (2021). Digital storytelling: Facilitating learning and identity development. *Journal of Computers in Education*, *8*, 33-61. https://doi.org/10.1007/s40692-020-00170-9

Kim, D., Long, Y., Zhao, Y., Zhou, S., & Alexander, J. (2021). Teacher professional identity development through digital stories. *Computers & Education*, *162*, 104040. https://doi.org/10.1016/j.compedu.2020.104040

Kobayashi, M. (2012) A digital storytelling project in a multicultural education class for pre-service teachers, *Journal of Education for Teaching, 38*(2), 215-219. https://doi.org/10.1080/02607476.2012.656470

Kocaman-Karoglu, A. (2016). Personal voices in higher education: A digital storytelling experience for pre-service teachers. *Education and Information Technologies*, *21*, 1153-1168. https://doi.org/10.1007/s10639-014-9373-1

Korukluoğlu, P. & Toy, B. Y. (2022) Digital storytelling in online elementary science education: a case study on science and technology club activities. *International Journal of Science Education, 44*(17), 2541-2564. https://doi.org/10.1080/09500693.2022.2138727

Lambert, J. (2013). *Digital storytelling: Capturing lives, creating community*. Routledge.

Lasica, J. D. (2006). Digital storytelling: A tutorial in 10 easy steps. http://www.techsoup.org/learningcenter/training/archives/page10096.cfm.

McLellan, H. (2007). Digital storytelling in higher education. *Journal of Computing in Higher Education*, *19*, 65-79.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

Ministry of National Education [MoNE] (2018). Curriculum of mathematics for 1-8 th grades. Ankara.

Morra, S. (2013). 8 steps to great digital storytelling. https://edtechteacher.org/8-steps-to-great-digital-storytelling-from-samantha-on-edudemic/

Mojtahedzadeh, R., Mohammadi, A., Emami, A. H., & Zarei, A. (2021). How digital storytelling applied in health profession education: a systematized review. *Journal of Advances in Medical Education & Professionalism*, *9*(2), 63.

Ng, W. (2015). *New digital technology in education*. Switzerland: Springer.

Niemi, H., Shuanghong, N. İ. U., Vivitsou, M., & Baoping, L. İ. (2018). Digital storytelling for twenty-first-century competencies with math literacy and student engagement in China and Finland. *Contemporary Educational Technology*, *9*(4), 331-353. https://doi.org/10.30935/cet.470999

Nunvářová, J., Poulová, P., & Poláková, P. (2022, May). Software tools for creating digital storytelling. In *KES International Conference on Smart Education and E-Learning* (pp. 309-318). Singapore: Springer Nature Singapore.

O'Byrne W.I., Houser K, Stone R., & White M. (2018). Digital storytelling in early childhood: Student illustrations shaping social interactions. *Front. Psychol, 9* (1800). http://doi.org/10.3389/fpsyg.2018.01800

Özcan, S., Kukul, V., & Karataş S. (2016). Dijital hikayeler için dereceli değerlendirme ölçeği. 10th International Computer and Instructional Technologies Symposium (ICITS), 16-18 May 2016.

Özen, N. E., & Duran, E. (2021). Contribution of digital storytelling to creative thinking skills. *Turkish Journal of Education*, *10*(4), 297-318. https://doi.org/10.19128/turje.909865

Özpınar, İ. (2017). Preservice mathematics teachers' opinions on the use of digital stories and ınstructional environments. *Bartın University Journal of Faculty of Education*, *6*(3), 1189-1210. https://doi.org/10.14686/buefad.340057

Özüdoğru, G., & Çakır, H. (2020). An investigation into the opinions of pre-service teachers toward uses of digital storytelling in literacy education. *Participatory Educational Research*, *7*(1), 242-256. http://dx.doi.org/10.17275/per.20.14.7.1

Robin, B. (2006, March). The educational uses of digital storytelling. 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. http://dx.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. https://doi.org/10.1007/s11423-008-9091-8

Saritepeci, M. (2021). Students' and parents' opinions on the use of digital storytelling in science education. *Technology, Knowledge and Learning*, *26*(1), 193-213. https://doi.org/10.1007/s10758-020-09440-y

Schneider, S., Beege, M., Nebel, S., Schnaubert, L., & Rey, G. D. (2022). The cognitive-affective-social theory of learning in digital environments (CASTLE). *Educational Psychology Review*, *34*(1), 1-38. https://doi.org/10.1007/s10648-021-09626-5

Schuck, S., & Kearney, M. (2008). Classroom-based use of two educational technologies: A sociocultural perspective. *Issues in Technology and Teacher Education, 8*(4), 394-406.

