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Non-linear digital storytelling: Effect on technology utilization and writing self-efficacy

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ABSTRACT

This study aimed to investigate the effect of non-linear digital storytelling on pre-service teachers' use of information technologies and their writing self-efficacy. It also focused on the effects of non-linear digital storytelling in education environments. Convergent parallel design, one of the mixed methods, was used in the study. The quantitative part of the study was designed with pretest-posttest control group design while the qualitative part was designed as a case study. The study group consisted of pre-service teachers enrolled in the Multimedia Design and Development course at the Computer Education and Instructional Technologies Department. In the framework of the study, the pre-service teachers in the experimental group participated in the non-linear digital storytelling activity while the pre-service teachers in the control group participated in the linear digital storytelling activity. Self-Efficacy Scale for Using Communication and Information Technologies, Writing Self-Efficacy Scale, semi-structured interview form and student reflections were used to collect the data. Based on the results of the study, it was found that non-linear digital storytelling method did not significantly affect the use of information technologies and writing self-efficacy statistically. The analysis of qualitative data presented the advantages and various aspects of using the non-linear digital storytelling method in education.

1. Introduction

In today's information age, educational environments are becoming more and more enriched and interactive to ensure students' active participation. This process requires a continuous restructuring of teacher qualifications, learning skills that students are expected to have, and training and learning environments supported by technology [1]. Training and learning environments utilize many technologies to encourage students' active participation. One of these technologies is digital storytelling. Digital storytelling is the narration of stories with various multimedia elements such as sound/audio, image, and video [2]. In other words, digital storytelling is the combination of traditional storytelling and the use of multimedia technology [3].

Digital stories may be linear and straight forward. In linear stories, there is only one path: the story has an introduction, a body, and a conclusion [4]. The path that the user must follow is clear; the user cannot interfere with the sequence, cannot change the result of the story and user's only interaction with the story is to stop, pause, forward, or rewind the story [5]. However, in non-linear digital storytelling the stories are created with non-linear scripts [6] and the story includes different paths [7]. There is more than one alternative path in the story and different stories may be created depending on the users' preferences in interaction points [5]. This approach allows the user to combine and organize different ideas [4]. In traditional narratives, the user is less likely to evaluate or criticize the story's claim or outcome, but in interactive ones, the user can evaluate options at decision points [8].

Holase [9] stated that a single formal structure cannot be defined in non-linear narratives, and there can be many different forms and applications. The author also stated that probabilities shape the occurrence of a series of events, providing ways for choice and/or changeability. Özüdoğru and Çakır [10] presented the sequence examples for linear and non-linear digital storytelling structure as provided in Fig. 1 and Fig. 2.

Non-linear narrative is a form of narration that is structured by using non-linear representations of knowledge, time and space [9]. This method is very valuable for educators too regarding the influences on the lessons since students can change the outcome of a story and affect the story in non-linear digital storytelling [11]. Green and Jenkins [8] stated that interactive narratives, which have an educational and entertaining structure, can be a persuasive and interesting way to

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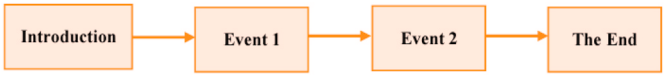

Fig. 1. Linear story order.

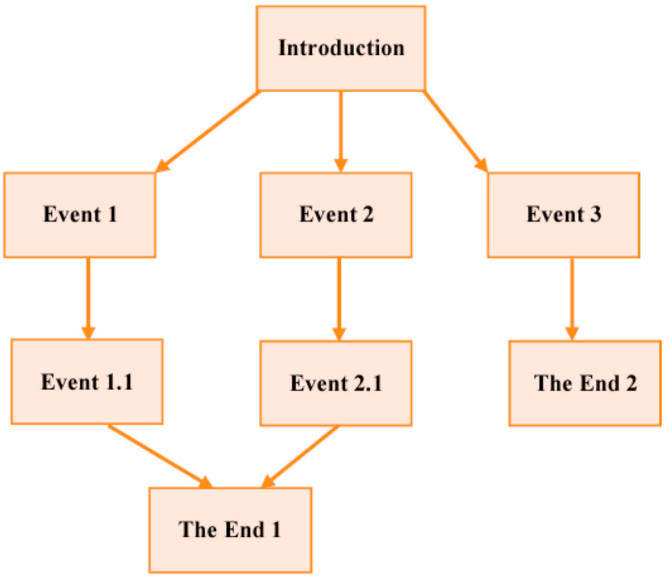

Fig. 2. Non-linear story order.

perform behaviors. In addition, they stated that increased sense of responsibility may lead to attitude and behavior changes, since the results of the story in interactive narratives are the user's own choice.

