

A Digital Storytelling Workshop with Mathematics Teachers

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Abstract

This qualitative case study presents reflections from an online Digital Storytelling Workshop conducted with four secondary mathematics teachers studying for a master's degree at a state university in Turkey. Data were collected through online lesson recordings, a semi-structured interview form, participants' reflective diaries, and digital stories prepared during the process. Content analysis was used in the analysis of the data. According to the results of the research, it was determined that the participants had the most difficulty in creating a dramatic question and adding multimedia. It was seen that they paid more attention to the dramatic question, sound, and music elements while evaluating sample digital stories. They mentioned time-saving in terms of the advantages of holding the workshop online, and the fact that interaction was limited regarding the disadvantages. They stated that the workshop mostly benefited them in terms of using technological digital storytelling tools. They reported that due to the disruptions experienced in online education, they used the prepared digital stories limitedly in their own classrooms, and stated they could not receive sufficient feedback. They also stated that in the event that they could use digital stories in mathematics classes, they would benefit students in various ways eg boosting imagination and associating mathematics with daily life. The digital stories prepared at the end of the workshop were examined, and it was seen that there was an improvement in terms of preparing digital stories in accordance with mathematical and rules in all participants.

Keywords: Digital Storytelling, mathematics teachers, online digital storytelling workshop.

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Introduction

Stories give our lives a sense of reality through narrative (Cuppit, 1991). Stories are utilized for establishing communication and developing an understanding of people. Lewis (2011) stated that stories are one of the main ways of understanding the world we live in. Stories provide the reader with a true-life and embodied experience that accompanies the literary experience (Garrett, 2006). Due to its structure, mathematics is a field in which there are mostly abstract concepts. Therefore, there is sometimes a need for concretization in the mathematics education process. Since stories are about concretization and making connection between abstract concepts and real life, one of their usage areas is in mathematics education. It has long been understood that stories can be used to teach mathematical ideas to primary and secondary school students (Balakrishnan, 2008). In mathematics education, stories develop students' cognitive abilities (Toor & Mgombelo, 2015). Moreover, stories also have an effect on increasing academic achievement, reducing mathematics anxiety (Katipoğlu, 2019), and increasing the retention of knowledge (Ulupınar Özkuzukıran & Kayabaşı, 2020).

Storytelling is a traditional approach that is also used in mathematics education and contributes to the process. Due to the rapid development of information technology, the trend in education has changed from traditional classroom teaching to teaching through digital media. One of the reasons for this is the change in students' learning styles as a result of their interest in appropriate technologies and the internet (Tsai et al., 2015). Many teachers integrate multimedia tools into their lessons in order to teach students different skills such as synthesizing, analyzing, evaluating, and presenting the information. When students use technology, they learn to transform data into information. Moreover, using multimedia tools gives students the opportunity to participate in and interact with the lesson. One of these multimedia tools is digital storytelling (DST) (Alismail, 2015). Many educators have recognized the potential of DST, which is used as a tool in subject areas such as history, language arts, social studies, teacher training, etc. (McLennan, 2006).

As in many other fields, DST is also utilized in mathematics education. In order for DST to be used as an effective tool in mathematics education, mathematics teachers and educators should acquire knowledge about DST. Considering the fact that workshops are effective in education (Köse, 2021; Öztürk & Korkut, 2020; Sökezoğlu-Atılğan & Taş, 2020), conducting online workshops is preferred. Due to the COVID-19 epidemic which has affected the world, there has been an online education process in our country, as in many countries. Therefore, the DST workshop was conducted online from the beginning. The primary aim of the research is to introduce DST to mathematics teachers and to have them make designs on how DST can be used in mathematics education. In other words, it is to give mathematics teachers experience in designing DST with the help of an online workshop. For this purpose, it is aimed to reveal the difficulties faced by the teachers in the workshop process, the evaluation criteria of DSTs, and the advantages and disadvantages of conducting the workshop online. In addition, it was aimed to examine the contribution of the workshop to the teachers and their experiences regarding the use of the DSs in the classroom environment. From the teachers' point of view, it is also aimed to determine the contribution of DST to students if it is used in classrooms. Another aim is to determine the progress of the participants in the workshop process. For this reason, the online DST workshop held with mathematics teachers in this study was presented by evaluating from the perspectives of both the participants and the researcher.

DST and mathematics education

In the most general sense, the digital story (DS) is the creation of short films by combining digital images, texts, and sounds with the aim of informing people about various subjects (Robin, 2016). In other words, it is a technique that permits computer users to become creative storytellers through the processes of doing research, writing a scenario, and developing an interesting story on a topic. This material is then combined with various types of multimedia, including computer-based graphics, recorded audio, computer-generated text, video clips, and music so that it can be played on a computer or uploaded to a website (Robin, 2008). In this way, people are able to produce and publish their own stories to be shared with others (Ellum, 2005). The DS is a multimodal form of communication that appeals to different student groups (Sweeder, 2008). It requires limited technological expertise and

