An Investigation of Pre-Service Elementary Teachers' Skills of Teaching Numbers Through Digital Storytelling

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Abstract – Digital storytelling is an educational method that narrates educational objectives with photographs and stories in the computer environment. In this study, pre-service elementary teachers' skills of teaching numbers through digital storytelling were examined. 98 pre-service elementary teachers participated in this descriptive research. The digital stories were evaluated with the rubric developed in the study. The analysis results revealed that pre-service teachers' skills of teaching numbers were at a moderate level. Besides, while it differed significantly according to gender, it did not differ significantly according to mathematics achievement. The analysis results also showed that the pre-service teachers have some deficiencies in teaching numbers. They designed activities related to introducing the number and the use of numbers but not the part-whole relationships of numbers in their digital stories.

Key words: digital storytelling, first-grade students, mathematics education, pre-service elementary teachers, teaching numbers.

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Introduction

Numbers appear in every aspect of our lives, and we even live with numbers in daily life. The foundations of mathematics are based on numbers, and all mathematical operations are done using numbers. Therefore, numbers are among the first mathematical concepts that students learn and constitute the first mathematics subject of primary school. Since teaching numbers is important in mathematics education, there are many studies in the literature on this subject. In different studies, integers (Battista, 1983; Fuadiyah & Suryadi, 2019), rational numbers (Behr et al., 1984; Kieren, 2020; Moss & Case, 1999), decimal numbers (Tian et al.,

2020; Wearne & Hiebert, 1988), exponential and rooted numbers (Duatepe Paksu, 2010), teaching these types of numbers and students' learning difficulties about them were investigated. Studies on teaching numbers to young children are generally carried out for students with intellectual disabilities (Kaplan, 2019; Murphy et al., 1984; Van Luit & Schopman, 2000). In addition, Alptekin (2015) listed the important points and suggestions about teaching counting skills. Albayrak et al. (2019) examined the opinions of pre-service teachers on how to teach the concepts of counting and numbers. However, there is a gap in the literature about the studies examining the pre-service elementary teachers' skills of teaching numbers. Therefore, in this study, pre-service elementary teachers' skills of teaching numbers were investigated through digital storytelling.

Teaching Numbers to First Graders

As a tool that forms the basis of mathematics, numbers can be used in different meanings. Haylock and Cockburn (2008) mention three types of numbers according to the use of numbers. First is the nominal use of numbers and allows objects to be distinguished. For example, waiting for bus 3 is not waiting for 3 buses or waiting for 3th bus. The nominal use distinguishes it from the others by labeling it with the number 3. The counting use of numbers, which is called cardinal use of the number, is used to express the number of elements in a set. For example, like 3 pens. The last type of using numbers is sorting use, which refers to giving order to the objects, like the student in the third row. This is also known as the ordinal use of numbers. The comprehension of the numbers requires the students to understand these three meanings together.

Children's learning numbers also requires the development of counting skills. Counting skills are prerequisites for teaching number-related concepts, developing prediction skills, and mathematical thinking (Olkun & Toluk Uçar, 2012; Olkun et al., 2013; Muldoon et al., 2013). Van de Walle et al. (2014) stated that the counting skills of children depend on counting numbers sequentially and associating the sequence of numbers with one-to-one matching of items in a set. According to Baykul (2000), some preparatory studies should be done before teaching of numbers to children in the first grade. These are the activities of rhythms, meaningful counting, conservation of numbers, quantity comparisons based on intuition, and one-to-one matching. Accordingly, the child must first acquire back-and-forth rhythms for counting skills. The child can count rhythmically by heart, so he must learn to count meaningfully. The child should count the number names corresponding to each object. The ability to learn the concept of number also depends on gaining conservation. Comparing the

number of elements of the sets made with one-to-one matching is also important and necessary for children to comprehend the size expressed by the number. Altun (2014) states that the teaching of numbers actualizes in three stages:

1. Introducing the number: Showing the number with a cluster scheme, counting the number of set elements with one-to-one matching, giving examples of different sets suitable for the number.