Shinas, V. H., & Wen, H. (2022). Preparing teacher candidates to implement digital storytelling. *Computers and Education Open*, *3*, 100079. https://doi.org/10.1016/j.caeo.2022.100079

Smeda, N., Dakich, E., & Sharda, N. (2010, July). Developing a framework for advancing e-learning through digital storytelling. In *IADIS International Conference e-learning* (pp. 169-176).

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

Stenhouse, V. L. & Schafer, N. J. (2019). Empowering teachers through digital storytelling: A multimedia capstone project. *Journal of Digital Learning in Teacher Education, 35*(1), 6-19. https://doi.org/10.1080/21532974.2018.1532359

Turgut, Y. E., & Aslan, A. (2021). Factors affecting ICT integration in TURKISH education: A systematic review. *Education and Information Technologies*, *26*(4), 4069-4092. https://doi.org/10.1007/s10639-021-10441-2

Walters, L.M., Green, M.R., Goldsby, D., & Parker, D. (2018). Digital storytelling as a problem-solving strategy in mathematics teacher education: How making a math-eo engages and excites 21st century students. *International Journal of Technology in Education and Science (IJTES), 2*(1), 1-16.

Wang, S., & Zhan, H. (2010). Enhancing teaching and learning with digital storytelling. *International Journal of Information and Communication Technology Education (IJICTE)*, *6*(2), 76-87.

Wu, J., & Chen, D. T. V. (2020). A systematic review of educational digital storytelling. *Computers & Education*, *147*, 103786. https://doi.org/10.1016/j.compedu.2019.103786

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

Yilmaz, F. G. K., & Durak, H. (2018). Examining pre-service teachers' opinions about digital story design. *Education and Information Technologies*, *23*, 1277-1295. https://doi.org/10.1007/s10639-017-9666-2

Yilmaz, M. M. & Sığirtmaç, A. (2023). A material for education process and the Teacher: the use of digital storytelling in preschool science education, *Research in Science & Technological Education, 41*(1), 61-88. https://doi.org/10.1080/02635143.2020.1841148

Genişletilmiş Türkçe Özet

Teknolojik gelişmeler eğitim ortamında dijital materyallerinin kullanılmasını mümkün kılmaktadır. Dijital materyaller eğitimci ve öğrencilere bilgi ve becerilerini geliştirme imkânı sunmakta, dolayısıyla eğitim standartlarının yükselmesine fırsat sağlamaktadır (Smeda ve ark., 2014). Özellikle Covid 19 sonrası dijital materyallerin öğrenmeye olan katkısı giderek önem kazanmaya ve kullanımı konusunda daha bilinçli olmaya başlanmıştır. Dijital materyallerin yelpazesi oldukça geniştir. (Schneider ve ark., 2022). Eğitimde kullanılan dijital materyallerinden biri dijital hikayelerdir (DH). DH çoğunlukla sanat ve beşerî bilimler ile ilişkilendirilmiş olsa bile matematik gibi sayısal derslerde etkili bir öğretim materyali olarak kullanılabilir (Sadik, 2008; Wu & Chen, 2020).

DH, belli bir konudaki hikâyenin dijital ortamda sunulması (Çetin, 2021; Kobayashi, 2012) başka bir ifade ile çoklu ortam araçları kullanarak hikâyenin zenginleştirilmesidir (Yilmaz & Durak, 2018). DH kavramı, hikâye anlatma sanatını resim, ses ve video gibi çeşitli dijital multimedya ile birleştirme fikrine dayanır. Teknoloji kullanarak belli bir konu hakkında bilgi sunmak için metin, ses, video, grafik ve müziğin bir araya getirilmesidir (Chung, 2007; Robin, 2006, 2008; O'Byrne ve ark., 2018). DH bireylerin duygu ve düşüncelerini aktarmaya (Kocaman-Karoglu, 2016; Ng, 2015) ya da karmaşık kavramları hem dilsel hem de dilsel olmayan yollarla iletmeye yarayan araç olarak tanımlanabilir (Kim & Li, 2021; Kim ve ark., 2021).