enables students to demonstrate what they have learnt through different approaches (Shelton, Archambault & Hale, 2017). Digital stories encourage students to think more deeply about the meaning of a topic or story, to personalize their experiences, and also to clarify what they know about the topic (Sadık, 2008). According to Bran (2010), the DS provides an original way for students to display their knowledge, skills and creativity, and provides increased interest for both the content creator and the viewer by enabling students to go through the process of writing and storytelling in an engaging way. DST is characterized by flexibility, interaction, nonlinearity, user participation and even creating with collaboration (Barber, 2016). While DST encourages literacy development, it also improves reading comprehension (Royer & Richards, 2008). Moreover, it develops 21st-century skills (Robin, 2008), collaboration, and proficiency in technology (McLennan, 2006), and digital literacy (Churchill, 2020; La Rose & Detlor, 2021). Furthermore, it is effective in shaping students' social practices and identities (Istemic et al., 2016). It improves students' motivation, creativity, and connections with others (Kim & Li, 2021). It enables changes in classroom management practices and strengthens teacher-student and peer-to-peer collaboration (Kaminskienė & Khetsuriani, 2019). It also provides benefits such as trust, different perspectives, satisfaction, and impartiality in peer reviews (Tatlı et al., 2018). DST is a suitable platform for developing behavioral, emotional, and cognitive commitment in mathematics education (Marsico et al., 2019). Moreover, it is a tool that helps children to learn basic mathematics and preserve knowledge (Lawson & Olokunde, 2016). It has been observed that DST is effective in eliminating errors and misconceptions (Karaođlan Yılmaz et al., 2017) and changing students' motivation and attitude toward mathematics in a positive way (Çakıcı, 2018). Furthermore, it contributes to students' ability to see mathematics learning as useful, and benefits their learning (Niemi & Niu, 2021). It also facilitates the association of mathematics with daily life and enables the creation of interesting and entertaining learning environments (Özpinar, Gökçe & Yenmez, 2017). Moreover, it improves students' abilities to be active solvers of real-world problems (Albano & Pierri, 2017). It has been determined that DST is an effective tool for developing children's mathematics and computer literacy skills in the preschool period (Preradovic et al., 2016). At the primary school level, it is an effective tool used in teaching subjects that students have difficulty with (e.g., subtraction) (Bratitsis & Mantellou, 2020). Furthermore, it is used successfully for developing pre-service teachers' pedagogical competencies and mathematical content knowledge (Istemic Starčić et al., 2016) and for introducing mathematical concepts to them (Arora, 2020). It also develops students' computer skills (Tsai et al., 2015) and creative thinking skills (Hill & Grinnel, 2014). By directing students towards active collaborative learning, DST enables students' active knowledge generation and active participation in class (Niemi et al., 2018). DST not only supports teachers in transferring abstract content but also increases students' levels of understanding of concepts (Petrucco et al., 2013).

The DS creation process begins with identifying a topic. It then continues as researching the topic, writing the content, selecting the images, recording the story, placing the images, setting the timing, adding music (optional), recording the project and sharing the DS (Royer & Richards, 2008). Morra (2013), on the other hand, explained that the first stage is to find an idea and then to carry out the research/discovery/learning process related to this idea. In the next stage, the scenario is written and the plan is made with the storyboard. The music, visuals and sound are determined, and the DS is created and shared by combining all of these. The elements of the digital story have been defined by different researchers. One of these is Lambert (2006), who describes these elements as point of view, a dramatic question, emotional content, the gift of your voice, the power of the soundtrack, economy, and pacing. Point of view means the author's point of view and the purpose of the story are included. A dramatic question is the question that gives the purpose of the story, arouses curiosity and will be answered at the end of the story. Emotional content is the bond between the story and the audience. Voice means of the story where necessary in accordance with its purpose. Appropriate music should be chosen to increase the effectiveness of the story. Economy is the element that expresses the use of unnecessary content in accordance with the purpose of the story. Pacing is the element that indicates how fast the story will progress. Also Robin (2008), stated the elements as the overall purpose of the story, the narrator's point of view, a dramatic question or questions, quality of the images, video and other multimedia elements, use of a meaningful audio soundtrack, the choice of content, pacing of the narrative, good grammar and language usage, economy of the story detail, and clarity of voice. When

the definitions of the aforementioned researchers are examined, it is seen that there are similarities and differences. In order to enrich the study, it was planned that teachers would examine both perspectives rather than the perspective of a single researcher. For this reason, the focus was on the digital story elements of both researchers.

DST and the workshop

Workshops are a process in which a group of people comes together to acquire new knowledge, produce creative solutions to problems, or work on innovations related to a field-specific topic. It is seen that workshops are designed according to three different perspectives. These are classified as workshops as a means, workshops as practice, and workshops as a research methodology (Ørngreen & Levinsen, 2017). Workshops are an effective method used in education (Buchbinder et al., 2005; Haghani et al., 2012; Safari & Hosseini, 2016; Salman, 2009). Workshops can be conducted face-to-face and online. Looking at the studies on DST workshops, it has been determined that the DS creation process is handled in different ways, but that these processes are in fact similar (Tekeli, 2018). For example, Şimşek (2013) discussed this process as the stages of creating the story circle, writing the story down, recording the voiceover, preparing the images, putting the DS together, and in-group screening. In the workshop, the DS creation stages are cyclical and encourage participants to be more relaxed due to their non-hierarchical nature. In online DST workshops, however, the situation is different. Here, choosing a suitable tool for simultaneous meetings becomes more important. When designing the DST workshop, everything should be done at the service of the learners. Learners should be given the necessary space for their learning and study in the process. In the online workshop process, the informant should have the role of a learner, a guide, and a teacher (Yee & Stevens, 2019).

