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Abstract

In recent years, students' interest in technology has become a part of their daily lives. Students' interests in technology are concentrated on topics such as coding, software programmes, creating and sharing video content and curiosity about the use of social media. This study aims to determine the effect of using interactive digital storytelling activities to teach the Circulatory System topic to 6th-grade students in science courses on their academic achievement and attitudes. It significantly contributes to understanding how teaching methods impact students' learning and attitudes. This study used a quasi-experimental design with the pre-test-post-test control group, one of the quantitative research approaches, to answer the research problem and sub-problems. The study group research consists of 6th-grade students in a secondary school in the central district of Altınordu in Ordu province in the 2021-2022 academic year. One of these classes was randomly selected as the experimental group and one as the control group. While the digital storytelling material developed within the research was used in the classroom environment in the experimental group, it was not applied in the other control group. The same researcher and the course teacher attended both classes together. The science and technology attitude scale and the circulatory system achievement test were applied to the experimental and control groups as a pre-test at the beginning of the study and a post-test at the end. Independent samples t-test was used to analyse the data obtained from the study. As a result, it was observed that only the interactive digital storytelling applied to the experimental group increased the students' achievement and attitudes towards the science course in a statistically significant and positive way. It is recommended that the researchers provide the necessary pre-training for the students to use the interactive digital storytelling work they prepared in the science course and encourage them to share it with their friends.

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Research Article

The Effect of Interactive Digital Storytelling on the Academic Achievement and Attitudes of 6th Grade Students in Learning the Circulatory System *

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Abstract

In recent years, students' interest in technology has become a part of their daily lives. Students' interests in technology are concentrated on topics such as coding, software programmes, creating and sharing video content and curiosity about the use of social media. This study aims to determine the effect of using interactive digital storytelling activities to teach the Circulatory System topic to 6th-grade students in science courses on their academic achievement and attitudes. It significantly contributes to understanding how teaching methods impact students' learning and attitudes. This study used a quasi-experimental design with the pre-test-post-test control group, one of the quantitative research approaches, to answer the research problem and sub-problems. The study group research consists of 6th-grade students in a secondary school in the central district of Altınordu in Ordu province in the 2021-2022 academic year. One of these classes was randomly selected as the experimental group and one as the control group. While the digital storytelling material developed within the research was used in the classroom environment in the experimental group, it was not applied in the other control group. The same researcher and the course teacher attended both classes together. The science and technology attitude scale and the circulatory system achievement test were applied to the experimental and control groups as a pre-test at the beginning of the study and a post-test at the end. Independent samples t-test was used to analyse the data obtained from the study. As a result, it was observed that only the interactive digital storytelling applied to the experimental group increased the students' achievement and attitudes towards the science course in a statistically significant and positive way. It is recommended that the researchers provide the necessary pre-training for the students to use the interactive digital storytelling work they prepared in the science course and encourage them to share it with their friends.

Keywords: Interactive digital storytelling, circulatory system, digital storytelling, science education

1. INTRODUCTION

In recent years, students' interest in technology has become a part of their daily lives. Students' interests in technology are concentrated on topics such as coding, software programmes, creating and sharing video content, and curiosity about the use of social media. However, using these interests in the wrong direction in an aimless, unplanned way can also cause students to move away from the lessons (Karademir, 2020; Olur, 2021). In addition to the positive effect of students' interest in technology, it is thought that this negative effect will be eliminated by planning and using formal and informal learning environments within a particular purpose. In this way, integrating students' interest in technology with the lesson will allow them to participate more actively, have fun and learn by concentrating their attention. In this way, more effective and educationally efficient use of technology can be provided. Adapting students to technology and the technological conditions of today's

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developing education also shows compatibility with 21st-century skills. Today, a student's critical thinking, creativity, collaboration and problem-solving skills are defined as 21st-century skills (Kaya et al., 2024). In addition, 21st-century skills are related to how that knowledge is accessed and used rather than the knowledge itself (Karademir, 2020). The changes brought by 21st-century skills have also impacted education and training practices. Teachers planning the lesson to cover 21st-century skills will contribute positively to increasing students' success in the lessons.