2. Comprehending the number: The part-whole relationships of the number, the division of the number into parts.

3. Use of number: Using the number to represent quantity and order, ordinal and cardinal meanings of number.

Olkun and Toluk Uçar (2012) listed the developmental stages of numbers in children: verbal counting, regular counting, one-to-one matching, comparison (less-more, equality), cardinal use, conservation of number. According to verbal counting stage, the child starts counting the numbers randomly in the pre-school period without understanding them conceptually. After this stage, called regular counting, the child discovers a sequence among the numbers and starts counting regularly. Then, while counting, he understands the necessity of using a number for each object in a set and performs the one-to-one matching. In this stage, classification, sorting, and comparison activities with one-to-one matching contribute to the development of the number concept. He then realizes that the number corresponding to the last object in the set represents the number of set elements; thus he understands cardinal use. Conservation is acquired by realizing that different arrangements of the elements of a set do not change the number of elements.

Understanding numbers is also closely related to the development of the number sense. The development of number sense is vital for developing mathematical thinking and forming a mathematical background in young children. Number sense is the flexible use of numbers when mentally estimating, evaluating, calculating between number representations, and relating numbers, symbols, and operations to make sense of a numerical situation (Markovits & Sowder, 1994). According to McIntosh et al. (1992), the components of number sense are the ability to understand numbers and operations and use numbers in flexible ways for mathematical judgments. Studies show that mathematical activities can improve number sense (Markovits & Sowder, 1994; McIntosh et al., 1992). Number sense is also associated with estimation and computational skills (McIntosh et al. 1997; Reys & Yang, 1998), and it is

included in the mathematics curriculum concerning estimation skills (Ministry of National Education [MoNE], 2018).

Digital Storytelling

Digital storytelling combines narratives with digital media to create a story (Robin, 2008). In digital stories, students create a short video film by designing a story with their knowledge of a particular subject and combining it with painting and musicfor the aim of using these films as an educational application in the classroom (Wang & Zhan, 2010). In this digital story design, students first determine the subject, explore it, and create the story from the obtained information by combining it with multimedia elements, so a short video of a few minutes is created (Kajder, 2004). Digital stories usually last between two minutes and ten minutes in length (Foley, 2013). The reasons such as the cheaper technology tools, the more accessible information and equipment on the subject, and the easy sharing of the created stories on the web have made the use of this approach widespread (Meadows, 2003). The elements of digital stories are as follows:

Perspective: Determining the story's main idea and the author's point of view.

A striking question: A key question that will keep the audience engaged until the end of the story.

Emotional content: The emotional connection of the story content with the audience.

Good vocalization: Voiceover to help the target audience understand the content.

Music that enhances the impact: Background music that matches the story and serves the purpose of the story.

Affordability: Using enough content to tell the story without overloading it.

Speed: The rhythm of the rapid and slow pace of the story (Bull & Kajder, 2004; Robin, 2008).

The use of digital stories positively affects student performance, improves students' 21st-century skills, and increases motivation and participation in lessons (Dogan & Robin, 2008; Robin, 2008). In addition, the use of digital stories in teacher education increases pre-service teachers' knowledge, provides them interdisciplinary knowledge for problem-solving, and improves their pedagogical skills (Shelton et al., 2017; Starcic et al.2016). Pre-service teachers view using digital stories in the teaching process positively due to their advantages, such as active participation, success, motivation, creativity (Özpınar, 2017).

Studies are also carried out to use digital stories in mathematics education. Gould and Schmidt (2010) reported the positive results of using digital stories in trigonometry teaching. Albano and Pierri (2017) developed a storytelling model based on digital story problems in mathematics education and reported that this model has positive results on students' mathematics achievement. Walters et al. (2018) used digital stories as a problem-solving strategy tool for pre-service mathematics teachers. They reported that pre-service teachers evaluated this strategy as an effective tool in teaching mathematics concepts to their future students, providing participation and motivation. Besides, Niemi et al. (2018) examined the effects of using digital stories in mathematics teaching. The results showed that digital stories in mathematics lessons support the development of mathematical literacy and 21st-century skills. It enables students to work in collaborative groups actively, generate new ideas, associate them with daily life, and show high creativity, motivation, and participation. Dinçer and Yılmaz (2019) found that the digital stories developed in data analysis provide conceptual learning and middle school students showed a positive attitude towards digital storytelling. Albano et al. (2020) revealed the contributions of digital stories in mathematical processes. Bratitsis and Mantellou (2020) examined the effect of using digital stories in teaching two subtraction algorithms, and it was found that students learned these algorithms more efficiently through digital storytelling. However, it is seen that there is a gap in the studies that examine the teaching skills of pre-service teachers through digital stories from a pedagogical perspective.