Studies on DST workshops in education exist in the literature (Brushwood Rose & Granger, 2013; DeGennaro, 2008; Doğan & Robin, 2008; Hausknecht et al., 2016; Yüksel Arslan et al., 2016). However, these studies appear to be rather limited (Çıralı Sarıca & Koçak Usluel, 2020; Wu & Chen, 2020). It is also seen that online workshops are held for various reasons, for example promoting HPN vaccination (Chen, Kim, Todd & Larkey, 2022), developing digital literacy and social work leadership knowledge (La Rose & Detlor, 2021); but that online workshops are also limited. The Digital Storytelling COntests (DISTCO) with the participation of teachers and students are one of these (Doğan, 2010). Among the topics studied are the effects of the online workshop on the development of English learners' literacy skills (reading and writing) (Rahimi & Yadollahi, 2017), and on student achievement in science, social presence, and attitude (Nam, 2017). In addition, Oakley et al. (2018) conducted an online DST workshop on the exchange of multimodal digital stories in the Australian-Chinese context.

Due to the COVID-19 pandemic process, lessons have been conducted online in many countries, including Turkey. The inability to hold face-to-face workshops in the online education process and the completely online execution of the education process necessitated conducting an online workshop in the research. In this study, an online DST workshop was designed as a graduate course at a public university. In the research, the workshop process and the prepared products were evaluated.

Research Questions

1. What are the situations in which the participants have difficulties in the DST workshop?
2. What are the elements that the participants pay attention to while evaluating digital stories in the DST workshop evaluation activity?
3. What are the advantages and disadvantages of conducting the DST workshop online?
4. What has been the benefits of the DST workshop for the participants?
5. What are the participants' experiences in using the digital stories they prepared in the workshop in their mathematics classes?
6. What would be the benefits of digital stories for students in the event that they are used in mathematics classes?
7. What is the progress of the participants in the workshop process?

Method

The research was designed as a qualitative case study.

Participants

The participants in the study were four people studying for a master's degree in the field of mathematics education at a public university in the northeast of Turkey. The participants of the research work and live in different cities of the country. The research was carried out within the scope of the Mathematics Teaching Methods and Models II course. Criterion sampling (Patton, 1987) was used for sample selection. The criterion was that the participants taught at public secondary schools and had successfully completed the Mathematics Teaching Methods and Models I course. All of the participants were women. Participants were coded as P1, P2, P3, and P4. P3 had two years of teaching experience, while the other participants had one year of experience. All of the participants stated that they had not heard of the concept of DST before.

Study process

During the research process, an online DST workshop was conducted with the participants. The Yee & Stevens (2019) perspective was used for the online workshop. Accordingly, Microsoft Teams, which is used within the university, was used for simultaneous meetings. The reasons for choosing Microsoft Teams are that it enables online conferences to be conducted easily, it allows the lessons to be recorded and watched later, it is free of charge, it is easy to use, and screen sharing and file-sending operations are performed. The choice of the tool to be used to design the digital stories was made together with the participants. The participants examined and presented a total of eight tools, two for each participant. The aim here was not to oblige the participants to use a single software, but for them to be flexible and to support their own choices in this regard.

In the first week of the process, the participants were met online. The demographic characteristics were determined and the scope of the study was explained. Theoretical information about DST was given and the reasons for using it in mathematics education were explained. The participants were asked to watch samples of digital stories on the topic of mathematics education. A short DS was designed together with the team. In this sample DS design, the subject of mathematics was decided together with the participants and the DS was prepared with one of the DST preparing tools called Storyjumper. Here, the researcher is the person at the computer and actively using the tool. Participants took an active role in the whole process, such as choosing the subject, creating the scenario, creating the characters, adding sound and music, and deciding on the content. Everyone expressed their opinions with their reasons, and a story and digital story were created with the help of discussions. While designing this, care was taken to ensure that the whole team was active and that a common product was produced by evaluating each of their views. For the following week, each participant was asked to select and introduce two DS design tools. While the tools were being introduced, they were asked to make presentations through mini digital stories and in this way, an attempt was made to familiarise the participants with the concept of DST. In the second week, the participants presented the examined tools through the digital stories they had prepared. Participants created two different stories with the two digital story creation tools they chose. Then their advantages and disadvantages were discussed with the team. For the following week, the number of tools investigated was reduced from eight to four, and the participants were asked to choose one tool each and prepare a DS for this tool the following week. In the third week, the digital stories, which each participant had designed for 3-5 minutes on a free topic, concept, or learning outcome in mathematics with the tool they had chosen, were shared and examined. The aim here was to determine the appropriateness of the tool for use in mathematics. In the third week, the number of tools was reduced to four. Unlike the second week, a story was designed and it was aimed to have more ideas in tool selection. The prepared digital stories were examined and the problems and difficulties experienced in the process were determined. With the consensus of all participants, Animaker, which is one of the appropriate tools for the study, was chosen, and it was decided to continue with this tool in the next part of the study. Animaker is a tool that was created in 2014 and has both paid and free options. What

distinguishes it from the other tools examined is that the number of free characters, character movements, visuals, and music tracks is quite high, and there is also the possibility to add your own voice. Moreover, although the tool has no Turkish language option, the participants did not see this as a disadvantage because the interface is extremely simple and practical. The following week, the free mathematics digital stories prepared by the participants in Animaker were examined. The theoretical parts were emphasized in terms of the prepared digital stories. How the digital stories would be evaluated and what needed to be considered were explained on the basis of DS assessment scales. In the fifth and sixth weeks, the theoretical part was reinforced by examining and discussing 20 mathematics digital stories. For the next week, it was stated that digital stories would be prepared again with the aid of Animaker, but first of all, the participants were asked to create their stories. The topic was not restricted so that the participants could move more freely and apply the resulting products in a real classroom setting. Similarly, the choice of grade level was left to the participants. There were cases where the participants got stuck in the story creation process from time to time. Here the researcher has tended to relieve the bottleneck by offering options. In addition, in some stories, the researcher provided guidance in situations such as keeping the dialogues long, throwing the purpose into the background or allocating more limited time to problem solving. In the seventh week, the stories prepared by the participants were examined, discussed, and worked on before being digitalized. In the eighth week, the stories were digitalized and shared with the team. In the ninth and tenth weeks, the digital stories, reflective diaries, and semi-structured interview forms were collected. For the first 8 weeks, the meetings lasted 90 minutes per week.