Holase [9] expressed that the user changes his/her role of a passive observer to an interactive participant in branched narratives. In regards to the classroom environment, teachers' ability to create non-linear digital stories can be effective in activating students during the lesson.

Within the scope of this research, pre-service teachers studying in the Department of Computer Education and Instructional Technologies (CEIT) in the Faculty of Education were selected as participants due to their experience in technology use and software compared to the pre-service teachers in the other departments of the Faculty of Education. Developing non-linear digital storytelling method requires expertise in various software.

This study aimed to investigate the effect of non-linear digital storytelling on pre-service teachers' writing self-efficacy and self-efficacy in using technology because the two main points that distinguish developing non-linear digital storytelling from developing linear digital storytelling are writing and technology use. In addition, the study aimed to provide pre-service teachers with a product/material development experience using technology. This research was designed on the basis of studying how pre-service teachers' self-efficacy could be improved to better prepare them for their professional lives since teachers gain rich experiences in pre-service training and improve their self-efficacy which will contribute to their qualifications. During the study, the non-linear digital storytelling group wrote stories with non-linear scripts while the other group wrote a linear straight story. Similarly, while students in the linear digital storytelling group created digital stories similar to plain videos, the other group used special software to combine different stories and to add interactivity. The study investigated how students' self-efficacy was affected by this. In addition, exploring the opinions of pre-service teachers about the process with the help of this study was thought to be valuable in regards to revealing the different points related to the method. This study investigated the following research problem: "What is the effect of non-linear digital storytelling on the self-efficacy in using information and communication technologies and writing self-efficacy?" along with the following sub-problems:

- Is there a significant difference between the experimental and control group pre-service teachers' scores of self-efficacy in using information and communication technologies (SEUICT) that they acquired from pretest and posttest?
- Is there a significant difference between experimental and control group pre-service teachers' writing self-efficacy (WSE) scores acquired from pretest and posttest?
- What are the opinions of the information technology pre-service teachers about the non-linear digital storytelling method?

1.1. Literature review

1.1.1. Non-linear digital storytelling

The use of non-linear digital storytelling in educational settings has various impacts. Letonsaari and Selin [12] associated non-linear digital storytelling with digital games and stated that the non-linear structure requires a more detailed study of the subject and careful consideration of various perspectives. Similarly, Rasmusson and Bourne [11] likened the paradigm of selection in non-linear digital storytelling to games. Non-linear structures are also effective in creating individualized learning environments [6] and cooperative learning environments [4, 7]. In their study, Spanoudakis et al. [13] introduced a socially interactive digital storytelling platform. They stated that branched structures in non-linear digital storytelling attract attention and evoke a sense of continuity and can improve students' language skills, technological skills and presentation skills. In their research, Shelton, Warren, and Archambault [14] had one group of pre-service teachers watch an interactive digital story while the other group watched a traditional digital story for 15 weeks as part of a course. According to the findings, interactive digital stories were more effective in obtaining lesson outcomes and ensuring participation, but did not increase accountability compared to traditional videos.

While interactive environments such as non-linear digital storytelling are claimed to offer student-centered, constructivist environments, it is essential to do research about the reality of this claim [6]. In their study, Liu et al. [4] compared the linear and non-linear digital storytelling methods in a collaborative setting with primary school students. They made it easier for the students to draw pictures, create animations and share the comments of the works in cooperation with the platform they designed within the scope of the study. Children's activities on the screen, the cooperation process and screen videos were analyzed. They concluded that the non-linear group performed better in terms of derivation, remix, ownership and positive dependency.

