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The Effect of Digital Storytelling on Students' Scientific Process Skills and Attitudes towards the Course

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Abstract

This study aimed to investigate the effect of the digital storytelling method on 7th-grade students' scientific process skills and their attitudes toward the science course within the context of the "Cells and Cell Division" unit. We conducted an action research design, with a sample consisting of gifted students divided into experimental and control groups. We developed digital stories using Adobe Character Animator software for the students in the experimental group. During this process, we asked students to write scientifically grounded scripts based on the "Cells and Cell Division" topic and design appropriate characters and scenes. Then, they voiced the characters they had created, recorded their dialogues, and used the software's features, such as facial expression tracking, motion detection, and lip synchronisation, to generate their digital stories. We taught the students in the control group based on the content and learning outcomes specified in the Turkish Ministry of National Education's curriculum. We gathered data using the "Scientific Process Skills Test" and the "Science Attitude Scale" to determine the intervention's impact. The research findings revealed that the digital storytelling method had a statistically significant, positive effect on both students' scientific process skills and their attitudes toward science. Throughout the digital storytelling process, we also observed that students actively participated in tasks such as scriptwriting, character design, voice acting, and animation, acting as content creators.

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Introduction

Today, an educated individual is defined not only as someone who possesses knowledge but also as someone who can question, analyze, and make sense of that knowledge—an ability closely linked to scientific literacy (Kucuk, 2008). Achieving this competence requires a proper understanding and internalization of fundamental scientific concepts (Deve & Kucuk, 2016; Unal & Ergin, 2006; Sevim, 2013). Therefore, to develop their scientific literacy, individuals must understand basic scientific knowledge and concepts and be able to apply this knowledge across different contexts; in other words, they must be raised as scientifically literate individuals (Cepni et al., 2003; Koseoglu et al., 2003). Thus, scientific literacy is not just about content knowledge; it also involves understanding scientific ways of thinking and processes, as well as being able to apply them across various situations. Scientific process skills, as one component of this competence, support scientific literacy by boosting individuals' scientific thinking and problem-solving abilities. These skills are fundamental when individuals seek solutions to personal or societal problems in their environment. They include a systematic, logical thinking process in which individuals generate hypotheses, gather data, conduct experiments, interpret data, and draw conclusions (Dokme, 2005; Akdeniz, 2005). Ortakuz (2006) emphasizes that these skills form a theoretical foundation for science education. However, effectively developing these skills depends not only on cognitive and psychomotor competencies but also on fostering a positive attitude toward science courses (Zengin & Kucuk, 2018). Attitude is a multidimensional structure that reflects individuals' cognitive, affective, and behavioral tendencies toward objects, events, or situations (Allport, 1935, as cited in Erkus, 2003; Cetin, 2006). In this context, attitudes toward science courses not only reflect interest in science but also involve participation in learning, motivation, and overall perception of the course (Kucuk & Yildirim, 2020). Therefore, developing scientific literacy requires students to possess both scientific process skills and a positive attitude toward science. Their experiences in science courses, interactions with teachers, the quality of the learning environment, teaching methods and techniques, technological tools, and innovative practices all play significant roles in shaping both their scientific process skills and attitudes (Kececi & Kırbag Zengin, 2015; Sevim & Ayvaci, 2016). In this context, audiovisual content created through digital technologies in education attracts students' attention, increases motivation, and enhances learning effectiveness (Burmark, 2004; Gyabak & Godina, 2011; Ohler, 2008; Simkins et al., 2002). Because students are increasingly immersed in the digital world today, the importance of technology-supported learning environments continues to grow (Barrett, 2006; Dexter et al., 1999; van Gils, 2005; Harris, 2005). Accordingly, researchers and educators highlight digital storytelling as an approach that effectively integrates technology into education. Digital storytelling transforms multimedia elements such as text, sound, images, and videos into a cohesive digital presentation centered around a theme (Bull & Kajder, 2004; Chung, 2007; Robin, 2006). This process enables students to reconstruct and give meaning to information by combining content in various formats, such as text, images, and sound (Robin, 2006; Sadik, 2008). It not only facilitates individual knowledge generation but also supports the development of multifaceted skills such as researching, writing, editing, presenting, and reflecting (Heo, 2009; Robin, 2008b). Consequently, digital storytelling emerges as an effective teaching method that promotes students' cognitive, emotional, and social development (Alterio, 2003; Bilen et al., 2019; Buyukcengiz, 2017; Maier & Fisher, 2006; Mello, 2001). It also plays a key role in shaping students' attitudes toward the course and increasing their interest in learning. Especially in constructivist learning environments, digital storytelling is valued for its ability to ensure meaningful and pedagogically effective integration of technology. In such settings, the quality and effectiveness of the technologies used greatly influence students' active participation (Dexter et al., 1999). van Gils (2005) states that digital storytelling not only supports students' cognitive growth but also serves as a powerful tool for long-term technology integration. However, realizing this potential depends heavily on the capabilities of the software used. In Turkey, digital storytelling tools generally have limited visual design, motion features, and synchronization capabilities. These tools typically allow basic integration of sound, visuals, and text but fall short in enabling students to create original content or produce creative presentations (Ulu, 2021; Yilmaz et al., 2017). Particularly in character design, expression, and movement synchronization, these programs are inadequate and restrict students from expressing narratives in a multidimensional way, thus limiting the full potential of digital storytelling. In this regard, Adobe Character Animator stands out with its advanced features, including character creation, automatic detection of facial expressions and body movements, voice-lip synchronization, and real-time performance capture (Sevim & Denizhan, 2025). The software enables users to modify pre-made characters or design original characters from scratch, and can synchronize with other programs such as Adobe Photoshop and Illustrator. Additionally, its trigger system allows expressions and movements to be defined via keyboard commands, making stories more dynamic and interactive. These features distinguish Adobe Character Animator from other digital storytelling tools, empowering students to participate more creatively and effectively in digital content creation.