Data collection tools

Four types of data collection tools were used in the study. The first data collection tool was Microsoft Teams video recordings, which contained recordings of each week's lesson. Secondly, the participants' reflective diaries were utilized. At the end of each week, the participants were asked to create a reflective diary (in Word format) containing their views on that week's lesson, and these were collected at the end of the process. Thirdly, a semi-structured interview form was implemented at the end of the process. The questions in the form are as follows:

- ✓ We conducted the lessons online due to the COVID-19 outbreak. What do you think were the advantages and disadvantages of holding the DST workshop online?
- ✓ What was the impact of the DST design process on you, and what qualities did it foster, develop or negatively affect you?
- ✓ Did you use the digital stories you prepared in your classes? Explain why/why not.
- ✓ Can you explain what the most difficult issue was while creating a DS?
- ✓ In your opinion, how do digital stories affect which skills of students? Please explain.

The fourth data collection tool was the digital stories prepared by the participants throughout the process.

Data analysis

Content analysis (Weber, 1990) was used to analyze the data. The views of two experts were obtained in the analysis of the data. The percentage of agreement was determined as 89%. According to Miles and Huberman (1994), a percentage of agreement of 80% and above is determined to be sufficient for inter-coder reliability. Codes, categories, frequencies and direct quotations have been included in the research.

Research ethics

In this study, the data of the participants were recorded. In addition, the participants were informed in detail about the study. Ethics committee approval was obtained by the Social and Human Sciences Scientific Research and Publication Ethics Committee of the university where the study was conducted. (27.05.2021/20)

Findings

Findings regarding the situations in which participants had difficulty in the DST workshop

By analysing the data, two categories were identified, and these are presented in Table 1.

Table 1.
Categories and Codes for Situations in Which Participants had Difficulty in the DST Workshop

Categories	Codes	f
Story writing	Creating a dramatic question	4
	Adjusting the length of the story	2
	Adjusting the mathematical operations	1
	Choosing a topic	1
	Adapting the story to mathematics	1
Digital story creation	Adding multimedia	3
	Using the software	2
	Voiceover	1
	Music	1
	Scene selection	1
	Character selection	1

As can be seen in Table 1, in story writing, the participants had the most difficulty in creating a dramatic question and adjusting the length of the story. While creating a DS, adding multimedia, and using the software were among the situations they found difficult.

“While I was preparing the DS, I had trouble with the voiceover and music, I couldn’t adjust the sound ratios, and besides, I couldn’t transfer pictures or photos to the application from outside... In our lesson this week, we shared the story creation drafts we had prepared as homework with each other. After getting feedback on my story draft from the instructor, I learned that I might have a problem with the length, so I learned his advice to reduce the process intensity and how my dramatic question should be revised; my friends also said that they liked it without giving any additional feedback... Here, I had difficulty in the ‘writing a dramatic question’ part” (P1 / Voiceover / Music / Adding multimedia / Adjusting the mathematical operations / Creating a dramatic question).

“I had difficulty at the beginning because I was not used to the Animaker program, but over time its layout could be understood. I had a lot of problems in this program when I wanted to add something after finishing the story, as when I added something, it was very difficult to record and adjust the location of all the sound recordings. After watching the videos, I realized that my deficiency was in the dramatic question. The areas where I had the most difficulty while preparing my own DS were choosing a topic and preparing a dramatic question. For this reason, I generally decided by looking at the outcomes, and an idea came into my mind in that way. Moreover, advertisements were a source of inspiration for me while preparing the video” (P2 / Using the software / Adding multimedia / Creating a dramatic question / Choosing the topic).

Findings regarding the elements that the participants paid attention to while evaluating digital stories in the DST workshop evaluation activity

Two categories were obtained from the analysis of the data, and these are presented in Table 2.

Table 2.
Categories and Codes for Elements That Participants Paid Attention to When Evaluating Digital Stories

Categories	Codes	f
Relating to the story	Dramatic question	4
	Purpose of the story	2
	Originality	2
	Daily life-mathematics relationship	1
	Grammar	1
	Length of story	1
	Economy	1

Table 2 continuing

Technological elements	Sound	3
	Music	3
	Multimedia synchronization	2
	Character selection	1
	Scene transition	1
	Sound-scene compatibility	1

It was determined that the participants mostly focused on the dramatic question, the purpose of the story, and originality in their evaluations of the story. In the technological elements, sound and music evaluations were at the forefront.

“This week, we watched and evaluated digital stories prepared on different topics in mathematics. Most of the stories lacked a dramatic question, and I realized once again how important this part was. In some videos, the music was not suitable or else the music drowned out the character’s voice. This issue also needs to be given close attention. Some of the stories were very appropriate for their purpose and covertly embedded mathematics in real life, but some of them were like direct mathematics questions. I realized that it was more correct to use the same characters in the scenes in terms of story integrity. When a real human figure is put in a cartoon character, there is a break in the story, so it is necessary to set the characters correctly. We should also choose music that is appropriate for the scenes” (P2 / Dramatic question / Music/ Daily life-mathematics relationship / Character selection).