Maleki and Sajjadi [15] compared linear and non-linear storytelling method in teaching technical English to medical students. They concluded that non-linear storytelling had a positive effect on student motivation and participation. Prosser [6] used digital stories with non-linear, interactive narrative structures in language teaching and investigated the effect of non-linear structures on cognitive load. By enabling the language learners to access non-linear digital stories via a website, their screen behaviors were analyzed while they were watching the story. He/she reached the conclusion that non-linear structures did not cause cognitive overload. In their research, Rasmusson and Bourne [11] reported that the non-linear approach to digital storytelling would support achieving the learning outcomes in various disciplines. Thompson [16] implemented a non-linear story creation activity with a digital software in forensic medicine education to a group, while the other group used a traditional narrative model. It was concluded that non-linear narration had a positive effect on comprehension and students found it more interesting.

1.1.2. Digital storytelling and writing and technology self-efficacy

Self-efficacy in using information technologies and writing self-

efficacy are important for pre-service teachers because in their professional careers, they will be expected to design learning environments that are enriched with technology. In addition, teachers' writing self-efficacy is an important factor due to the immense influence they have over their students [17]. Therefore, it is extremely important to develop these skills in pre-service training. Teachers can use writing as a powerful learning tool to help their students to reflect on what they read and listen and to develop their own thoughts [3]. Some studies in the literature argue that pre-service teachers' competencies in technology use [18,19] and writing [20,21] are not sufficiently high. Therefore, contributing to the efforts that design and develop instructional interventions remedying lack of technology competencies and writing skills of pre-service teachers is important.

Students who participate linear or non-linear digital storytelling developing activities use computer technologies intensively. There are studies revealing that digital storytelling has an effect on self-efficacy in using technology [22–25]. Chan, Shurchill and Chiu [26] investigated how to use digital storytelling activities to facilitate students' digital literacy. Videos and the digital stories prepared by the investigators were examined to measure students' digital literacy. They found that the use of digital storytelling improves students' digital literacy in higher education. Al-Shaye [27] investigated the effect of online digital storytelling on improving pre-service teachers' critical reading skills, critical thinking and self-regulated learning skills. With the quasi-experimental method, online digital storytelling was implemented to the experimental group and traditional narration was used for the control group for 12 weeks. It was observed that online digital storytelling improves pre-service teachers' critical reading skills, critical thinking and self-regulated learning skills.

Various special software is used to combine the parts of the story and to facilitate making the bridges and the connections [12]. Hence, learners' technological self-efficacy can be regarded as one of the key factors in the success of the digital storytelling method. Teachers' technological competence is important because of their responsibilities such as being a role model, providing technological solutions, and increasing their students' motivation to use technology [28]. Pre-service training is of great importance in developing teacher competencies.

One of the most important stages of the digital storytelling process is writing and writing skills and other language skills are effectively used in digital storytelling [29]. In their experimental study [1], presented that digital storytelling increased student attitudes towards story writing. In addition, there are studies that show that digital storytelling has an impact on writing self-efficacy perception [3,29–32]. However, in their experimental study, Sudarmaji, Mulyana and Karsiyah [33] concluded that digital storytelling had no significant effect on writing.

Literature review shows that the results may differ based on various aspects such as the context, field, participants, and type of storytelling used in the studies. For this reason, the generalizability of the results can be increased by enriching the studies with different participant groups in different contexts, in different genres and fields.

2. Materials and methods

2.1. Model

The research was carried out by using the mixed method which integrates quantitative and qualitative research methods to better understand the research problems [34]. Convergent parallel design (triangulation), one of the mixed research method designs, was used in the study. This design gives equal priority to qualitative and quantitative methods to determine whether the investigated research problems can be explained with a uniform understanding [34]. A quasi-experimental design with pretest posttest control group was used in the quantitative part of the study. The case study method was used in the qualitative part of the research. The case is pre-service teachers' usage the non-linear digital storytelling.

2.2. Implementation process

The implementation was carried out for 9 weeks with 4 h per week sessions during the Multimedia Design and Development course in the 2018–2019 spring semester. The process took place in a computer lab with 45 laptop computers. There was also a projector and internet connection in the laboratory. Multimedia Design and Development course is included in the pre-service teachers' curriculum as a compulsory course. The course content includes components such as adding pictures and sound, animation and activities such as preparing a multimedia application. For this reason, the study was implemented within the scope of this course. Each student in the experimental and control groups was expected to design and produce a multimedia project at the end of the course. The course instructor is a computer and instructional technology expert, who has conducted academic and scientific research on digital storytelling and taken part in projects on the subject. During the study, the instructor undertook the tasks of informing the students, providing feedback and guiding them in the process of linear and non-linear digital storytelling.