Research Problem and Sub-Problems

The main research problem of this study is defined as: "What is the effect of the digital storytelling method on seventh-grade middle school students' scientific process skills and their attitudes toward the science course within the unit 'Cells and Cell Division'?"

Based on this problem, we answered the following research questions:

1. What is the effect of the digital storytelling method on students' scientific process skills?
2. What is the effect of the digital storytelling method on students' attitudes toward science?

Method

Research Model

We conducted this research using the action research design. Action research is a systematic and disciplined process that aims to uncover the unknown, test the validity of current knowledge, and present the obtained data for critical evaluation by others (McNiff & Whitehead, 2005). Through this method, teachers aim to improve teaching and learning processes and enhance the effectiveness of education (Elliott, 1991, p. 55; Kucuk & Cepni, 2005).

Participants

In this study, the population consisted of gifted students. The sample group was selected from among 7th-grade gifted students attending one of the two Science and Art Centers located in Denizli, Türkiye. One of the two pre-existing classes was assigned to the experimental group, and the other to the control group. This assignment was conducted through randomisation, and efforts were made to ensure equivalence between the groups. The digital storytelling method was implemented with the students in the experimental group. In contrast, the students in the control group received instruction based on the new science teaching curriculum in Türkiye (Ministry of National Education [MoNE], 2018). The sample comprised both experimental and control groups, with 41 students: 20 in the experimental group and 21 in the control group. The gender distribution of the sample group is presented in Table 1 below.

Table 1

Gender Distribution of the Students in the Sample Group

Groups	Female student		Male student	
	f	%	f	%
Experimental group	13	65	7	35
Control group	14	67	7	33
Total	27		14	

Data Collection Tools

We used two data collection tools, the Scientific Process Skills Test and the Science and Technology Attitude Scale.

Scientific Process Skills Test

The Scientific Process Skills Test used here includes 27 multiple-choice questions and was created by Aydogdu et al. (2012). Its KR–20 reliability coefficient was reported as 0.84, with an average item difficulty of 0.54. To evaluate item discrimination, the researchers compared scores between students in the top 27% and bottom 27% groups, finding significant differences on each item ($p < .05$). These results suggest that the test items are highly effective at distinguishing between different levels of student understanding. Overall, the data support that the test is a valid and reliable instrument for measuring scientific process skills.

Science and Technology Attitude Scale

The scale we used to measure students' perceptions of the science course is a well-established, valid, and reliable instrument. It was developed within the scope of the international Relevance of Science Education (ROSE) project, making it applicable in 46 countries. The scale consists of 16 items and has been reviewed by prominent scientists and expert researchers in the field of science and technology education. Konukaldi (2012) adapted the scale into Turkish and reported a reliability coefficient of .83.