The science curriculum is aimed at students to be individuals who are ready for development and change, as well as to be able to produce knowledge and use it in their lives, to bring solutions to problems in this way, to gain a critical perspective, to be entrepreneurial, curious, determined, able to use communication skills, to have a developed sense of empathy, to be qualified individuals who contribute to social values and culture (MoNE, 2018). Making the methods and techniques required by contemporary education applicable to every teacher will be more beneficial for education and training. The importance of using digital tools comes to the fore once again at this point. Within the scope of the objectives of the science curriculum, it is tried to ensure that students can use meta-cognitive thinking skills from basic thinking skills, transfer knowledge between disciplines and benefit from the teaching strategy through research and investigation. Interactive applications have gained an important place in the education and training process because they contain features to meet the specific objectives of the science curriculum. One of the techniques that can be used in developing and implementing interactive applications in science education is digital storytelling (DST).

The most important difference that distinguishes DST from other digital tools is that it provides interdisciplinary transitions by using different disciplines together (Aldemir-Engin, 2022; Yılmaz, et al., 2017). It is also compatible with the principle of integrity within the scope of teaching principles. With the principle of integrity, it is possible to provide multidimensional development such as cognitive, psychomotor, and affective features. DST is one of the digital tools that enable the listener to obtain concrete information on the subject by using basic thinking skills to bring them together on a common denominator by attracting attention through charts, pictures, animations, figures and text and transferring them through video (Dayan & Girmen, 2018; Deliveli, 2022; Demir & Çetinkaya, 2021).

Unlike a normal DST, an interactive DST has a non-linear style of expression. This narration style is called the non-linear narration style. In this way, the person watching the interactive digital storytelling (IDST) can provide a two-way interaction with the narration by leaving the passive listener state. Thus, the audience will turn into a user. The user will produce a result with the author (Ünlü, 2020). At the same time, while the audience remains an "object" in traditional narratives, they become users who become "subjects" in interactive narratives. The user or users will be able to accept input from the user and respond to this input beyond the restrictions such as "play" and "pause" in traditional narratives, and the user will make his/her own decision (Öndin, 2008). In a free environment, the user or users have two different preferences in which they can choose the event flow. They can provide guidance in the event flow. The application can be done in two ways: One is collective, that is, progress with the decision made by the majority, and the other is progress with personal decision (Ünlü, 2020). IDST, which is applied by choosing one of the two options presented by the author during the event flow, does not leave the user alone with a truth. IDST leads the user to an experience and makes them a part of the story by providing interaction to the user (Salman & Kalender, 2019; Demir & Çetinkaya, 2021). One of the benefits of interactive use is that a user who wants to reach all decision points in the scenario quickly needs to try all options. Collecting data with this method will enable a user to focus on the subject and allow the user to explore (Tepe & Ovalı, 2021). Adding an interactive part to the DST technique provides teachers and students with auxiliary resources related to the unit topics, enabling students to access the information learnt by exploring, adapting it to real life, and perceiving abstract concepts more easily in educational environments. It also allows interactive teaching to be carried out by students in groups or individually.

In this way, one of the main objectives of the science curriculum is for students to participate actively in the learning process and concentrate their attention on the subject by using applications. In the Science Curriculum of the Ministry of National Education, there are many unit topics at different grade levels suitable for the use of DST. One is the 6th grade circulatory system (MoNE, 2018). There are many studies on this unit (Kılıç, 2019; Morris & Nilsson, 2021). These studies reported many misconceptions in students regarding the circulatory system unit (Nainggolan & Sipahutar, 2017). IDST, in which the student is interactively involved in the learning process, can help reduce the formation of misconceptions while supporting permanent learning.

Since the student is involved in the process within the IDST process, he/she will instantly see the results of his/her right/wrong choices. The study we have conducted is to enable this. The IDST process used for the study was created by the researcher and supported by expert opinion. All acquisitions of the circulatory system subject were included in the IDST. Several activities were presented to the students in the participant position to arouse their curiosity. It is thought that this study, in which the effectiveness of the CBL technique covering the subject acquisitions of the "Circulatory System" on students will be investigated, will contribute to the literature. This study aims to investigate the effect of using IDST on students' academic achievement and attitudes in the 6th grade "Circulatory System" subject of science course.