Data collection tools were applied to the experimental and control groups as a pre-test before the research. A nine-week experimental process was carried out. At the end of the application, data collection tools were applied as a post-test. In addition, interviews were conducted and pre-service teachers' reflection reports were collected. The design of the study is provided in Fig. 3.

Before the experimental procedure, experimental and control groups were given the Personal Information Form, SEUICT and WSE scales. A weekly plan was developed by the researchers for the implementation process. The process was based on the stages of digital story creation as proposed by Cennamo, Ross and Ertmer [35]: script writing, storyboard development, placement of images, creating a digital story and sharing with others. Table 1 displays the weekly implementation plan for the experimental process:

During the application process, the students used only one software for linear digital stories while transferring the story to the digital environment (such as Vyond, Powtoon, Storyboard That, Adobe Captivate, Adobe After Effects and Adobe Flash). However, in non-linear digital storytelling, this process could be performed in two ways. First, students created the story sections with a tool that did not allow branching and then combined these stories with a tool that allowed branching. Secondly, they created the whole story with software that allows creating a branched structure.

Both groups of students developed digital stories as a course project assignment. In other words, these assignments were evaluated with a score. Students were informed about this at the beginning of the process. This may have motivated the students in the process. In addition, the instructor's continuous feedback during the course and outside of the course at difficult points and the permission to use the laboratories outside of the classroom for those with no have technical means were effective in their motivation.

At the end of this 9-week implementation process, students were

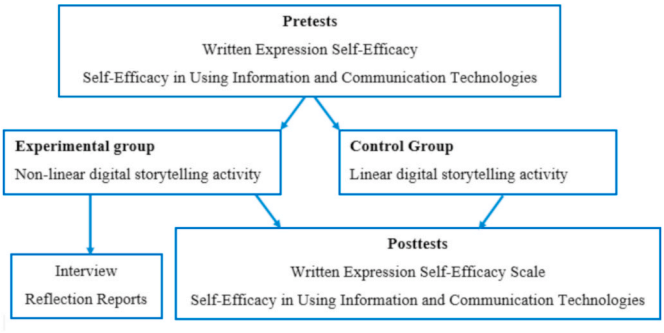

Fig. 3. Design of the study.

Table 1
Weekly implementation plan.

Weeks	Experimental Group	Control Group
Week 1	Information was given about non-linear digital storytelling and good practices were shared. Scripts, storyboards and digital stories for good practices were presented.	Information was given about linear digital storytelling good practices were shared. Scripts, storyboards and digital stories for good practices were presented
Week 2	Students were informed about the software that they could use for non-linear digital storytelling. Students were free to use any digital story creation software. Students used programs such as Vyond, Powtoon, Storyboard That, Adobe Captivate, Adobe After Effects and Adobe Flash. Students already knew how to use the cited software within the scope of their previous courses. Students were asked to come to the next lesson by writing a non-linear (branched) story script.	Students were informed about the software that they could use for linear digital storytelling. Students were free to use any digital story creation software. Students used programs such as Vyond, Powtoon, Storyboard That, Adobe Captivate, Adobe After Effects and Adobe Flash. Students already knew how to use the cited software within the scope of their previous courses. Students were asked to come to the next lesson by writing a linear story script.
Week 3	The instructor provided feedback to the non-linear stories written by the students. Then, the students finalized their stories.	The instructor provided feedback to the linear stories written by the students. Then, the students finalized their stories.
Week 4	Some students created the storyboards for their scripts by hand (drawing) while some used computer programs. However, most of the students created the storyboards by drawing on papers.	Some students created the storyboards for their scripts by hand (drawing) while some used computer programs. However, most of the students created the storyboards by drawing on papers.
Week 5	Students made decisions about the visuals such as the scenes, characters, objects etc. through the software they planned to use and started to digitalize them.	Students made decisions about the visuals such as the scenes, characters, objects etc. through the software they planned to use and started to digitalize them.
Week 6–7	They continued to create non-linear stories in the digital environment. The instructor checked their work and gave feedback.	They continued to create linear stories in the digital environment. The instructor checked their work and gave feedback.
Week 8	The students continued their work on digital storytelling. The instructor checked their work and gave feedback. They were asked to come to the next lesson with their final work.	The students continued their work on digital storytelling. The instructor checked their work and gave feedback. They were asked to come to the next lesson with their final work.
Week 9	The students presented the non-linear digital stories they prepared to their classmates and instructor.	The students presented the linear digital stories they prepared to their classmates and instructor.