Data Analysis

In the study, data were collected by administering the Science and Technology Attitude Scale and the Scientific Process Skills Scale before and after the implementation of the digital storytelling method. We analysed the Scientific Process Skills Test, administered before and after the implementation of the digital storytelling method, using SPSS. To compare the pre- and post-test scores of students in the experimental and control groups, we applied appropriate statistical tests based on the data's distribution characteristics. When the data exhibited parametric properties, we used the paired-samples t-test; when the data were nonparametric, we used the equivalent Mann-Whitney U test (Can, 2016, p. 136). We also analysed the attitude scales administered before and after the implementation of the digital storytelling method using SPSS. To compare students' attitude scale scores before and after the intervention, we selected appropriate statistical tests based on the data's distributional characteristics. When the data exhibited parametric properties, we used the paired samples t-test; when the data showed nonparametric characteristics, we applied the equivalent Mann-Whitney U test (Can, 2016, p. 136).

Implementation Process

The students in the experimental group received a detailed introduction to the fundamental principles of digital storytelling. Following this, we taught them how to operate and use Adobe Character Animator. We covered the puppet options offered by the software and the techniques for integrating skeletal structures into animated characters. Students were introduced to motion and facial tracking systems, and we provided the necessary information to enable characters to move naturally and realistically within them. Additionally, we demonstrated technical details, including character design, scene arrangement, camera movements, lip synchronisation, and walk-cycle animations, through hands-on activities (See Figures 1 and 2).

Figure 1.

Figure 2

We divided the students into small groups, and each group conducted an in-depth investigation of the topic “Cells and Cell Division,” transforming the information they gathered into story scripts. To support their scripts, they began to design characters and backgrounds. While some students created their designs through hand-drawn illustrations, others preferred to work directly in the digital environment using digital tools. (See Figures 3,4,5,6).

Figure 3

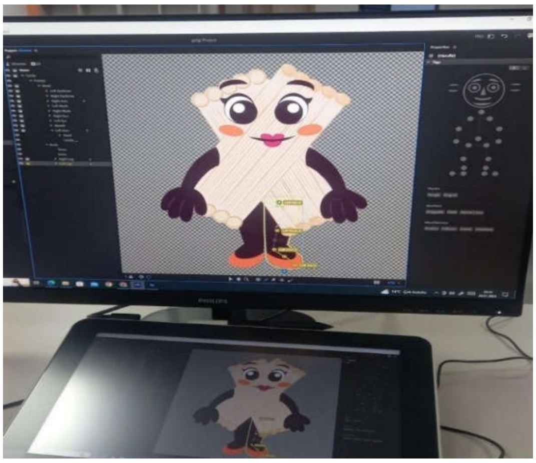

Figure 4

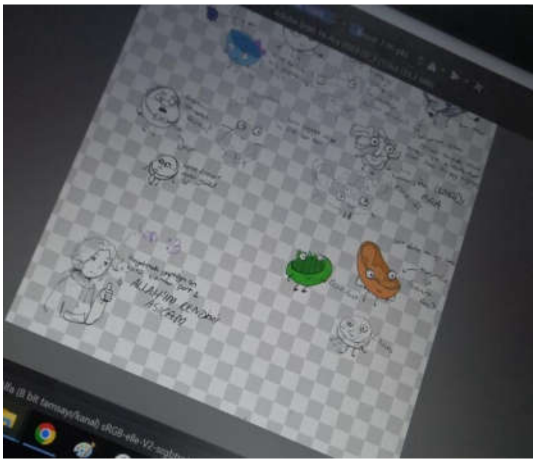

Figure 5

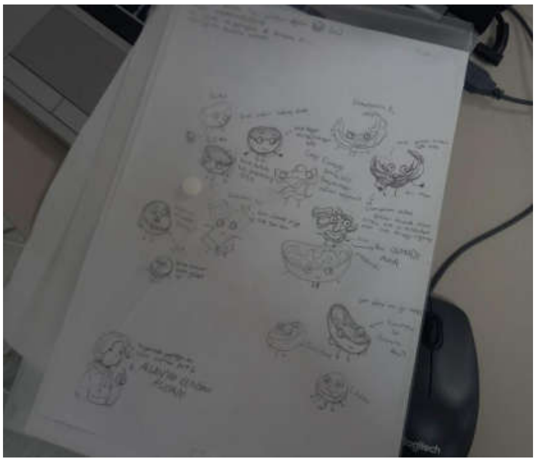

Figure 6

All materials were transferred to Adobe Character Animator, and students animated their scripts. During the voice-over process, group members assigned characters among themselves and recorded the dialogues. They guided the characters' movements in accordance with the script using the program's camera-based motion tracking system and manual control features. (See Figures 7-14).