“During the course, in my mind, I always thought, ‘What great ideas these are, why don’t I think of them?’. However, there were some situations that I saw were lacking, of course, and these were a few more scene transitions, the compatibility of the sound with the scene, and the length of the story. Most of the stories I examined did not have a dramatic question. This was one of the biggest shortcomings. Most of them were original and has not have unnecessary content in accordance with the purpose of the story but some of them had inconsistency between scenes and sounds” (P3/ Scene transition/ Sound-scene compatibility / Length of story / Dramatic question / Originality / Economy).

Findings regarding the advantages and disadvantages of conducting the DST workshop online

The data were analysed and are presented in Table 3:

Table 3.

Categories and Codes for the Advantages and Disadvantages of Conducting the Workshop Online

Categories	Codes	<i>f</i>
Advantages	Time saving	3
	Online sharing	1
	Both the stories and the process are online	1
	Opportunity to watch lesson recordings later	1
	Opportunity for screen sharing	1
	Efficiency	1
Disadvantages	Limited interaction with participants	2
	Loss of time	1
	Difficulty of group work	1

As seen in Table 3, the participants mostly stated that conducting the workshop online was advantageous in terms of saving time. The limited interaction with the participants was the code mostly stated as a disadvantage.

“Our advantages were that we saved time, and the fact that we all had a computer at hand in a lesson that should take place in a technological environment increased the efficiency, and thus, everyone had the opportunity to experience one-to-one the work done and the applications used by each other. Our disadvantages were that since we could not be in the same environment and breathe the same air during the lesson, we may not have been able to fully exchange our thoughts, ideas, and feelings with each other, and had we been able to work

face-to-face, the exchange of ideas in the discussion environments we created might have been better” (P1 / Time saving / Efficiency / Online sharing / Limited interaction with participants).

“As an advantage, it was nice that the lessons were taught in this way since the stories were prepared in an online environment. With screen mirroring, we were able to learn the programs more easily and quickly and put them into practice. I don’t think there was a disadvantage. I think the DS design process can be taught online” (P4 / Both the stories and the process are online / Screen sharing).

Findings Regarding the Benefits of the DST Workshop for the Participants

The data on the benefits of the DST workshop for the participants were analyzed, and two categories were obtained and are presented in Table 4.

Table 4.

Categories and Codes for the Benefits of the DST Workshop for the Participants

Categories	Codes	<i>f</i>
Technological benefits	Positive attitude towards technology	3
	Acceleration in technology use	1
	Using technology in class	1
	Discovering new programs	1
	Adapting technology to mathematics	1
	Production through technology	1
	Learning a method that will draw attention in class	1
Other benefits	Daily life-mathematics relationship	1
	Writing stories, developing scenarios, and fictionalizing	1

As can be seen in Table 4, the participants mostly state toward they developed a positive attitude towards technology. The frequency of codes in the other category is the same.

“In this process, I discovered programs that I did not know about before and learned how to adapt them to mathematics and to draw attention in class in different ways. This increased my interest in technology” (P2 / Discovering new programs / Adapting technology to mathematics / Positive attitude towards technology).

“There was pleasure and excitement given by producing something with technology. Normally, I don’t like technology and avoid it, but I designed the digital stories with love. I am sure that my future connection with technology will be less biased because I realised that I could achieve what I said I could not achieve” (P3 / Production through technology / Positive attitude towards technology).

Findings Regarding the Participants’ Experiences in Using the Digital Stories They Prepared in the Workshop in Their Mathematics Classes

While P1 and P3 stated that they could not use the prepared digital stories in their mathematics classes since there was no participation in the relevant course in online education, P2 and P4 stated that they used them.

“Yes, I used them. Since the class size was small, I did not have any difficulties. I used them for the process priority topic and the students watched them carefully and said that they liked them very much. I think it was beneficial” (P2).

“I used the videos we prepared within the scope of the workshop in the online environment during the pandemic process. Due to the low participation in the online classes and the internet connection problems experienced, I only had the chance to show them one story. However, I evaluated the stories in the evaluation stage of the lesson, in terms of repetition of the topic and in order to inform the students about DST. Due to the very low participation, I did not have the chance to get much feedback from the students. When I examined some of the reactions I received, the fact that the digital stories contained stories and examples from daily

life attracted the attention of some students, but they were not liked by other students as well” (P4).

Findings Regarding the Benefits of Digital Stories for Students in the Event That They Are Used in Mathematics Classes

The data were analysed and are presented in Table 5.

Table 5.

Codes Regarding the Benefits of Digital Stories for Students in the Event That They are Used in Mathematics Classrooms

Codes	f
Boosting the imagination	2
Associating mathematics with daily life	2
Improving communication skills	1
Developing creative and critical thinking skills	1
Arousing curiosity	1
Developing problem-solving skills	1
Improving perception skills	1
Grasping the subject	1
Activating different types of intelligence	1
Developing a positive perspective on the subject	1
Improving the use of technology	1

The most repeated codes were boosting students’ imagination and associating mathematics with daily life.

“It improves communication skills because effective listening and effective speaking, which are two important aspects of communication, are used both while watching and commenting on these stories. It develops creative and critical thinking skills because creativity is used to explain one’s own different ideas while commenting on a story. It makes the lessons feel close to real life because students can find themselves in any part of the stories. It develops their curiosity and imagination skills because it increases their interest and curiosity thanks to what they watch. It improves students’ problem-solving skills because they watch and interpret the problems and solutions exposed in the stories” (P1 / Improving communication skills / Developing creative and critical thinking skills / Associating mathematics with daily life / Arousing curiosity / Boosting the imagination / Developing problem-solving skills).

“I think students’ perception levels increase thanks to digital stories. In other words, their ability to perceive what is intended in the story develops. Thus, they can perceive the thing that is intended more easily in new generation questions, which are actually the problems of the present day” (P2 / Improving perception skills).