given the Personal Information Form, SEUICT and WSE scales, 12 students were interviewed via the semi-structured interview form and student reflection reports were collected.

2.3. Study group

Convenience sampling method was used in the study. The study group consisted of pre-service teachers enrolled in the Multimedia Design and Development course in their 3rd year at Computer Education and Instructional Technologies (CEIT) Department of a university in the spring semester of the 2018–2019 academic year. Pre-service teachers from the CEIT Department were selected for this study due to their skills to use software (Adobe Flash, Adobe Captivate etc.) that can be utilized in developing non-linear digital storytelling activity. Table 2 presents the gender-based distribution of the experimental and control group pre-service teachers.

Table 2 shows an equal number of female pre-service teachers in the experimental and control groups while the number of male pre-service teachers in the experimental and control groups was close. Experimental studies require a minimum of 15 participants in each group [36].

Table 2
Distribution of pre-service teachers based on gender.

Gender	Experimental Group		Control Group		Total	
	N	%	N	%	N	%
Female	11	50	11	50	22	46.8
Male	12	40.6	13	31.2	25	53.2
Total	23	100	24	100	47	100

Chi-square analysis was conducted to examine whether pre-service teachers' groups differed according to gender.

According to Table 3, it was concluded that participants' groups did not differ according to gender, since $p > .05$. Table 4 displays their distribution according to their general grade point averages.

Chi-square analysis was conducted to examine whether pre-service teachers' groups differed according to their general grade point averages. Table 5 presents the Chi-square analysis performed in this regard.

According to Table 5, it was concluded that participants' groups did not differ according to grade point average, since $p > .05$.

2.4. Data collection tools and their validity and reliability

2.4.1. Self-efficacy in using information and communication technologies (SEUICT)

The scale was developed by Ertürk to determine pre-service teachers' SEUICT by collecting data from 206 pre-service teachers [43]. Exploratory factor analysis was performed for construct validity. The 15-item scale is a five-point Likert-type with options ranging from "Insufficient = 1" to "Completely Sufficient = 5" and has got three-dimensions: hardware-operating system usage skill (5 items, $\alpha = 0.884$), application programs usage skill (7 items, $\alpha = 0.916$) and dynamic web tools usage skill (3 items, $\alpha = 0.827$). The overall reliability of the scale was found to be $\alpha = 0.939$, which indicates sufficient reliability to use the scale collecting data from pre-service teachers.

2.4.2. Written expression self-efficacy scale

The scale was developed by Aydın et al. by collecting data from 601 pre-service teachers and by using principal component analysis, one of the factor analysis techniques to measure pre-service teachers' writing expression self-efficacy [17]. For reliability, the researchers performed item-total correlation, testing the differences of lower and upper 27% groups using the unrelated *t*-test, Spearman Brown split half-test correlation and Cronbach alpha internal consistency coefficient calculations. The 3-dimensional five-point Likert type scale ranging from "I'm not good at all = 1" to "I am very good = 5" has a total of 54 items. Scale dimensions and their reliability scores are as follows: draft (33 items, $\alpha = 0.96$), prewriting (12 items, $\alpha = 0.88$), revising and editing (9 items, $\alpha = 0.89$). The overall reliability of the scale was found to be $\alpha = 0.96$.