2. METHOD

In this section, the findings related to the sub-problems are given depending on the problem sentence “What is the effect of the IDST to be used in the 6th-grade circulatory system subject of science course on the academic achievement and attitudes of the students?”.

The first sub-problem of our research is “Is there a statistically significant difference between the academic achievement pre-test / post-test mean scores of the students in the experimental group and the control group before and after the application?”.

The second sub-problem of our research is ‘Is there a statistically significant difference between the pre-test / post-test mean scores of the attitudes of the students in the experimental group and the control group towards the science course before and after the application?’.

2.1. Research Design

This study used a quasi-experimental design with a pretest-posttest control group, an experimental method from quantitative research approaches. The study group consists of 6th-grade students from two different branches of a secondary school located in Altınordu, the central district of Ordu province, during the 2021-2022 academic year. The experimental and control groups were randomly selected. This study lasted a total of 8 lesson hours and 4 weeks, including the pre-test before the application, teaching the students with the material prepared during the unit subject and post-test processes.

2.2. Data Collection Tools

This study collected data from the circulatory system achievement test (CSAT) and the attitude scale of science and technology courses. In addition, semi-structured interviews were conducted with some students voluntarily. The interviewed students were coded as M1, M2,.. These tools were used in the study as follows:

2.2.1. Science and technology attitude scale

In this study, the "science and technology course attitude scale" developed by Çetinkaya (2015) was used to measure students' attitudes towards science courses. This attitude scale is a 5-point Likert-type scale and consists of 27 items. In this study, the scale was graded as follows: "strongly agree: 5", "agree: 4", "undecided: 3", "disagree: 2", "strongly disagree: 1". The negative sentences in the scale were recoded in the reverse direction. In order to determine the construct validity of the scale, factor analysis was applied, and the varimax rotation method was used. The data obtained from applying the

prepared science and technology course attitude scale were analysed in the SPSS 17 package program, and the reliability coefficient of the scale, Cronbach-α value, was found to be 0.919 (Çetinkaya, 2015). The scale was found to be valid and reliable and was used in our study.

2.2.2. Circulatory system achievement test (CSAT)

The CSAT developed by Kılıç (2019) to measure students' achievement in the subject of the circulatory system was used for this study. As the first step of the achievement test development process, the achievements of the "Circulatory System" subject within the scope of the 6th Grade Science Curriculum "Systems in Our Body" unit were listed, and a specification table was created. Sources were used while writing the multiple-choice items, science textbooks, question banks, subject screening tests, and published exam questions. It was stated that the distribution of the questions related to the gains was determined according to the sub-topics within the scope of the gain. To ensure the scale's content validity, the trial forms were submitted to the opinions of two academicians who are experts in science education and two science teachers working in different schools. The pilot application of the achievement test was applied to 150 students studying in the 6th grade of a state secondary school in the Keçiören district of Ankara province in the 2016-2017 academic year who had studied the subject. After the application, the CSAT, consisting of 22 multiple-choice items with an average difficulty of 0.50, was finalised with item analysis. The KR-20 reliability coefficient of the achievement test was calculated as 0.73 (Kılıç, 2019).

2.3. Data Collection

The problem statement of the research is: What is the effect of the IDST to be used in the 6th grade "Circulatory System" subject of the science course on the academic achievement and attitudes of the students? For this reason, while the dependent variables in the research are the students' achievement and attitudes to be obtained from the pre-post test, the independent variable is the IDST technique in circulatory system teaching. The validity and reliability analyses of the data collection tools used to answer the research problem statement were the circulatory system achievement test (CSAT) and the science and technology course attitude scale.

It was impossible to make unbiased assignments to the groups since the 6th-grade students who would participate in the study were required to follow the course programme and attend classes in which they were enrolled. For this reason, within the scope of this design, experimental and control groups were formed by determining the subjects as unequalised groups in terms of certain variables (Çepni, 2018). The selected experimental group was given the necessary information about the study and its importance. The pre-test before the application and the post-test after the application were applied to both groups. The prepared IDST material was applied only to the experimental group (Table 1).