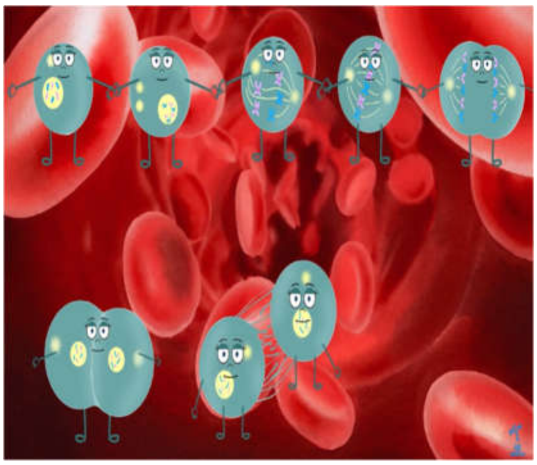

Figure 7

Figure 8

Figure 9

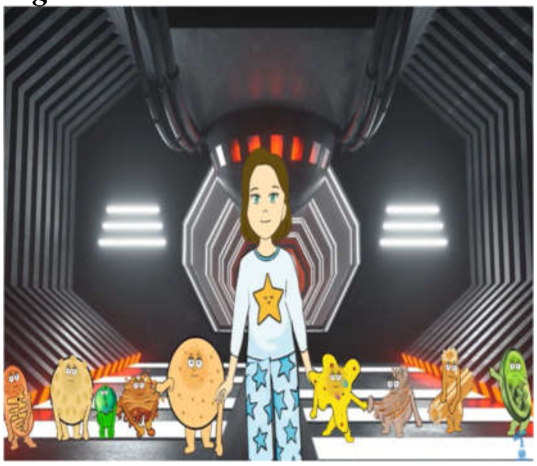

Figure 10

Figure 11

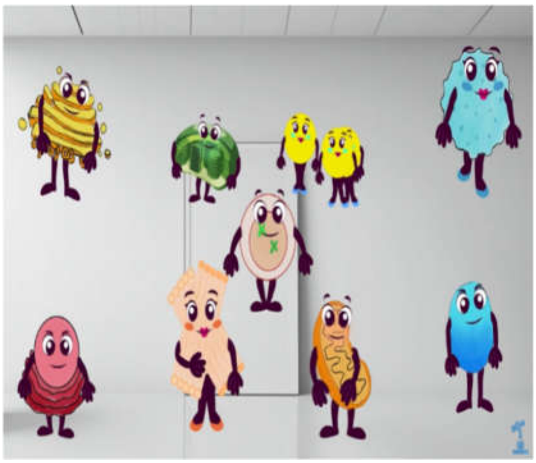

Figure 12

Figure 13

Figure 14

The digital stories they created were presented in an exhibition they organised with their group members, allowing them to showcase their projects. Additionally, they shared their work on social media platforms, drawing attention to the educational potential of the digital storytelling method.

Results

Results Related to the Scientific Process Skills Test

The scores obtained by students in the experimental and control groups on the Scientific Process Skills Test before the experimental procedure were analysed using the independent-samples t-test, a parametric statistical test. For this test to be applicable, the following assumptions must be met: the two groups must be independent of each other, the dependent variable must be measured on an interval or ratio scale, the raw score distribution of each sample's population must be normal, and the variances of the populations represented by the samples must be homogeneous (Buyukozturk et al., 2019).

Therefore, to determine whether the assumptions of the t-test were met for the Scientific Process Skills Test administered before the experimental procedure, we presented the descriptive statistics obtained in Table 2.