DH geleneksel hikâye oluşturma fikrine dayanır bu nedenle aralarında benzer ve farklı noktalar bulunmaktadır. DH ile geleneksel hikâye arasında fark ise, DH'nin, çeşitli dijital multimedya araçları tarafından desteklenmesidir (O'Byrne ve ark., 2018). Sınıf ortamında teknoloji etkinliğini artırmak için kullanılan DH'lere yönelik teorik bir çerçevenin net olarak ortaya konduğu söylenmez (Robin, 2008; Smeda ve ark., 2010). Genel olarak, DH'leri hazırlama süreci iki boyuttan oluşmaktadır. İlk boyut bağlam çerçevesinde hikâye ve buna bağlı olarak senaryo aşaması diğer boyut senaryo çerçevesinde gerçekleşen teknoloji entegrasyonunu kullanma aşamasıdır (Saritepeci, 2021; Wang & Zhan, 2010; Büyükkarcı & Müldür, 2022). Literatürde DH hazırlama sürecini farklı araştırmacılar farklı boyutlar altında toplamıştır. Robin (2008), Center for Digital Storytelling (2005) tarafından belirlenen yedi unsuruna odaklanmaktadır. Bu unsurlar DH üzerine çalışmak için bir başlangıç kabul edilen DH'nin yedi elementini oluşturmaktadır. Cennamo ve ark. (2010) ise DH oluşturma sürecini beş aşamada tasarlamıştır. Lasica (2006) DH unsurlarını daha geniş kapsamda oluşturarak on aşamalı bir süreçten bahsetmektedir.

İnsan yaratıcılığı ve teknolojinin harmanlanması ile oluşturulan DH'ler öğrenci merkezli, etkileşimli öğrenme ve öğrenmeyi teknoloji açısından zengin ortamlara aktarabilen materyaller olarak nitelendirilmektedir (Smeda ve ark., 2014). Bu nedenle, DH'ler öğretmen ve öğrencilere teknolojiyi etkin bir şekilde kullanma fırsatı sunmaktadır (Robin 2006, 2008). Barrett (2006) DH'lerin katılım, derin öğrenme, proje tabanlı öğrenme ve teknoloji entegrasyonu olmak üzere dört öğrenci merkezli öğrenme stratejisini kolaylaştırdığını belirtmektedir. Bunun yanı sıra, eğitimde kullanılan DH'nin bireylerin

bilgi toplama, problem çözme becerisi, eleştirel düşünme ve estetik duyarlılık geliştirme konusunda teşvik edici bir araç olduğu görüşü hakimdir (Chung, 2007; Çetin, 2021; Kim ve ark., 2021; McLellan, 2007; Yilmaz & Durak 2018; Walters ve ark., 2018).

Bu çalışma, ilköğretim matematik öğretmen adaylarının dijital öğretim materyali olarak tasarladıkları DH değerlendirmek ve sürece ilişkin görüşlerini incelemeyi amaçlamaktadır. Bu bağlamda, araştırma aşağıdaki sorulara cevap aramaktadır.

1. Öğretmen adaylarının matematik öğretimi için geliştirdikleri DH'lerin genel çerçevesi nedir?

2. Öğretmen adaylarının DH tasarlamaya yönelik görüşleri nelerdir?

3. Öğretmen adaylarının matematik derslerinde dijital öğretim materyali DH'lerin kullanımına yönelik görüşleri nelerdir?

Araştırma nitel olarak tasarlanmıştır. Nitel araştırma, kişilerinin yaşadıklarını nasıl deneyimledikleri, yorumladıkları, algıladıkları, nasıl yapılandırdıklarına odaklanmaktadır (Merriam & Tisdell, 2015). Araştırmaya, Türkiye'nin iç bölgesinde bulunan bir üniversitenin ilköğretim matematik öğretmenliği bölümüme devam eden 49 lisans düzeyinde öğretmen adayı katılmıştır. Katılımcıların %78 (38)'i kız, %22 (11)'i erkektir. Katılımcıların seçiminde amaçlı örnekleme yöntemi kullanılmıştır. Araştırmada dört farklı veri toplama aracı kullanılmıştır.