Table 1. Symbolic representation of the research design

Group	Phase 1	Phase 2	Phase 3
Experiment	Pre-test Applied	Application Available	Post-test is Applied
Control		No Application	

2.4. Data Analyses

The CSAT and attitude scales were applied to the experimental and control groups as pre-tests and post-tests. The data from the data collection tools were analysed using SPSS 22 software. Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to the pretest data to determine whether the study groups showed a normal distribution. The p-value was evaluated at the 0.05 significance level in the test results obtained. Independent samples t-tests were used for intergroup comparisons to evaluate pre-test and post-test data.

In a statistical test, the p-value is the value of the null hypothesis, which can help you decide whether or not to reject it. However, the p-value alone is not sufficient. Cohen's d value is used to interpret the effect size of t-test results. Although the most widely used calculation of effect size is Cohen's d (Cohen's d) developed by Cohen (1998), calculations such as Pearson's correlation coefficient (Pearson's r), Eta-squared (η^2), Hedge's d, R-squared (R-squared) can also be found in the literature (Cohen, 2013). Cohen (1998) states that if the d value is less than 0.2, the effect size is weak, moderate if 0.5, and strong if greater than 0.8. Independent samples t-test results Cohen's d in interpreting the effect value in cases where a significant difference occurs value was used.

Voluntary semi-structured interviews were conducted with the students and transcribed. The interview data were used for descriptive analysis while interpreting quantitative data.

2.5. Development and Implementation Process of Interactive Digital Storytelling (IDST)

2.5.1. Development process

The development process of the interactive digital storytelling application was carried out uniquely for the 6th-grade science course "circulatory system" subject. In the research process, the subject of the circulatory system, which will be used in the IDST, was first searched. To transfer the subject to the students thoroughly and accurately, the 6th-grade science textbook of the Ministry of National Education was used. In addition, the types of questions asked to students in the 6th-grade science question bank books were also examined. Particular attention was paid to ensuring that the prepared IDST covered the subject acquisitions in the 2018 Science Curriculum. A scenario on the 6th-grade circulatory system was created in line with the information and gains obtained. Unlike the DST, the scenario was not created in a straight text flow because the interactive part would be added. The DST was created with different path options to gain interactive features in some parts. Thus, the student can continue the story with the option of his/her choice. The scenes used in the scenario were divided into sections in the form of dialogues specific to the characters. After the panelisation processes were completed, a programme that could create the panels was selected to prevent the students from getting bored and learning the subject by having fun. For this reason, the storytelling panels were first prepared in the computer environment with the "plotagon" program. Combining and interactive features were provided by using the "Camtasia 2021" programme.

2.5.2. Implementation process

Before the students used the prepared IDST, the opinions of experts in the fields of science education and information technologies were considered, and updates were made based on these opinions. The finalised IDST was then applied to the students. Before starting the IDST application, students were asked to brainstorm, and their thoughts and predictions about the subject were considered.

After the students' predictions and thoughts about the subject were taken, they were informed about IDST. In the school where the application was carried out, since the students did not have the opportunity to apply for the IDST individually, the IDST was applied to the students in the classroom with a collective (majority vote). The IDST can be used individually, but it can also be used in the classroom with the participation of the whole class according to the environment and conditions (Figure 1).

Figure 1. When students are asked questions, when they are brainstorming and when they are given information about the use of IDST

3. FINDINGS

In this section, the findings depend on the problem sentence "What is the effect of the IDST to be used in the 6th-grade circulatory system subject of science course; on the academic achievement and attitudes of the student?" and are given.

3.1. Findings Related to Circulatory System Achievement Test (CSAT) Analysis

In the analysis of the findings of the experimental and control groups for the "Circulatory system achievement test (CSAT)", comparisons between groups were made. An independent samples t-test was used to compare the groups.

CSAT examined whether the data obtained from the pre-test results applied to the experimental and control groups showed a normal distribution. The normality test results are given in Table 2.