Table 2

Descriptive Statistics for Pre-Test Scores of the Scientific Process Skills Test

	n	$\bar{x}$	Median	Mode	SD	Skewness	Kurtosis
Experimental group	20	11.90	13	13	2.63	-0.840	0.088
Control group	21	12.47	13	14	2.32	-1.101	0.364

When Table 1 is examined, it is observed that the measures of central tendency—such as mean, median, and mode—regarding the scores obtained by students in the experimental and control groups on the Scientific Process Skills Test are pretty close to each other. According to the data obtained, the skewness and kurtosis coefficients were calculated as Skewness = -0.840 and Kurtosis = -0.088 for the experimental group, and Skewness = -1.101 and Kurtosis = 0.364 for the control group. The fact that the skewness and kurtosis values fall within the ±2 range indicates that the data are normally distributed (George & Mallery, 2010). In line with these findings, both groups met the assumption of normality.

Following the confirmation of this assumption, Levene's Test of Equality of Variances was conducted to examine whether the variances of the populations represented by the samples were homogeneous. According to Levene's test, the variances were homogeneous ($F = 0.432$; $p = .515$).

After confirming that all assumptions were met, an independent-samples t-test was conducted to determine whether there was a statistically significant difference in post-test scores between the experimental and control groups. The results obtained from this analysis are presented in Table 3.

Table 3

Independent Samples t-Test Results for Pre-Test Scores of the Scientific Process Skills Test

Groups	N	$\bar{x}$	SD	t	p
Experimental group	20	11.90	2.63		
Control group	21	12.47	2.32	-0.745	0.461*

*p>0.05

An examination of the findings presented in Table 3 shows that there was no statistically significant difference between the pre-test scores of students in the experimental and control groups, $t(39) = -0.745$; $p > .05$. When we examined the group means, we found that the average score of the experimental group students was ($\bar{x} = 11.90$), while the average score of the control group students was ($\bar{x}$ = 12.47). Although this indicates that the control group students had slightly higher achievement levels compared to the experimental group, the difference is not statistically significant. In other words, we can state that the experimental and control group students were equivalent in terms of scientific process skills prior to the study. To determine whether the data obtained from the Scientific Process Skills Test administered after the experimental procedure met the assumptions of the t-test, we presented the descriptive statistics in Table 4.

Table 4

Descriptive Statistics for Post-Test Scores of the Scientific Process Skills Test

	n	$\bar{x}$	Median	Mode	SD	Skewness	Kurtosis
Experimental group	20	25.05	25	25	1.32	-0.101	-1.010
Control group	21	19.95	20	20	2.40	-0.323	-1.198

As shown in Table 4, the mean, median, and mode of the post-test scores on the Scientific Process Skills Test for the experimental and control groups are similar. The skewness coefficient (SK) and kurtosis coefficient (KC) for the experimental group were calculated as SK = -0.101 and KC = -1.010, respectively. For the control group, SK = -0.323 and KC = -1.198. The fact that the skewness and kurtosis values fall within the ±2 range indicates that the data of both groups are normally distributed (George & Mallery, 2010).

After confirming the assumption of normality, we conducted Levene's Test for Equality of Variances to determine whether the population variances across groups were homogeneous. According to the Levene test results, the variances were found not to be homogeneous, $F = 7.477$; $p = .009$. However, the Independent Samples t-Test is a robust parametric test that can still be applied even when the assumption of homogeneity of variances is violated (Büyüköztürk et al., 2019). Accordingly, we proceeded with the independent-samples t-test, taking the assumptions into account. The results of the analysis to determine whether the difference in post-test scores between the experimental and control groups on the Scientific Process Skills Test was statistically significant are presented in Table 5.

Table 5

Independent Samples t-Test Results for Post-Test Scores of the Scientific Process Skills Test

Groups	N	$\bar{x}$	SD	t	p
Experimental group	20	25.05	1.32		
Control group	21	19.95	2.40	8.491	0.000*

*p<0.05

An examination of the findings presented in Table 5 revealed that there was a statistically significant difference between the post-test scores of students in the experimental and control groups, $t(68) = 8.491$; $p < .05$. The group means were calculated as ($\bar{x}$ = 25.05) for the experimental group and ($\bar{x}$ = 19.95) for the control group. These results indicate that students in the experimental group scored significantly higher on scientific process skills than those in the control group.

We also calculated the effect size of this difference. Cohen's d was found to be 2.63, and the eta-squared value was .648. These findings suggest that the difference between the group means corresponds to 2.63 standard deviations and that approximately 64% of the total variance is attributable to the intervention. The calculated effect sizes demonstrate that the digital storytelling method had a highly significant impact on scientific process skills.