Araştırmada toplam 21 DH hazırlanmıştır. Uzmanlar tarafından değerlendirilen DH'lerin ortalama puanı 27.6 olarak belirlenmiştir. Grupların %57'si ortama puanın üstünde puan almıştır. Bu oran grupların oluşturduğu DH'lerin orta düzeyde kabul edilebilir olduğunu göstermektedir. Bir grubun puanı ise oldukça düşük seviyede kalmıştır. Araştırmanın bu sonucu Çetin (2021)'in çalışması ile farklılaşmaktadır. Çetin (2021)'in çalışmasına katılan bilgisayar öğretmen adaylarının oluşturduğu DH (%75) yüksek düzeyde başarılı olmuştur. DH hazırlanın temel aşamalarından biri içerik kısmının oluşturulmasıdır. Öğretmen adayların çoğu senaryo ve hikâyeye özgünlük katabilmekten dolayı memnun olduklarını belirtirken bazı katılımcılar için senaryo hazırlama, hikâye özgünlük katmak ve hikâyenin günlük hayatla bağlantısını kurmakta oldukça zorlanmışlardır. İlgili literatürde öğretmen adaylarının DH konu seçme, hikâye yazma, senaryo yazma aşamalarında zorlandıklarını göstermektedir (Çetin, 2021; Özpınar, 2017). Ciğerci ve Yıldırım (2023) hikâye yazmada başarılı olan bireylerin DH yaratmada daha başarı olduklarını belirtmektedir. Hikâyeyi yazan kişi hikayesinden memnun ise diğer aşamalar daha kolay ilerlemektedir. Öğretmen adayları, DH tasarlarken teknoloji konusundaki yetkinliklerini geliştirmişlerdir. Literatürde, dijital materyallerin öğrencilerin teknolojik yetkinliklerini geliştirdiği vurgulayan araştırmalar mevcuttur (Niemi ve ark., 2018; Nunvářová, ve ark., 2022; Kobayashi, 2012; Korukluoğlu & Toy, 2022; Özpınar, 2017; Sadik, 2008; Saritepeci, 2021; Smeda ve ark., 2014; Shinas & Wen, 2022). Uygun ortamlar sağlandığı takdirde öğrenciler teknolojiyi etkin bir şekilde kullanabilmektedir (Sadik, 2008). Araştırmanın bir diğer sonucu ise öğretmen adaylarının DH tasarlarken iletişim, grup çalışması, araştırma

yapma becerilerini geliştirdiğidir. Literatürde DH'lerin öğrencilerin çeşitli becerilerine olumlu katkılar sağladığını gösteren araştırmalar mevcuttur. Istenic-Starčič ve ark. (2016) çalışması DH tasarlayan öğretmen adaylarını pasif alıcı konumundan aktif üretici konuma geçtiğini göstermektedir. Niemi ve ark. (2018) çalışması DH'nin öğrencileri yeni teknolojiler öğrenmeye teşvik ettiği, matematik okuryazarlık ve 21. yüzyıl becerilerinin gelişimine katkı sağladığını göstermektedir. Korukluoğlu ve Toy'un (2022) çalışması ise öğrencilerin kendi hikayelerini oluşturması ve sunmasının iş birliği içinde çalışma becerilerine katkı sağladığını göstermektedir. Ayrıca DH oluşturmanın öğrencilerin merak ettiği konuda daha fazla araştırma yapmasına olanak sağladığı belirtilmiştir.

Ethics Committee Approval: This research received ethical approval from the Social and Humanities Ethics Committee at Yozgat Bozok University, as per decision number 38/14, dated 16.11.2022

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interests: The authors have no conflict of interest to disclose.

Author	Contact
Emine Özgür Şen	Yozgat Bozok University, Faculty of Education, Department of Mathematics Education, Turkiye