Table 2. Skewness, Kurtosis, Kolmogorov-Smirnov and Shapiro-Wilk results for achievement pre-test scores of experimental and control groups

N	Skewness	Std.	Kurtosis	Std.
26	-0.189	0.327	-0.779	0.644

Kolmogorov-Smirnov			Shapiro-Wilk		
Statistic	df	*p*	Statistic	df	*p*
0.1	53	.200*	0.967	53	0.152

Skewness and kurtosis tests are performed to determine whether a distribution is expected. Skewness measures the degree to which a distribution is not symmetrical, while kurtosis is an index showing the degree to which there are too many or too few samples in the centre of the distribution. For the distribution not to differ significantly from the normal distribution, these values are expected to remain in the range of -1 to +1 (Cevahir, 2020). In addition, it is possible to use various normality tests to determine whether the data are suitable for normal distribution. These tests, such as the Kolmogorov Smirnov and Shapiro-Wilk, provide reassurance by validating the data distribution. If a p-value greater than 0.05 is obtained in the results of these tests, it is interpreted that the distribution does not differ significantly from the normal distribution (Uysal & Kılıç, 2022). When the skewness and kurtosis values fall within the -1 to +1 range and the significance value of the Kolmogorov Smirnov, Shapiro-Wilk results is above 0.05, it indicates the appropriateness of using the independent samples t-test, a parametric analysis, for the study.

Independent samples t-test was used to evaluate the equality of the groups before the application and to compare the differences between the two groups obtained in the pre-test. CSAT was used as a pre-test before the application between the experimental group, in which the teaching based on IDST was carried out, and the control group, in which only the activities in the current programme were applied. The independent samples t-test analysis is given in Table 3.

Table 3. Independent samples t-test results of pretest achievement scores of experimental and control groups

Tests	Groups	N	$\bar{X}$	S	sd	t	*p*
Pre-test	Experiment	26	9.15	3.484	51	0.789	0.434
	Control	27	8.41	3.4			

p>0.05

In Table 3, when the achievement test pre-test data of the control and experimental group students are compared, it is seen that there is no statistically significant difference between the groups (t=0.789; *p>0*.05). Accordingly, the mean of the pre-test scores of the experimental group (N=26) regarding the achievement value ($\bar{X}$=9.15) and the mean of the pre-test scores of the students in the control group (N=27) regarding the achievement value ($\bar{X}$=8.41) is close. In this case, the experimental and control groups were equivalent in their achievement in the science course before the application.

CSAT was used as a post-test after the application between the experimental group in which IDST-based learning was carried out and the control group in which the lesson was taught only with the activities in the current programme. Independent samples t-test analysis is given in Table 4.

Table 4. Independent samples t-test results of the post-test achievement scores of the experimental and control groups

Tests	Groups	N	$\bar{X}$	S	sd	t	*p*	*Cohen's d*
Post-test	Experiment	25	14.64	4.329	47	2.04	0.047	0.585
	Control	24	12.29	3.689				

p<0.05

Table 4 shows a significant difference between the achievement test scores of the groups after the application in favour of the experimental group (t=2.04; *p<0*.05). The independent sample t-test revealed a significant difference between the groups with a moderate effect value (Cohen's d = 0.585). Accordingly, the mean of the post-test scores of the experimental group (N=25) regarding the achievement value $\bar{X}$=14.64, while the mean of the post-test scores of the students in the control group (N=24) related to the achievement value $\bar{X}$=12.29. In this case, it is seen that there is an increase in terms of science course achievement after the application within the experimental and control groups, as well as a significant positive difference in favour of the experimental group students when we compare the groups with each other.

Figure 2 below presents graphically the findings related to the mean scores obtained from the pre-test and post-test results of the experimental and control groups.

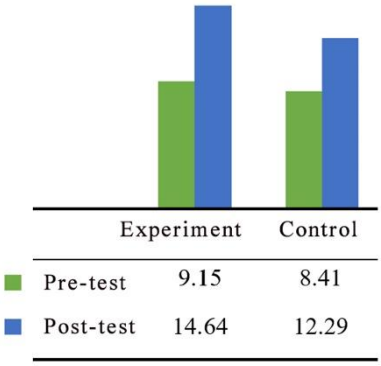

Figure 2. Mean achievement scores of the groups according to pre-test and post-tests

At the beginning of the study, the experimental group students received an average score of 9.15, while the control group students received an average score of 8.41. At the end of the experimental application, the scale was applied again as a post-test, and the students in the

experimental group scored 14.64 points on average. In comparison, the control group students scored 12.29 points. It is observed that the success level of the experimental group students after the application is higher than the control group students (Figure 2).