Results Related to the ScieOnce Attitude Scale

The scores obtained by students in the experimental and control groups on the Science Attitude Scale before the experimental procedure were analyzed using an independent-samples t-test, a parametric statistical method. For this test to be applicable, the following assumptions must be met: the two groups must be independent of each other, the dependent variable must be measured on an interval or ratio scale, the raw scores of the populations represented by the samples must be normally distributed, and the variances must be homogeneous (Buyukozturk et al., 2019).

Therefore, to determine whether the scores from the Science Attitude Scale administered before the intervention met the assumptions of the t-test, we presented the descriptive statistics obtained in Table 6.

Table 6

Descriptive Statistics for Pre-Test Scores of the Science Attitude Scale

	n	$\bar{x}$	Median	Mode	SD	Skewness	Kurtosis
Experimental group	20	46.60	47.50	37	7.13	0.200	-0.878
Control group	21	47.80	48	37	0.041	0.041	-1.100

Upon examining Table 6, we observed that the mean, median, and mode of the pre-test scores on the Science Attitude Scale for the experimental and control groups were quite similar. The skewness and kurtosis coefficients for the experimental group were calculated as 0.200 and -0.878, respectively. For the control group, the skewness was 0.041, and the kurtosis was -1.100. The fact that these values fall within the ±2 range indicates that the data are normally distributed (George & Mallery, 2010).

After confirming the assumption of normality, we conducted Levene's Test for Equality of Variances to determine whether the population variances across groups were homogeneous. The test results indicated that the variances were homogeneous, with an F-value of 0.090 and a p-value of 0.766.

Once all assumptions were confirmed, we conducted an independent-samples t-test to examine whether there was a statistically significant difference in the pre-test scores of the experimental and control groups on the Science Attitude Scale. The findings from this analysis are presented in Table 7.

Table 7

Independent Samples t-Test Results for Pre-Test Scores of the Science Attitude Scale

Groups	N	$\bar{x}$	SD	t	p
Experimental group	20	46.60	7.13		
Control group	21	47.80	0.041	-0.548	0.601*

*p>0.05

An examination of the findings in Table 7 showed that there was no statistically significant difference between the pre-test scores of students in the experimental and control groups, $t(39) = -0.548$; $p > .05$. The mean score was calculated as $\bar{x} = 46.60$ for the experimental group and $\bar{x}$ = 47.80 for the control group. Although the mean scores suggest that the control group students had slightly higher attitude levels compared to the experimental group, this difference was not statistically significant. In other words, the experimental and control group students were equivalent in their attitudes toward the science course before the intervention.

To determine whether the data obtained from the Science Attitude Scale administered after the experimental procedure met the assumptions of the t-test, we presented the descriptive statistics in Table 8.

Table 8

Descriptive Statistics for Post-Test Scores of the Science Attitude Scale

	n	$\bar{x}$	Median	Mode	SD	Skewness	Kurtosis
Experimental group	20	71.65	69.50	69	4.77	0.093	-1.553
Control group	21	58.14	60	63	5.58	-1.452	1.991

Upon examining Table 8, we observed that the mean, median, and mode of the post-test scores on the Science Attitude Scale for the experimental and control groups were quite similar. The skewness and kurtosis coefficients were calculated as 0.093 and -1.553 for the experimental group, and -1.452 and 1.991 for the control group, respectively. Since these values fall within ±2, the data are normally distributed (George & Mallery, 2010).

After confirming the assumption of normality, we conducted Levene's Test for Equality of Variances to determine whether the variances across the groups were homogeneous. The results of the Levene test indicated that the variances were homogeneous, with an F-value of 0.029 and a p-value of 0.866.

Once all assumptions were met, an independent-samples t-test was conducted to examine whether there was a significant difference in post-test scores between the experimental and control groups on the Science Attitude Scale. The results of this analysis are presented in Table 9.

Table 9

Independent Samples t-Test Results for Post-Test Scores of the Science Attitude Scale

Groups	N	$\bar{x}$	SD	t	p
Experimental group	20	71.65	4.77		
Control group	21	58.14	5.58	8.304	0.000*

*p<0.05

An examination of the findings presented in Table 8 revealed that there was a statistically significant difference between the post-test scores of students in the experimental and control groups, t(68) = 8.304; $p < .05$. The group means were calculated as $\bar{x}$ = 71.65 for the experimental group and $\bar{x}$ = 58.14 for the control group. These findings indicate that students in the experimental group had significantly higher attitude scores toward the science course than those in the control group.