“There are concrete examples in terms of associating mathematics with daily life, and I think there will be a positive effect in this respect. At the same time, I believe it will have a successful effect in terms of grasping the subject” (P3 / Associating mathematics with daily life / Grasping the subject).

Findings Regarding the Progress of the Participants During the Workshop Process

In order to analyse the progress of the participants during the workshop, the online lesson recordings and the digital stories they designed in the process were analysed.

The case of P1

In the workshop, P1 introduced the Animaker and Biteable programs. While introducing the programs, she made presentations via mini videos. Compared to her other teammates, she prepared a more detailed introductory video and made more detailed explanations. She designed a total of three digital stories in the Animaker program. Her first story about the story of the number pi was 3 minutes and 8 seconds long. In the DS she prepared, the sound of the music drowned out the voice of the character in some places. The images transferred from outside the program were found not to be very compatible

with the story. In addition, it was determined that there were writing and spelling errors in the story. The subject of the second DS made with Animaker was the calculation made by two friends between themselves of the number of flowers using fractions. A dramatic question was not used in the DS. In addition, the music used drowned out the character's voice. It was also determined that there was an error in reading the fractional number. It was seen that there were writing and spelling errors throughout the story. In the last DS, the problem of determining empty seats and rows, on the condition that a group of friends sat side by side at a basketball match, was discussed. Contrary to the stories she prepared before, no errors or deficiencies were found in this DS, which was based on calculating the specified percentage of a quantity.

P1 told the story of the number pi in her first story. There is a speaker in the story and he gives information about the number of pi. He said that throughout history there were people who were interested in circles and that this was a need. He also gave a short formula on how to calculate the number pi. In the second story, there are two characters. The first character told the other character how beautiful the flowers he grew in his house were. The first character asked her to do a calculation and said that if she did the calculation correctly, he could gift him a flower. Accordingly, there are 4 flowers in the room and this number is $\frac{2}{7}$ of the total number of flowers. The other character remembers how she learned in school how to find the multiplicity given as a simple fraction, and by calculating he finds that the total number of flowers is 14. Since the result is correct, his friend gives the flower as a gift. Here, P1 chose an example from the subject of fractions and associated it with daily life. In her last story, P1 dealt with the situation of four close friends going to a basketball game and sitting side by side in the stands. Accordingly, the first row of the tribune is 100% full and the number of seats here is 50. There are 4% vacancies in the second row and 8% in the third row. They realized that they could not be in the first row in the dialogues, but they should look at the second and third rows. However, they stated that the number of seats in the second and third rows is not certain. P1 made a presentation with the help of video in her first story. It is observed that only information is given in this presentation. In the second and third stories, mathematical subjects are associated with daily life. Problem solving was done with calculations and explanations by including mathematical operations in line with a problem.

The case of P2

Using the program called Moovly, P2 first discussed the calculations made among themselves by students, who accidentally broke the window of the classroom, to pay for the cost of the glass. It was determined that the prepared DS was very short (1 minute). P2 stated that this was due to the fact that she could not use the program in the way that she wanted and that the feature of adding sound in the program was limited. After choosing Animaker, she designed a 3-minute DS aimed at cooperation that included exchange and ratio-proportion. It was determined that there were problems in sound, writing, and spelling in the DS. Moreover, it was determined that a large part of the story included unnecessary dialogue. In the last DS, it was seen that she created two different scenarios in the same story for calculations of area. It was observed that questions and explanations were frequently used in the story. Unlike the previous one, no problems were encountered regarding sound and music.

In its first story, P2 is about 4 students breaking the classroom window while playing ball. Their teachers reported that they had to pay a total of 60 TL to have the glass made. Everyone has a different amount of money in their pocket. The amount that each of them has to pay is 15 TL. Everyone will calculate how much to give out of their pocket money. Fractions are used here. For example, he stated that a child who has 45 TL in his pocket must give $\frac{1}{3}$ of his total money in order to give 15 TL. It includes both four operations and fractional notation and calculation. In the second story, the teacher watched a video. This video is about helping each other. Two friends want to sell orange juice to apply for this cooperation project. They stated that 50 ml of water comes out of an orange and that a glass of orange juice is 200 ml. They calculated that it takes 4 oranges for a glass of orange juice. He then stated that they would sell 100 glasses of orange juice for 5 TL. He calculated that they would earn 500 TL from 100 glasses of orange juice. He calculated that an orange costs 25 cents and 400 oranges are needed, that is, they will spend 100 TL. In the end, he explained that they would earn 400 TL and that they could give it to the project. P2 constructed a shopping problem in this story and calculated the profit by subtracting the expenses from the expenses. Four processes were used extensively. P2

developed a fiction about area calculation in his last story. The girl, sitting with her father, watched a news report about the obligation of parking in houses of 120 m^2 and tried to find out whether their house complied with this obligation. To the girl who knows meter but not m^2 , her father explained that m^2 is used in area calculations. She calculated the area of all the rooms in turn and found that the total area was less than 120 m^2 . Later, the character, who was talking to his friend on video, liked the wallpaper in his friend's room very much and wanted to buy it. The father of the girl, who could not find the wallpaper she wanted, stated that they could make the wallpaper themselves. She calculated that the wall of her room was 20 m^2 . She tried to make the wallpaper she wanted by creating rectangles with side lengths of 25 cm and 20 cm. For this she calculated that she would need 400 rectangles. P2 associated mathematics with daily life in this story. He also made area calculations. She also addressed the issue of converting area measurement units to each other. Looking at the stories of P2, it is seen that she started with four operations and fractions and then formed more complex fictions including these.