Aim of The Study

This study aimed to examine the pre-service elementary teachers' skills of teaching numbers through digital stories. In the study, to determine whether gender and mathematics achievement have a significant effect on pre-service teachers' skills of teaching numbers, the effects of these variables on their skills of teaching numbers were also examined. The research questions are as follows:

1. What is the level of pre-service elementary teachers' skills of teaching numbers through digital stories?

2. What deficiencies do they have in the stages of teaching numbers?

3. Do their skills of teaching numbers vary by gender?

4. Do their skills of teaching numbers vary by mathematics achievement?

Method

This study was carried out using the descriptive methodology. Descriptive studies obtain data to identify certain characteristics of a group. It is the most widely used method for summarizing the characteristics of individuals or groups in educational research (Fraenkel, Wallen & Hyun, 2012). This method was used to describe pre-service elementary teachers' skills of teaching numbers.

Participants

The study was carried out in the Education Faculty of a university in the Black Sea Region in the 2020-2021 academic year. Convenience sampling from random sampling methods was used to select the participants. The participants consist of 98 pre-service elementary teachers attending the Mathematics Teaching course. 72 of them are female (73.5%), 26 are male (26.5%).

Data Collection Tool

The data collection tool consists of digital stories created by pre-service teachers on teaching numbers. In the scope of the Mathematics Teaching I course, pre-service teachers were asked to create a digital story to teach first-grade students the achievement of "*Read and write numbers*" (MoNE, 2018) belonging to the first year of the Mathematics curriculum. Firstly, digital stories were introduced to pre-service teachers. How digital stories are used in the educational environment, and the design stages of them were explained. A sample of the digital story was created using the Photo Story 3 program and shared with them. Then they were asked to design a digital story following the stages proposed by Jakes and Brennan (2005). These stages are; writing, scripting, storyboarding, using multimedia tools, creating and sharing a digital story. Pre-service teachers were given 15 days to design digital stories.

All ethical rules were followed in this study. Ethics committee approval for the study was obtained with the decision of the Ondokuz Mayıs University Social and Human Sciences Ethics Committee, dated 26.02.2021 and numbered 2021/184.

Data Analysis

The digital stories designed by the pre-service teachers were analyzed with the rubric developed in the study. The rubric was developed by taking into consideration the stages of teaching numbers by Altun (2014). The rubric is included in Table 1.

Table 1. Rubric Used in The Evaluation of Digital Stories

The stages of teaching numbers	Insufficient (0 points)	Moderate (1 point)	Sufficient (2 points)
1 Introducing the number			
2 Comprehending the number			
3 Use of number			

The three stages of teaching numbers in the rubric were evaluated using the assessments of insufficient - moderate - sufficient. The total score of the rubric ranges from 0 to 6. Total scores of pre-service teachers' skills of teaching numbers were obtained by evaluating the digital stories with the rubric. To ensure scoring reliability, after the researcher scored the digital stories, they were presented to an expert working in mathematics education. He was asked to score the digital stories by using the rubric independently. Then, the scores were compared, the different scorings were determined, and after discussion, a joint decision was made by the researcher and the expert. So the scoring was finalized. Descriptive statistics of total scores were calculated and presented in the findings. Since the total scores did not show a normal distribution (Kolmogorov-Smirnov; p<0,05), Kruskal Wallis and Mann Whitney U tests from nonparametric analysis methods were used in the data analysis. The first-grade mathematics course scores of the pre-service teachers were used as their mathematics achievements. The deficiencies of the pre-service teachers in the stages of teaching numbers were also determined by examining the digital stories and summarized. The data were analyzed in SPSS 17.0 program.