We also calculated the effect size of this difference. The Cohen's d value was determined to be 2.60, and the eta-squared value was calculated to be 0.638. These values indicate that the difference between the means corresponds to 2.60 standard deviations and that approximately 63% of the total variance is attributable to the intervention. The calculated effect size values indicate that the digital storytelling method has a significant impact on students' attitudes toward science.

Discussion

In this study, we examined the effect of the digital storytelling method on 7th-grade students' scientific process skills and their attitudes toward science in the "Cells and Cell Division" unit. In this section, we discuss the findings for the relevant variables and provide general evaluations by comparing them with the existing literature.

Discussion and Conclusion Regarding Scientific Process Skills

In this study, we employed the "Scientific Process Skills Test" to investigate the effect of the digital storytelling method on students' scientific process skills. As part of the research, we conducted both pre- and post-tests with an experimental group that received instruction through digital storytelling and a control group that continued with traditional teaching methods. The pre-test mean scores analysis showed that the experimental group ($\bar{x} = 13.40$) and the control group ($\bar{x} = 13.47$) were at a similar level. The difference between them was not statistically significant, $t(62) = -0.124$, $p > .05$. This finding is important because it indicates that both groups were equivalent in scientific process skills before the intervention.

Upon examining the post-test mean scores, we observed that the experimental group ($\bar{x} = 28.81$) outperformed the control group ($\bar{x} = 23.87$). This difference was found to be statistically significant, $t(62) = 3.964$, $p < .05$. The effect size calculated (Cohen's $d = 0.996$; $\eta^2 = 0.202$) revealed that the digital storytelling method had a strong effect on scientific process skills. This result suggests that the observed difference is not random but a direct outcome of the implemented method.

A key factor in achieving this result was our intentional effort to engage students in the active use of scientific process skills through digital storytelling. At the beginning of the process, students were asked to construct a story scenario related to the topic "Cells and Cell Division." During this stage, they actively used skills such as observation, information gathering, and classification while researching scientific content to support their stories. This aligns with Tatar's (2006) findings, which emphasise that learning based on scientific processes enables students to become active participants in accessing and organising information.

In the scriptwriting stage, students analysed scientific data and incorporated skills such as formulating hypotheses and making predictions into their story characters. For instance, students who constructed stories about the process of cell division established cause-and-effect relationships regarding which organelle functions at which stage, thereby developing inference-making and problem-solving skills. We observed that students activated their logical reasoning and scientific thinking abilities during the knowledge production phase.

This finding is consistent with the study by Dogruoz (1998), which reported that instruction based on scientific process skills enhances student achievement. During character design and animation development, students reflected on abstract concepts (e.g., nucleus, mitochondria, ribosome) and concretised them using a visual language. In this way, they not only reconstructed their knowledge but also applied skills such as measurement, associating data, and data presentation in an integrated manner.

The voice-over and animation stages, utilising Adobe Character Animator, enabled students to learn through multiple sensory channels, making the process more meaningful and memorable. These phases also align with Bilici's (2021) findings, which showed that digital storytelling fosters students' critical thinking tendencies and collaborative reasoning skills.

During group work, students developed abilities such as making collective decisions, evaluating ideas, and progressing in a structured manner—acquiring higher-order scientific process skills, including identifying controllable variables through collaboration. While integrating scientific fiction into the story structure, they experienced both individual and collective learning. As emphasised by Bilici (2021), digital storytelling increases students' participation in processes such as co-thinking, discussion, and decision-making, thereby combining scientific process skills with a social dimension.

At the final stage of presenting their digital stories, students organised and shared the knowledge they had learned and gained opportunities to both self-assess and understand others' perspectives through peer feedback. This outcome aligns with Bhatt's (2012) findings, which suggest that integrating digital tools students use in their daily lives into the classroom facilitates meaningful learning.