3.2. Findings Related to the Science and Technology Course Attitude Scale

In analysing the findings of the experimental and control groups for the "Attitude Scale towards Science and Technology Course," comparisons between the groups were made. Independent samples t-test was used for pre-test / post-test in intergroup comparisons.

The science and technology course attitude scale examined whether the data obtained from the pre-test results applied to the experimental and control groups showed a normal distribution. The normality test results are given in Table 5.

Table 5. Skewness, Kurtosis, Kolmogorov-Smirnov and Shapiro-Wilk results for attitude pre-test scores of experimental and control groups

N	Skewness	Std.	Kurtosis	Std.		
26	-0.511	0.327	0.075	0.644		
Kolmogorov-Smirnov			**Shapiro-Wilk**			
Statistic	df	*p*	Statistic	df	*p*	
0.117	53	0.069	0.962	53	0.086	

The fact that the skewness and kurtosis values are in the range of -1 and +1, and that the Kolmogorov Smirnov and Shapiro-Wilk results are p>0.05 are the values that should be considered for normality and sample suitability (Cevahir, 2020; Uysal & Kılıç, 2022). When the skewness and kurtosis values fall within the -1 to +1 range and the significance value of the Kolmogorov Smirnov, Shapiro-Wilk results is above 0.05, it indicates the appropriateness of using the independent samples t-test, a parametric analysis, for the study.

Independent samples t-test was used to evaluate the equality of the groups before the application and to compare the differences between the two groups obtained in the pre-test. The science and technology course attitude scale was used as a pre-test before the application between the experimental group in which IDST-based learning was carried out and the control group in which only the activities in the current program were applied. The independent samples t-test analysis is given in Table 6.

Table 6. Independent samples t-test results of pretest attitude scores of experimental and control groups

Tests	Groups	N	$\bar{X}$	S	sd	t	*p*
Pre-test	Experiment	26	4.057	0.60941	51	1.276	0.208
	Control	27	3.8422	0.61518			

*p>0.*05

Table 6 shows no statistically significant difference between the control and experimental group students' attitude scale pre-test data (t=1.276; *p>0.*05). Accordingly, the mean of the pre-test scores of the experimental group (N=26) regarding the attitude value ($\bar{X}$=4.057) and the mean pre-test scores of the students in the control group (N=27) regarding the attitude value ($\bar{X}$=3.8422) is close. In this case, it is seen that the experimental and control groups were equivalent in terms of their attitudes towards science courses before the application.

The science and technology course attitude scale was used as a post-test between the experimental group, in which learning based on IDST was carried out, and the control group, in which the lesson was taught only with the activities in the current programme. The independent samples t-test analysis is given in Table 7.

Table 7. Independent samples t-test results of the post-test attitude scores of the experimental and control groups

Tests	Groups	N	$\bar{X}$	S	sd	t	*p*	*Cohen's d*
Post-test	Experiment	25	4.3600	0.51813	47	3.163	0.003	0.090
	Control	24	3.7068	0.88727				

$p<0.05$

Table 7 shows a significant difference between the attitude test scores applied to the groups after the application in favour of the experimental group (t=3.163; $p<0.05$). An independent sample t-test revealed a significant difference between the groups, with a low level effect value (Cohen's d = 0.090). Accordingly, the mean of the post-test scores of the experimental group (N=25) regarding the attitude value $\bar{X}$=4.3600, while the mean of the post-test scores of the students in the control group (N=24) regarding the attitude value $\bar{X}$=3.7068. In this case, in addition to the increase in the attitudes towards science courses after the application within the experimental and control groups, when we compare the groups with each other, it is seen that a significant difference emerged in favour of the experimental group students.

Figure 3 presents the findings related to the mean scores obtained from the pre-test and post-test results of the experimental and control groups.