The case of P3

P3 introduced the Plotagon and Renderforest programs and, with Renderforest, also reflected her sense of responsibility by creating a fictionalization to determine the amount of money a child should save each day in order to buy the bike he/she wanted. She had a problem while sharing the DS she prepared. In her story, it was seen that contrary to the first stories of the other participants, she successfully created the dramatic question. However, since she voiced all the characters in the story herself, the story was problematic in terms of voiceover. It was determined that as well as problems with the colors used, there were unnecessary dialogues. She also did not use music. The first DS that she prepared with Animaker lasted 3 min 31 sec. The aim of the DS was to introduce integers with the weather forecast. It is not a very understandable story and it was determined that there were typos. In addition, it was found that the images were incompatible and that a dramatic question was not used. The last story, on the other hand, was a four-minute story that aimed to introduce time measurement units, proceeded with questions and answers, and took place in two different locations. No problems with the sound, music and images were encountered in the story.

In its first story, P3 focused on a child's desire to buy a bicycle. Her mother stated that she needed to save money to buy the bike she wanted. She calculated how much money she had to save per day to buy the bike, which was 750 TL. There are 5 months to summer. By calculating a month from 30 days, she realized that there are 150 days in total. She calculated that she could buy the bike she wanted by saving 5 TL every day. P3 utilized four operations here. In the second story of P3, it was the subject of the teacher explaining the subject of integers to the students in the classroom. The teacher first showed the weather video. Accordingly, the expressions below 0, 0 and above 0 are used in the case of weather. After the teacher watched the video, he explained these concepts in turn and explained integers. Then, by asking questions, she explained the concepts of negative, positive and 0 in the class according to the video. It was seen that P2 made use of examples in explaining the definition in this story. In its last story, P3 has built a dialogue between two sisters on vacation at sea. Accordingly, the characters first defined the concepts of seconds, minutes and hours with the examples they gave among themselves. They then talked about the fact that it takes 10 hours for them to arrive at the resort, and it can be confusing to use the concepts of minutes and seconds in long-running situations. With their fathers included in the story, they calculated how long it would take their fathers, who had come to the holiday destination by plane, had come by bus. P3 used time units. It also benefited from four processes. In her stories, it was seen that there was a tendency towards making a definition without calculating and calculating with the definition.

The case of P4

P4 introduced the StoryboardThat and Animoto programs but stated that she was looking for another program to prepare her first DS. She designed her first DS with SuperAnimo. Due to the program feature, she designed two stories. In total, she achieved a three-minute video. She voiced all the characters herself, and therefore, the story was found to be problematic in terms of sound. She had trouble sharing the story. The story contained language and grammatical errors. She stated that she had problems in using Turkish fonts. The pictures added from outside the program were not suitable for

the background. She prepared her second story about percentages in Animaker. The first part of the story was about the implementation of a percentage discount on a camera the character liked. In the second part, she mentioned the subject of buying a gift for her mother on her birthday. The duration of the story was 3 min 21 sec. There was a dramatic question in the story and moreover, there were no spelling mistakes. It was determined that the colors were appropriate and that there was no problem in terms of sound and music. She stated that she was more comfortable with the application, but had difficulty in writing a script. When the second stories were examined, it was determined that P4's story was the best. She stated that she had difficulty writing a dramatic question while composing the final story. P4 created a story about the perimeters of triangles and quadrilaterals. It was determined that in the DS, there was incompatibility in the pictures added from the outside, but there was no problem other than that. The duration of the last story was 4 min 30 sec.

In her first story, P4 dealt with two sisters walking in the forest. These sisters talked about the order of shapes of some animals and plants they saw in nature. When they came home, they shared what they saw with their mothers, and their mothers also explained the concept of the golden ratio. In the second story of P4, father and daughter saw that there was a discount on a shopping site in the advertisement and this was expressed as a percentage. Her father explained to the girl who did not know the percent symbol. Upon this, they saw that there was a discount on the camera that they wanted so much. They calculated how much they could buy a 1000 TL photograph machine with a 20% discount. In the continuation of the story, mother's day is approaching. The girl, who wanted to buy a bag for her mother as a gift, calculated how much she could buy with a 20% discount over 200 TL, and took the gift and gave it to her mother. In the last story of P4, a girl wants to decorate her room. She shared with her sister that she wanted to place a lighted ornament on the edge of the mirrors in her room. The girl, who went shopping with her sister, took ornaments by calculating the perimeter of the isosceles triangle and rectangular mirror in her room. When she came home, she saw that she measured the edges of the rectangular mirror differently and saw that she had some ornaments left in her hands. Upon this, she wanted to evaluate these ornaments by having a new trapezoidal mirror made. For this, she constructed a trapezoidal shape with two different side lengths. It was seen that P4 gave information about the golden ratio in his first story. In the second story, percentages were used by relating it to daily life. Explanations are also included in this story. In the last story, perimeter calculations of polygons are presented by associating them with daily life. Compared to the first story, it was seen that the other stories focused more on problem solving.

It was observed that all participants actively participated in the course, criticized each other, helped each other, supported each other, and sometimes worked in cooperation. The fact that the final digital stories of the participants were good can be interpreted as the fact that the process was efficient.