2.4.3. Semi-structured interview form

The interview form was developed by the researchers to investigate pre-service teachers' opinions on non-linear digital storytelling activities. Expert opinions were sought during the development process and the first version consisting of 10 items was finalized with 9 items based on expert opinion. Unclear items were also updated. The form includes questions about the difficult and popular aspects of the activity, the effects of the method on education in regards to teachers and students, comparison of linear and non-linear digital storytelling, etc. The interview form was individually administered to 12 pre-service teachers in sessions lasting approximately 10 min.

2.4.4. Student reflections

Reflection reports were collected from 12 of the pre-service teachers who were both interviewed and participated in the implementation of the non-linear digital storytelling method. In these reports, pre-service teachers were asked to express their opinions about the activities

Table 3
Examining whether groups were dependent on gender.

Group	Gender						X^2	sd	p
	Female		Male		Total				
	N	%	N	%	N	%			
Experimental	11	23.4	12	25.5	23	48.9	.019	1	.891
Control	11	23.4	13	27.7	32	51.1			
Total	22	46.8	25	53.2	47	100			

Table 4
Distribution of pre-service teachers by general grade point averages.

Average	Experimental Group		Control Group		Total	
	N	%	N	%	N	%
1.1–2.5	12	25.5	10	21.3	22	46.8
2.6–4.0	11	23.4	14	29.8	25	53.2
Total	23	100	24	100	47	100

during the course process, the difficulties they experienced during the activity, how they overcame these difficulties, the activities they liked and their views on the method in general.

Using a voice recorder in recording data and providing a consensus between encoders in analyzing data provide reliability in qualitative research [34,37]. In this study, the interviews were recorded with a tape recorder as well, the data were encoded by two coders in analyzing the qualitative data and the consensus between the coders was calculated. Miles and Huberman [38] proposed the consensus/(consensus + disagreement)*100 formula to calculate the consensus between coders and stated that 80% agreement is acceptable.

2.5. Data analysis

In data analysis, descriptive statistics were used for the analysis of descriptive findings and chi-square analysis was conducted to examine kurtosis and skewness values and whether gender and grade point averages was dependent on group. With the help of the skewness and kurtosis values, it was observed that the data showed normal distribution. Repeated measures for two-way ANOVA was performed to answer the first and second research problems. Content analysis was conducted to answer the third research problem. First of all, individual interview data recorded by using a voice recorder were transcribed. In addition, all the reflection reports for the pre-service teachers were added one by one to the interview transcript. Consensus among coders was calculated as 84.6%.

3. Results

3.1. Technology utilization self-efficacy

Two-way ANOVA analysis for repeated measures was conducted to examine whether pre-service teachers' technology use self-efficacy changed according to group. Table 6 provides the analysis results.

Table 6 shows that pre-service teachers' technology use self-efficacy did not have a statistically significant difference according to group ($p > .05$). Hence, SEUICT scores were not related to group.

3.2. Writing self-efficacy

Two-way ANOVA analysis for repeated measures was conducted to examine whether pre-service teachers' written expression self-efficacy changed according to group. Table 7 provides the analysis results.

Table 7 shows that pre-service teachers' written expression self-efficacy did not have a statistically significant difference according to group ($p > .05$). Hence, WSE scores were not related to group.

3.3. Qualitative findings

Content analysis was conducted to answer this problem. As a result of its analysis, two themes, six categories and 26 codes emerged. Below, frequency indicates the number of participants who indicated the given code. Table 8 presents the theme, category and codes found as a result of analyzing the qualitative data.

3.3.1. Advantages theme

This theme includes pre-service teachers' opinions about the positive effects that will arise when the non-linear digital storytelling method is used in education. Three categories emerged in this theme as supporting

Table 6
Two-way ANOVA for repeated measures results for technology use self-efficacy.

Group	N	Pre-test		Post-test			F	p
		Mean	Sd	N	Mean	Sd		
Experimental	23	4.23	0.51	23	4.53	0.39	0.225	.637
Control	24	4.28	0.60	24	4.48	0.45		

$P < .05$.

Table 7
Two-way ANOVA for repeated measures results for written expression self-efficacy.

Group	N	Pre-test		Post-test			F	p
		Mean	Sd	N	Mean	Sd		
Experimental	23	3.94	0.55	23	4.22	0.60	1.262	.267
Control	24	3.70	0.68	24	4.15	0.42		

$P < .05$.