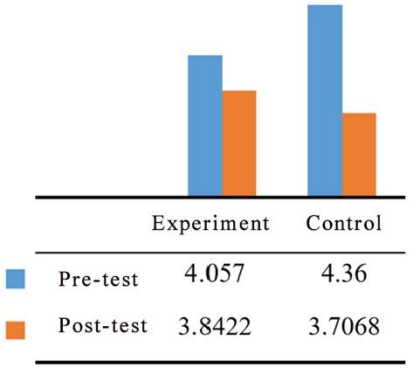

Figure 3. Mean attitude scores of the groups according to pre-test-post-tests

At the beginning of the study, the experimental group students received an average score of 4.057, while the control group students received an average score of 3.8422 from the science and technology course attitude scale we applied as a pre-test. The scale was applied again as a post-test at the end of the experimental application. The experimental group students received an average score of 4.36, while the control group received an average score of 3.7068.

It is observed that the attitude level of the experimental group students after the application provided a positive attitude level compared to the control group students (Figure 3).

4. DISCUSSION and CONCLUSION

This study analysed the effects of an interactive digital storytelling activity on students' achievement and attitudes. With the interactive feature of the activity in which interactive digital storytelling is used, students will be able to intervene in the flow of events and develop problem-solving skills related to the subject. In addition, when learning the subject, possible misconceptions and knowledge deficiencies that may arise while trying to find the right one from the options they encounter can be prevented. One of the options the student faces will allow him/her to continue the flow of the story correctly, while the other option will cause him/her to continue the story incorrectly. The results of the wrong option will be shown to the students, and they will return to the section with the same two options. In this way, students can actively participate in the science lesson and apply

experience and discovery-based learning. In environments where students are taught by watching videos, there is a situation where the learner remains passive in the process.

On the other hand, interactive material increases students' engagement in the online course (Aktepe, 2018; Tepe, 2022). It has been observed that students identify with the story's main character in order for the story to progress in the right way so that students are interested in the course with a sense of adventure as if they are experiencing the events themselves (Ünlü, 2020). It is ensured that students experience a sense of adventure during the plot and are responsible for their learning through their experiences in the decision-making process (Selvi, 2019). In the IDST technique, with the options presented to the student during the flow of the story, the student sees how the event can result in case the student chooses the wrong path and searches for the right path, which makes the student active in structuring the information away from misconceptions. In his study, Engelman (2016) states that students move away from misconceptions by using confront, solve and reflect frameworks in interactive video environments. Considering that interactive videos are based on the constructivist approach, it is seen that they will make a significant contribution to minimising misconceptions and student cognitive learning (Erdem, 2019).

In the interviews conducted with the students at the end of the course after the application of the IDST technique to the students in the experimental group, it was observed that the students stated that the lesson continued without getting bored during the application (M1, M2, M3, M12, M13), that they were curious about how the application was created (M1, M3, M22), and that they had fun by actively participating in the lesson throughout the lesson (M7, M11, M13, M18, M23). Studies also mention that students find lessons with interactive videos interesting (Torun, 2019). In the current school where the application was carried out since not all computer laboratories computers were working, the students were asked to complete the IDST on the smart board in their classrooms, and the students were asked to complete the IDST collectively (majority vote). In this way, it was ensured that the students established dialogue and socialised with the cooperation between the students. Students must establish a dialogue with each other in such learning environments and reach a common decision by discussing with a critical perspective (Bozdağ & Gökler, 2023; Kutluca et al., 2020). The fact that students actively contribute to the process and are involved in the scenario flow by asking questions in the narration process in which the subject is narrated makes students feel responsible for learning and learning by having fun. It is also important that they can instantly evaluate the results of their options by discussing them in the classroom environment. It is understood from the interview data in which the students evaluated the process and the application that they are aware of the importance of this situation and that most of the students have common thoughts (M8, M10, M11, M13, M14, M18, M22, M23). It is essential to keep the duration of the video as short as possible to ensure time efficiency and prevent students from losing motivation. It is stated that as the duration of the video increases, the number of students who view the entire video decreases (Aktepe, 2018; Torun, 2019).