Findings

Pre-Service Elementary Teachers' Skills of Teaching Numbers with Digital Stories

The descriptive statistics of the pre-service teachers' total scores are presented in Table 2.

Table 2. Descriptive Statistics of Pre-Service Teachers Total Scores

| Pre-service teachers	**M**	SD	Min	Max	Skewness	Kurtosis
1 Female	3,33	1,02	1,00	6,00	0,43	1,47
2 Male	2,96	0,92	1,00	6,00	0,76	1,73
3 Total scores	3,23	1,00	1,00	6,00	0,51	1,33

When the scores of the pre-service teachers were evaluated according to the min-max score range (0-6 points), the mean scores of the female pre-service teachers (M=3.33, SD=1,02), male pre-service teachers (M=2,96, SD = 0,92), and all the pre-service teachers

(M=3.23, SD=1,00) are observed to be close to the "moderate" level. Therefore, it can be concluded that pre-service teachers' skills of teaching numbers are at a moderate level.

The Deficiencies of Pre-Service Elementary Teachers in The Stages of Teaching Numbers

When the digital stories were examined in terms of design, it was determined that pre-service teachers designed digital stories well enough; the visuals, voices, and background music were satisfying. However, there were some deficiencies in terms of teaching numbers. It is possible to list these deficiencies as follows;

In the stage of "introducing the number", it was found that the pre-service teachers generally showed the number with a cluster diagram and wrote it with symbols. They gave different examples about the numbers, thus enriching the examples related to the number will enable the child to abstract the number easily. At this stage, the most striking deficiency in the stories was counting the number of the cluster's elements without one-to-one matching. Some pre-service teachers preferred to count the number verbally rather than match the elements in the cluster one-to-one. They thought that this was sufficient for the child to comprehend the number. Therefore, it can be said that some pre-service teachers overlooked the importance of one-to-one matching. Whereas one-to-one matching is essential in understanding the number and developing the number sense. In Figure 1, examples of this stage from digital stories were presented.
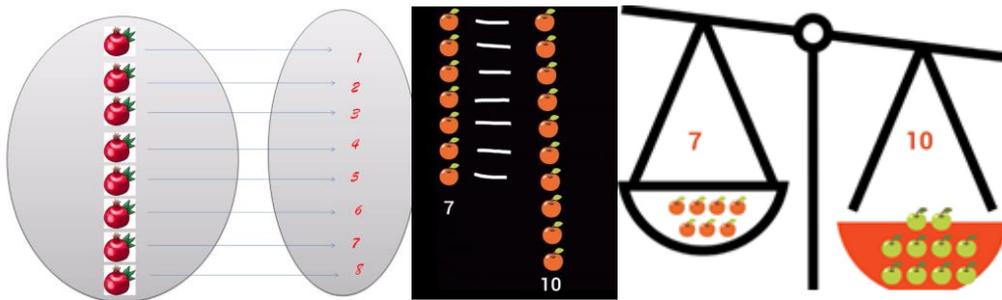
Figure 1. Examples of Activities About "Introducing The Number"

When the activities designed for the stage of "comprehending the number" were examined, it was seen that a small number of pre-service teachers designed activities for this stage. It is crucial to teach the part-whole relationships of numbers in developing the number sense and estimation skills. However, unfortunately, it has been found that pre-service teachers did not emphasize the part-whole relationships of the numbers and include this stage in their digital stories; many of them have overlooked this stage.