Table 5
Examining whether groups were dependent on grade point averages.

Group	Average						X^2	sd	p
	1.0–2.5		2.6–4.00		Total				
	N	%	N	%	N	%			
Experimental	12	25.5	11	23.4	23	50	0.521	1	.471
Control	10	21.3	14	29.8	24	50			
Total	22	46.8	25	53.2	47	100			

$p < .05$.

Table 8
Findings of qualitative data.

Theme	Category	Code	Frequency
Advantages	Supporting the lesson	Creating interest for the lesson	8
		Making the lesson fun	6
		Concretization	4
		Providing motivation	3
		Reinforcing the topic	2
	Supporting personal development	Development of self-confidence	9
		Development of imagination	6
		Professional development	4
	Skill development	Software use	6
		Writing skill development	6
		Relating to real life	5
		Research skill	5
		Creative thinking	3
		Decision making skill	3
		Problem solving skill	2
Different Aspects	In regards to user control	Opportunity to make choices/preferences	12
		Interaction	3
		Arousing curiosity	2
		Gamification	2
	In regards to thinking skills	Thinking from different perspectives	7
		Connective thinking	6
		Probabilistic thinking	3
		Algorithmic thinking	2
	In regards to difficulties	Difficulty in creating a branching structure in software	8
		It takes more time	4
		Difficulty in creating a branching structure while writing	3

the lesson, supporting personal development and skill development. Creating interest for the lesson was the most common code in supporting the lesson category, while development of self-confidence was the most common code in supporting personal development category and software use skill emerged as the most common code for the skill development category. Pre-service teachers were coded as P1, P2 …. Examples from teacher pre-service teachers' opinions for the three highest frequency codes in each category are as follows:

> P3: "It can also be an effective material for the teacher. There is a problem with the materials, in regards to what can be done with them. Since such materials are attention getting, they also connect students to lessons more."

> P9: "… I was not very interested in such things. When I saw that I could do these things, I wanted to address them more. Before, I always regarded myself as unable to do anything in these issues."

> P4: "… We have come across these (ideas) in our university years. If this is done at younger ages, it will be more effective in selecting careers as children. If someone is interested in computers, graphics and software, if someone has the talent, he/she can discover it."

3.3.2. Different aspects theme

This theme includes pre-service teachers' opinions about the aspects that differentiate non-linear digital storytelling from linear digital storytelling. Three categories emerged in this theme: in regards to user control user, in regards to thinking skills and in regards to difficulties. Opportunity to make choices/preferences was the most common code in the category titled in regards to user control user, thinking from different perspectives was the most common code in the category titled in regards to thinking skills and difficulty in creating a branching structure in software was the most common code in the category titled in regards to difficulties. Examples from pre-service teachers' opinions for the three highest frequency codes in each category are as follows:

> P4: "In branching, we leave it to the child's choice and decision, it depends on him/her. It can be a little more effective as he/she will see the results based on his/her own judgment. Like, you know, I chose this one so that happened. In straight stories, what is continued is something that is already there. Like watching a video. But in the other, I think education would be better provided because the child is interacting."

> P5: "As the person who creates it, you think 'what can I put differently'. It's simpler in the straight one, but you have a little trouble in the one you have to branch. For example, you offer two options, after choosing one of the options, you offer options. It is difficult in terms of selecting the options that can be offered."

> P1: "… For example I did it by using Captivate, it was quite difficult for us to get connections, combinations or buttons."

4. Conclusion and discussion

According to the first research result, there was no significant difference between the experimental and control groups in their self-efficacy in using information technologies. Both groups had high mean scores. Although the experimental group had a higher average than the control group, this difference was not statistically significant. While digital stories can be created most of the time by using single software in linear digital storytelling, there is often the need to use multiple software or use higher level software in the branched one. Therefore, it is believed that self-efficacy in using information technologies may have been affected by this. However, pre-service teachers who used the linear digital storytelling method in the study were found to prefer software such as Adobe Flash that required code knowledge instead of simpler software. In this case, both groups required intensive technology usage skills. In addition, the qualitative data show that while some pre-service teachers reported developing their technology use skills, some stated having difficulties. The significant difference may not have arisen for this reason. Similarly, Özüdoğru and Çakır [31] compared the group that developed materials with linear narrative and the group that developed materials with paper and pencil activities and concluded that the self-efficacy of using information technologies did not change significantly according to group. Göbel, Salvatore, and Konrad [39] stated that some of the software is limited to creating linear stories and there is a need for software that facilitates the non-linear narrative process and that can be used even by non-experts.