The IDST activity was applied to the experimental group but not the control group. When we compared the experimental and control groups, it was concluded that the groups were equivalent to each other according to the pre-test results and the quasi-experimental process was continued. In the post-tests applied between the students in the experimental group in which IDST was used and the students in the control group in which only the activities in the current programme were applied, it was determined that both groups showed a positive increase in their success rates. While the success of the groups increased positively within themselves, when we compare the groups with each other, it is seen that there is a statistically significant positive difference in favour of the control group. When the attitudes towards science courses were analysed, it was determined that there was an increase in the attitudes of the experimental group students and a decrease in the control group students. As a result, the students' attitudes in the experimental group, in which IDST was applied, were statistically more positive.

There are many studies in the literature reporting a positive increase in student attitudes in environments where DST is used (Büyükcengiz, 2017; Dinçer, 2019). When the effect of the interactive application of digital storytelling on student attitudes is examined, it is seen that there is no change in student attitudes (Erdem, 2019). It is known that affective characteristics such as attitudes are difficult to change quickly. For their habitual attitudes to change, they need to complete their cognitive reasoning to change their attitudes for a certain period. In this case, the results of the studies in the direction of changing or not changing attitudes can be considered valid in both cases. Changing or not changing attitude includes many different factors within itself. It can be thought that the fact that the content presented to the students in the study focuses on the subject acquisitions in a way that will attract the student's interest may attract the student's interest and motivation more. It is expected that studies in which the student is involved in the process contribute to his/her learning and in which the theoretical infrastructure is well planned will positively affect students' attitudes towards the course and learning.

It is seen that there are many studies on the use of digital storytelling in science education (Çalış & Demir, 2023; Demir & Çetinkaya, 2021; Doğan, 2021; Kaya & Yılmaz, 2022). Interactive digital storytelling, an interactive form that enables students to participate more in lessons, understand concepts better and develop scientific thinking skills, appears in science education as an innovative approach. However, there are fewer studies on the use of interactive digital storytelling in science education outside Turkey compared to digital storytelling (Murray, 2024). On the other hand, it is seen that there is only one practical study on this subject in Turkey (Demir, 2023). Demir (2023) prepared an interactive digital storytelling material and analysed its effect on student's academic achievement and attitudes in his study, which was prepared to "determine the effect of teaching the 6th-grade circulatory system subject in science course using interactive digital storytelling (IDST) teaching activity". As a result, he reported that interactive digital storytelling made a positive difference in students' achievement and attitudes.

The fact that there are very few studies on interactive digital storytelling, especially in Turkey, maybe because the preparation process is complex. The stages of creating interactive digital storytelling can be done by selecting appropriate software for this work and creating scenarios related to unit outcomes without requiring advanced computer programming knowledge. Our study guides researchers and teachers who want to use interactive digital storytelling in their lessons. An important benefit will be provided to researchers and teachers in terms of knowing the application stages of the process, creating scenarios suitable for the unit outcomes, and sharing them with students in the lessons.

IDST addresses many skills expressed in the specific objectives mentioned in the 2018 Science Curriculum published by the Ministry of National Education, which are also included in the 21st-century skills. These can be listed as thinking skills, problem-solving skills, critical thinking, cognitive learning, affective learning, technology skills, listening skills, scientific process skills, cooperation and association with daily life. When the studies on 21st-century skills are examined, it is seen that there are results in parallel with our study (Çelik, 2021; Yang & Wu, 2012).

Recommendations

Based on the data obtained as a result of the research, some suggestions about IDST were presented to the researchers:

- The course teacher or informatics teacher can train students to create interactive digital storytelling processes and provide training on the programmes to be used.
- Students can be encouraged to share the IDST they prepared in the science course with their friends.

- It may be preferable to use IDST to create lesson environments where students are active.
- For researchers planning to work on IDST,
- Conducting studies for the use of IDST in disciplines other than science,
- Besides the computer programmes used for this study, researchers can explore the development of diverse IDSTs using different tools and techniques. This could inspire creativity and innovation in the field.
- Providing students with preliminary information about IDST and enabling them to develop IDST in groups could foster a sense of collaboration and support, enhancing their learning experience.

IDST development studies should be carried out for other unit subjects in the science course.

Ethics Committee Decision

This study includes the research findings and results of the master's thesis study of İrem Cansu DEMİR, supervised by Assoc. Prof. Dr. Murat ÇETİNKAYA. Ethics committee permission was obtained from Ordu University Social and Human Sciences Research Ethics Committee with decision number 2021/157.

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