In the activities designed for "use of the number", the pre-service teachers created different activities according to whether the number expresses the quantity or sort. It was seen that they designed activities expressing the quantity of the number and counting objects with one-to-one matching to acquire the child the cardinal use of the number. Secondly, they designed visuals to teach the sorting meaning of the number. In Figure 2, there is an example of images belonging to the stories.
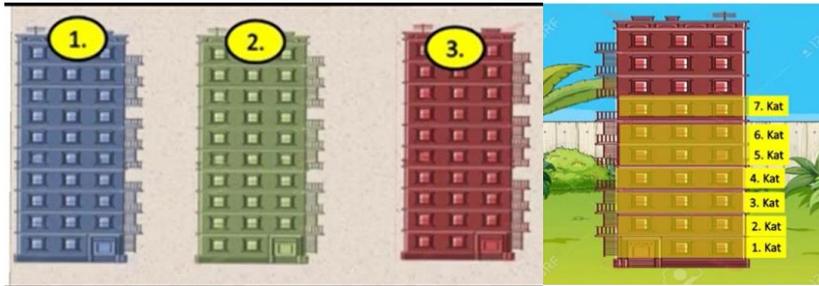
Figure 2. Examples of "Use of Number" in Digital Stories

Examination of Total Scores by Gender

The pre-service teachers' total scores of teaching numbers were compared according to their gender, and the results in Table 3 were obtained.

Table 3. The Mann Whitney U Test Results For The Examination of Total Scores According to Gender

		N	Average Rank	Sum of Rank	U	p
Total scores	Female	72	52,76	3799,00	701,00	,030*
	Male	26	40,46	1052,00		

*p<0,05

As shown in Table 3, the analysis results showed that the total scores of the pre-service teachers differ significantly according to their gender (U = 701,00; p <0,05). Average ranks according to gender revealed that female pre-service teachers (Average rank = 52,76) have significantly a higher average than male pre-service teachers (Average rank = 40,46). Consequently, it can be said that female pre-service teachers' skills of teaching numbers through digital stories are higher than males.

Examination of Total Scores by Mathematics Achievement

The pre-service teachers' total scores of teaching numbers were examined according to their mathematics achievement levels using the Kruskal Wallis test, and the results in Table 4 were obtained.

Table 4. The Kruskal Wallis Test Results For The Examination of Total Scores According to Mathematics Achievement

	Mathematics achievement levels	N	Average Rank	df	χ^2	p	Significant difference
Total scores	AA	12	58,58	6	7,548	,273	-
	BA	11	42,73				
	BB	25	52,64				
	BC	18	52,94				
	CC	18	49,44				
	DC	7	43,00				
	DD	7	31,14				
	Total	98					

As shown in Table 4, the total scores of the pre-service teachers did not show a significant difference according to their mathematics achievement levels ($\chi^2 = 7,548$; p> 0,05). Therefore, it can be stated that pre-service teachers' skills of teaching numbers do not differ according to their mathematics achievements.

Discussion and Conclusion

Teaching numbers to children requires the development of counting skills and number sense. However, counting is not a simple skill for young children as it requires using of different concepts together (Akman, 2002). The development of the number sense starting from pre-school years continues with the teaching of numbers formally in the first grade. In this regard, elementary teachers have a vital role in the development of this skill. In this study, pre-service elementary teachers' skills of teaching numbers through digital stories were examined. As a result, it was found that pre-service teachers' skills of teaching numbers were at a moderate level. When the digital stories were analyzed according to the stages of teaching numbers, it was determined that pre-service had some deficiencies. It was seen that the pre-service teachers showed the numbers with clusters on different examples to introduce the number to the children. However, it was also observed that many pre-service teachers did not design activities to match the numbers with the elements of the cluster one-to-one. One-to-one matching is important in comprehending the number and developing the number sense. Olkun et al. (2013) determined that the cardinal meaning, resulting from one-to-one matching, is less developed than other principles in children. It can be argued that this result is because teachers do not give enough examples of one-to-one matching and cardinal meaning in their lessons. In the stage of comprehending the number, it was determined that many pre-service teachers did not emphasize the part-whole relationships of numbers in their digital stories.

However, they designed activities to teach the quantity or sorting meanings of the number in the last stage. In this regard, the results of the study are in line with Albayrak et al. (2019)'s research. Albayrak et al. (2019) examined the opinions of pre-service pre-school teachers on how to teach counting and number concepts. As a result, they determined that pre-service teachers have deficiencies regarding the activities that can be done in the teaching of counting and number.