According to the second research result, there was no significant difference between the experimental and control groups in writing self-efficacy. Both groups had high mean scores. Although the experimental group had a higher average than the control group, this difference was not statistically significant. Pre-service teachers wrote a story script with a straight structure in linear digital storytelling, while they wrote a story script with a branching structure in non-linear digital storytelling. It is believed that writing self-efficacy may have been affected by this. In addition, the qualitative data point that while some pre-service teachers reported developing their writing skills, some stated having difficulty in creating a branched structure while writing a scenario. The significant difference may not have arisen for this reason. When the theme of different aspects was examined, it was stated that non-linear digital storytelling required a wide range of thinking skills. The act of writing is performed with thinking skills. Research on digital storytelling emphasized that students do not want to do writing activities due to reasons such as lack of knowledge on how to write and writing anxiety [40]. Especially in non-linear writing activities, students require high writing skills as they have to write in logical integrity and harmony, by linking the topics and associating different events with each other, instead of

using a linear/straightforward expression. It can be difficult to identify the narrative with the character, to maintain the narrative coherence, to make each path flow naturally in terms of event and character, and to construct it in a logical way.

In their study comparing the group who developed the material with linear storytelling and the group that developed material with paper-pencil activities, Özüdoğru and Çakır [31] found that writing self-efficacy significantly increased in digital storytelling group pre-service teachers. Dahlström [41] found that students were inspired for writing stories when they listened to and heard their own writings. This can be interpreted as the relationship between digital storytelling and writing.

Supporting the results of the quantitative data, the qualitative data analysis pointed to a small number of pre-service teachers stating an increase in their self-efficacy for using technology and for writing skills. The analysis of qualitative data also provided the advantages of using non-linear digital storytelling method in education and the different aspects of non-linear digital storytelling compared to linear storytelling. The advantages of using non-linear digital storytelling method was cited as supporting the lesson, supporting personal development and skill development. Different aspects were grouped into three categories as user control, thinking skills, and difficulties. Similarly the literature includes studies that emphasize the effect of non-linear digital storytelling on making connections and providing the ability to look from different perspectives [12], on making choices and therefore making decisions [11], on creative thinking [42], on connecting and organizing different ideas [4] and on increasing motivation [15].

Both linear and non-linear digital storytelling methods provide benefits to the training of pre-service teachers in various aspects. Comparison of the two methods shows that the differences were at the point of interaction in terms of user control and the person who creates the story. In addition, it also supports learners' active participation in the process by requiring the use of different thinking skills. There may not be a significant difference since both groups performed highly effective tasks in terms of writing and technology use. The integration of such constructivist approach-based methods into educational environments will contribute to the quality of education and training of qualified teachers.

4.1. Recommendations

Both groups were investigated by implementing methods that required writing and technology activities. Different studies can be conducted by implementing other methods to one of the groups that do not involve writing and technology activities. The effects of non-linear digital storytelling on other educational outcomes can be investigated with different experimental studies. Qualitative studies can be conducted comparing the stories developed by pre-service teachers in terms of creative thinking. Groups with high information technology use skills was chosen in this research. However, the effects of non-linear digital storytelling on information technology skills can be examined by conducting studies with different pre-service teacher groups. Due to the low number of participants in this study, more studies are needed to generalize the results to the whole population.

The researchers and practitioners who will apply this method should ensure that the information technology infrastructure works smoothly before the implementation. In addition, different software should be provided. The method may be difficult to implement in crowded classrooms because instructor support is required throughout the process. Another recommendation is related to providing sufficient time for activities to ensure one-on-one support. External classroom activities can also be included in addition to classroom activities to minimize the problems that can be caused by lack of time.

Credit author statement

Gül Özüdoğru: Conceptualization, Writing, Methodology, Review & Editing. Hasan Çakır: Conceptualization, Methodology, Review & Editing, Supervision

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