Discussion, Conclusion, and Suggestions

In this study, an online DST workshop was held with mathematics teachers studying for a master's degree, and the process was examined from various perspectives. Firstly, the situations in which the participants had difficulties in the DST workshop were determined. It was observed that all participants had difficulties in creating a dramatic question and transferring it to their stories. The dramatic question is defined as a question that draws the attention of the audience and is resolved at the end of the story (Bull & Kajder, 2005). The dramatic question is the one that keeps the audience curious throughout the story and is resolved at the end of the story. What is expected of a good dramatic question is that it encourages the listener to pay attention to the end of the story and to think about the end of the story. Similarly, there are studies in the literature that point out the difficulty of creating dramatic questions (Kildan & İncikabı, 2015; Kocaman- Karoğlu, 2016). It was determined from both video recordings and reflective diaries that not all participants initially understood what the dramatic question was. In addition, it was determined that they did not well on the dramatic question in their first stories. During the workshop, discussions were held on the dramatic questions that the participants tried to pose. The participants had an idea by getting feedback from both the researcher and each other. In addition, in the evaluation study of digital stories, they focused more on digital stories and gained knowledge about the dramatic question. However, when the participants' final digital stories were examined, it was seen that there was less problems with the dramatic questions. It can be said that the workshop benefited the participants in this regard. In digital storytelling,

technologies are utilized to support the educational process (Yüksel, Robin & McNeil, 2011). There are numerous technologies that have different features for designing digital stories. It is possible to mention a wide range of paid and free usage options that have different interfaces, characters, scenes, sound, and music alternatives. So as not to restrict the participants in this workshop, the choice of tool to be used was left to them. The participants examined and presented two tools each and determined the appropriate tool. Despite this, most of the participants stated that they had difficulties in adding multimedia. It is considered that the software selected in studies on DST should have many different multimedia content, because otherwise, participants have to make additions from outside. While making additions, the subject of copyright infringement may emerge, while various difficulties may also be experienced in obtaining suitable images for the story. Indeed, a similar situation was experienced in this study. In the study, it was seen that the participants mostly considered the dramatic question item while evaluating the sample digital stories. This situation can be associated with the fact that the participants mostly had difficulty in creating a dramatic question. In the evaluations, an important finding that emerged was that the participants focused not only on the technological elements but also on the story. Lambert (2006) stated that sound and music are important in providing the emotional content of the DS. The fact that the participants paid particular attention to these two elements can be interpreted as the fact that they understood the theoretical framework.

In the process, at first, the participants focused more on the technological part. However, in the later stages of the workshop, it was determined that they associated mathematics with daily life more in creating digital stories. It was determined that they thought about explaining the subject/concept more easily while designing their digital stories in the course recordings. In addition, it was observed that they had ideas such as attracting the attention of the listeners and emphasizing the use of mathematics in daily life. It was also determined that they posed a mathematical problem and made transaction calculations. For example, P1 and P4 gave more information about a concept in their first stories. (pi number and golden ratio). But later, they created stories that required complex mathematical operations and occasionally included explanations and definitions. In these stories, they started with a problem situation and eventually solved that problem.

While stating the advantages of conducting the DST workshop online, the participants mostly mentioned the saving of time. James (2002) also mentioned the benefit of online education in terms of saving time. Efficiency and shorter design time compared to face-to-face education for participants in different geographical areas (Piskurich, 2006) was another finding obtained in the research. The possibility to watch the lessons later (Çıralı-Sarıca & Koçak-Usluel, 2020) was another of the advantages mentioned, while limited interaction (Coman et al., 2020; Dung, 2020) was determined as a disadvantage in this study.

While expressing the benefit of the process for them, the participants frequently mentioned technology. Çetin (2021) also mentioned a similar situation in his study. Technical knowledge, which is one of the 21st-century skills, is expressed as the ability to use devices and applications to perform practical tasks and to recognize specific online environments (Van Laar et al., 2017). Researchers define 21st-century tools as critical facilitators of learning. The information age, which emerged with the widespread use of these tools, prepares people for a world in which there are deep information flows, opportunities, and choices. Information and communication technology helps people make sense of this preparation (Salpeter, 2003).

The participants were asked to use the last four digital stories they designed in their classes. However, it was determined that only two of the participants were able to use the stories in the classroom. In our country, which has switched to online education due to the pandemic, a number of problems are being experienced. Demir & Kale (2020) stated that the inadequacy of the internet, the lack of hardware tools, parents' technological knowledge, and students' individual characteristics cause problems in distance education. Erdem & Arı (2021), on the other hand, stated that lack of devices, internet connection problems, psychological, familial, and environmental factors, and health factor was effective on students' absenteeism in online education. Although the reasons for absenteeism were not focused on in the study, it is thought that there were absences due to similar reasons and that therefore, digital stories were not used. It is necessary to increase students' online satisfaction and engagement

by creating opportunities for designing online education in such a way as to better meet students' needs (Henry, 2020).

In their study, Karakoyun and Kuzu (2016) stated that performing digital storytelling activities in the online environment would attract students' attention, accelerate the digital storytelling process, increase communication between students, and contribute to the development of students' digital stories. In addition, both pre-service teachers and primary school students agreed that digital storytelling improves students' 21st-century skills. Özüdoğru (2021) stated that it increases motivation, facilitates learning, enables multiple learning, and develops technology use and creativity skills. Similar results were obtained in this study.

When the development of the teachers by means of the stories they prepared is examined, it can be said that they all made progress and that there was no problem with the final products that emerged, and therefore, that the process was efficient.

The presentation of the digital stories prepared in the research to students in the classroom environment was limited. The study was conducted in order to teach the DS design process to teachers so that they could carry out mathematics education more effectively and efficiently. However, it is thought that more comprehensive observations about the effectiveness of the process can be obtained by examining its use in the classroom environment. Therefore, it can be recommended that classroom applications are carried out after completing the DS workshop process.

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