When digital stories were evaluated in terms of design, it was determined that pre-service teachers created satisfying digital stories. Similarly, Shelton et al. (2017) conducted a 7-week hands-on training in which 31 primary school pre-service teachers created digital storytelling videos. As a result of the study, it was reported that all pre-service teachers created appropriate videos, liked using digital storytelling in education environments, and were interested in using it with their future students. However, in a different study, it was observed that pre-service teachers encountered technical problems and had difficulties while creating digital stories (Özpınar, 2017). In this study, the pre-service teachers did not experience any technical problems or difficulties. It has even been observed that they are enthusiastic and motivated, and they make different and creative designs with different programs. These positive results were also expressed as a result of other researches. Digital stories improve pre-service teachers' problem-solving and pedagogical competencies (Starcic et al., 2016), and they evaluate this method as an effective tool to teach mathematics concepts to their students, to provide participation and motivation (Özpınar, 2017; Walters et al., 2018). The results of different studies revealed that although teachers' perceptions of digital stories in the classroom were almost entirely positive after the workshops, most of them did not use digital storytelling in practice (Doğan & Robin, 2018).

Another result of the study was that the pre-service teachers' skills of teaching numbers through digital stories differ significantly according to gender, and female pre-service teachers had higher number of teaching skills than males. Consequently, it can be argued that women are better at teaching numbers than men. Besides, pre-service teachers' skills did not differ according to their mathematics achievement. This result showed that pre-service teachers' mathematics achievement did not affect their ability to teach numbers. It can be thought that academic success is not so effective on the teaching skills.

Recommendations

The research results revealed that although the pre-service teachers' skills of teaching numbers were at a sufficient level, they have some deficiencies in the stages of teaching

numbers. Therefore, pre-service teachers should comprehend the stages of teaching numbers well during undergraduate education. The need for the studies is striking due to the limited number of studies in the literature on this subject. Therefore, studies that examine these skills of pre-service teachers and elementary teachers with different methods will fill the gap in the field and guide researchers and educators.

Sınıf Öğretmeni Adaylarının Sayıları Öğretme Becerilerinin Dijital Hikayelerle İncelenmesi

Özet:

Hızla dijitalleşen dünyada eğitimin de giderek teknolojik yöntemlere yöneldiği görülmektedir. Dijital hikaye eğitim kazanımlarının bilgisayar ortamında fotoğraflar ve hikayelerle öyküleştirildiği yeni bir eğitim yöntemidir. Bu çalışmada Sınıf Öğretmeni adaylarının ilkokul birinci sınıf öğrencilerine sayıları öğretme becerileri dijital hikayeler aracılığıyla incelenmiştir. Betimsel türde gerçekleştirilen araştırmaya Sınıf Öğretmenliği 3. sınıfta öğrenim gören 98 öğretmen adayı katılmıştır. Öğretmen adaylarının sayıları öğretmek amacıyla tasarladıkları dijital hikayeler, çalışma kapsamında geliştirilen rubrikle değerlendirilmiştir. Elde edilen puanlar betimsel olarak ve nonparametrik istatistik yöntemleriyle analiz edilmiştir. Analiz sonuçları, sınıf öğretmeni adaylarının sayıları öğretme becerilerinin orta düzeyde olduğunu, cinsiyete göre anlamlı fark gösterirken matematik başarısına göre anlamlı olarak farklılaşmadığını ortaya koymuştur. Ayrıca dijital hikayelerin analizi, öğretmen adaylarının sayıları öğretirken sayının tanıtılması ve sayının kullanım şekilleri aşamalarına yönelik etkinliklere dijital hikayelerinde yer verdiklerini ancak sayının parça-bütün ilişkilerinin kavratılmasına yönelik etkinlik tasarlamadıklarını göstermiştir. Araştırma sonuçları öğretmen adaylarının sayıların öğretim aşamalarında bazı eksikliklerinin olduğunu göstermiştir.

Anahtar kelimeler: birinci sınıf öğrencileri, dijital hikayeler, matematik eğitimi, sayıların öğretimi, sınıf öğretmeni adayları.

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