In conclusion, through the digital storytelling process, we supported students' cognitive processes, including researching, analysing, organising, and presenting information. At the same time, we made significant contributions to the development of fundamental scientific process skills, including observing, inferring, problem-solving, predicting, and identifying variables. The individual and group-based production processes enabled students to experience a culture of scientific thinking. We therefore consider the digital storytelling method a practical and contemporary approach that contributes to the development of scientific process skills in science education.

Discussion and Conclusion Regarding the Science Attitude Scale

In this study, the Science Attitude Scale was administered to determine the effect of the digital storytelling method on students' attitudes toward science. According to the pre-test results conducted before the implementation, the mean attitude score of the experimental group was calculated as ($\bar{x} = 69.56$), and that of the control group as ($\bar{x} = 70.37$). The difference between the two groups was not statistically significant, $t(62) = -0.287$, $p > 0.05$. This suggests that both groups were equivalent in their attitudes toward science at the outset of the study.

In the post-test analysis conducted after the implementation, the mean score of the experimental group was found to be ($\bar{x} = 82.12$), and that of the control group ($\bar{x} = 75.93$). This difference was determined to be statistically significant, $t(62) = 2.192$, $p < 0.05$. Furthermore, the effect size was calculated (Cohen's $d = 0.552$; $\eta^2 = 0.072$), revealing that the digital storytelling method had a moderate effect on students' attitudes toward science.

A key factor in this result was enabling students to participate actively and interactively in the learning process through digital storytelling. Students were not merely receivers of knowledge but individuals who contributed meaning and reconstructed it through visualisation. Primarily through creative activities such as scriptwriting, character design, and voice-over, students became more engaged with science topics, and this closeness positively influenced their interest and attitudes toward the course.

Aslan-Akan (1994) also emphasised the necessity of students' active participation in the learning process for meaningful learning to take place. In this context, digital storytelling enabled such participation and supported the development of attitudes. Throughout the process, students worked collaboratively with their peers to create scripts, generate content, and produce a digital product. This collaborative environment enabled not only cognitive engagement but also the formation of social and emotional bonds among students.

Smeda et al. (2014) stated that digital storytelling fosters interaction, collaboration, and curiosity, helping students understand and retain information more easily. Aktas and Uzuner-

Yurt (2017) emphasised that digital stories increase interest in the course and encourage more active student participation in the learning process. The presentations at the end of the process helped students gain confidence. Seeing, comparing, and evaluating others' work supported a more positive connection to science.

Demirbas and Sahin (2022) also indicated that digital storytelling processes enriched with visual and auditory elements increase students' achievement and interest in the subject. In this context, students' interaction with science topics through multiple sensory channels positively influenced their attitudes toward science lessons.

The findings of our study are consistent with numerous studies in the literature, which indicate that digital storytelling positively influences student attitudes. Kahraman (2013) found that digital physics stories had a positive impact on 9th-grade students' attitudes toward science; Cigerci (2015) reported improvements in students' attitudes toward Turkish language classes. Similarly, Buyukcengiz (2017), Dincer (2019), and Mangal (2020) reported significant improvements in students' attitudes through digital storytelling practices conducted in different courses. These findings suggest that digital storytelling can positively impact attitudes across disciplines.

On the other hand, the literature notes that attitude change generally becomes more permanent through long-term implementations and repeated learning experiences (Kotluk & Kocakaya, 2017). Therefore, the moderate effect observed in our study may be associated with the limited duration of the implementation. Additionally, students' previous classroom experiences, individual tendencies toward science, and environmental factors are also important variables that influence the development of attitudes.

Recommendations

As a result of this research, we observed that the digital storytelling method had positive effects on students' scientific process skills and their attitudes toward science. In light of our findings and conclusions, we offer the following recommendations:

- This method positively influences scientific process skills and contributes to the development of students' positive attitudes toward the subject. We recommend incorporating digital storytelling more extensively into science lessons.
- It would be beneficial to integrate digital storytelling practices into teacher education programs. In this context, prospective teachers should be provided with hands-on training in using software such as Adobe Character Animator.
- Implementing digital storytelling in long-term instructional plans would support the sustainability of attitude development. Repeated use of such practices can offer diverse learning experiences.
- Students should be encouraged to participate not only as consumers but also as active content creators in the process. Involving students in scriptwriting, character design, and voice acting can increase their motivation for learning.
- We also recommend conducting digital storytelling projects as group-based activities. Such collaborative practices support students' social and emotional development and cognitive growth.

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