INVESTIGATING THE EFFECTS OF DIGITAL STORYTELLING USE IN SIXTH-GRADE SCIENCE COURSE: A MIXED METHOD RESEARCH STUDY

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ABSTRACT

INVESTIGATING THE EFFECTS OF DIGITAL STORYTELLING USE IN SIXTH-GRADE SCIENCE COURSE: A MIXED METHOD RESEARCH STUDY

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The main purpose of this study was to examine the effects of Digital Storytelling (DST) use in a 6th grade science course. Specifically, this study investigated how students' academic achievement, learning strategies, and attitudes toward creating Digital Stories (DS) in a science course were influenced by DST. Additionally, students' opinions based on DST use, and the quality of the DSs created by the students were determined. In this manner, 88 students in the 6th grade participated in this study and were assigned between one Control Group and two experimental groups.

Embedded experimental model was selected as the research design, and *nonequivalent control group pretest-posttest design* was employed in the current study. While quantitative data were collected by using five different instruments, qualitative data were gathered through standardized open-ended interviews and observation form. The collected quantitative data were analyzed by applying descriptive and inferential statistics, and the qualitative data were examined through content analysis method.

The results concluded that DST contributed to the students' academic achievement and learning strategies. Besides, students had positive attitudes toward creating DS, and females had statistically significant higher attitude scores than males. Additionally, the interviews and observations revealed many positive effects of DST in various respects, some preferences of students for creating DS, challenges they faced during the process, and several suggestions originating from the students. Lastly, the examination of DSs illustrated that even though there were some problematic issues related to the use of some components of DS, students in both experimental groups performed satisfactorily when considering the entire process.

Keywords: Digital Storytelling, Learning Strategies, Science Education, Constructivist Learning Approach

ÖZ

DİJİTAL HİKÂYELEME YÖNTEMİNİ KULLANMANIN ALTINCI SINIF FEN BİLİMLERİ DERSİNDEKİ ETKİSİNİN İNCELENMESİ: BİR KARMA YÖNTEM ARAŞTIRMASI

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Bu çalışmanın temel amacı, dijital hikâyeleme (DH) kullanımının altıncı sınıf fen dersindeki etkilerini incelemektir. Bu çalışma özellikle DH yönteminin öğrencilerin akademik başarısını, öğrenme stratejilerini ve fen dersinde dijital hikâye oluşturmaya yönelik tutumlarını nasıl etkilediğini ortaya çıkarmayı amaçlamaktadır. Ayrıca, çalışmanın sonuçları ışığında öğrencilerin dijital hikâye oluşturma sürecine yönelik düşünceleri ve öğrenciler tarafından oluşturulan dijital hikâyelerin kalitesi incelenmiştir. Bu bağlamda, bir kontrol ve iki deney grubuna atanmak üzere toplam 88 altıncı sınıf öğrencisi çalışmaya katılmıştır.

Araştırmada karma araştırma yöntemlerinden gömülü deneysel desen seçilmiş olup, yarı deneysel desen türlerinden *eşdeğer olmayan ön-test/son-test kontrol gruplu deneysel desen* kullanılmıştır. Bu araştırma deseni kapsamında, nicel veriler beş farklı veri toplama aracı kullanılarak, nitel veriler ise standartlaştırılmış açık uçlu görüşmelere ve gözlemlere başvurularak toplanmıştır. Toplanan nicel verilerin analizi için betimsel ve çıkarımsal istatistiklerden, nicel verilerin analizi için ise içerik analizi yönteminden faydalanılmıştır.

Araştırmanın sonuçları DH'nin öğrencilerin akademik başarısına ve öğrenme stratejilerini kullanmalarına yönelik katkı sağladığını göstermiştir. Öte yandan, öğrencilerin fen dersinde dijital hikâye oluşturmaya yönelik olumlu tutum sergiledikleri görülmüş olup, kızlar ve erkekler arasında tutum puanlarına göre kızlar lehine istatistiksel açıdan anlamlı fark bulunmuştur. Ek olarak, görüşmeler ve gözlemler, DH'nin öğrenmeye farklı açılardan çokça pozitif etkisinin olduğunu, dijital hikâye oluşturma esnasında öğrencilerin farklı tercihlerde bulunduğunu, süreç boyunca bazı zorluklarla karşılaşıldığını ve öğrencilerden süreç ile ilgili bazı önerilerin geldiğini göstermiştir. Son olarak, öğrencilerin oluşturdukları dijital hikâyeler değerlendirildiğinde, her ne kadar dijital hikâyenin bazı unsurlarını kullanmada sorunlar olduğu görülse de süreci bütün olarak ele aldığımızda öğrencilerin güzel ürünler ortaya çıkardığı görülmüştür.

Anahtar Kelimeler: Dijital Hikâyeleme, Öğrenme Stratejileri, Fen Eğitimi, Yapılandırmacı Öğrenme Kuramı

To my family…

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LIST OF ABBREVIATIONS

ANOVA – Analysis of Variance

ANCOVA – Analysis of Covariance

CFA – Confirmatory Factor Analysis

CFI – Comparative Fit Index

CV – Covariate

DISTCO – Digital Storytelling Contest

DH – Dijital Hikayeleme

DS – Digital Story

DSC – Digital Story Creating

DST – Digital Storytelling

DV – Dependent Variable

ELA – English Language Arts

ES – Elementary School

GFI – Goodness-of-Fit Index

HS – High School

ICT – Information and Communication Technologies

IT – Information Technologies

KR – Kuder Richardson

LO – Learning Outcome

ML – Maximum Likelihood

MS – Middle School

MSLQ – Motivated Strategies for Learning Questionnaire

RMSEA – Root Mean Square Error of Approximation

SB – Storyboarding

SE – Science Education

SRMR – Standardized Root Means Square Residual

SW – Story Writing

CHAPTER 1

INTRODUCTION

"Stories have to be told, or they die, and when
they die, we cannot remember who we are or why we are here."

Sue Monk KIDD,
The Secret Life of Bees

This chapter represents the introduction of this study with a background of the study, the problem statement, purpose, research questions, and the significance of the study. The definitions of the terms used in this study are also provided at the end of this chapter.

1.1. Background of the Study

The 21st century has brought with it many innovations, and particularly in technology. These technological innovations have helped shape the world in various settings from the economy and military, to healthcare and daily life, but especially and significantly within education. Information and Communication Technologies (ICTs) have developed rapidly, and the volume of global information has massively increased as a result. Parallel to this development and the associated data increases, educational environments have become varied and enhanced by technology in order to meet today's generations' needs. To put it another way, struggles for meaningful technology integration into education have played a significant role from K-12 right through to higher education. Jonassen and Carr (2000) asserted that when learners are actively engaged to a learning environment through the use of technology, they can more easily create their own meaningful knowledge. Along the same lines, Wheatley (1991) stated that technology might be an important instructional tool depending on its use in a learning setting while learners construct their own knowledge through self-criticism; and Strommen and Lincoln (1992) emphasized that no matter which technology is applied in a constructivist-based learning environment, it matters how the relevant technology is utilized in order to facilitate learning. From another perspective, some researchers (Griest, 1996; Hoffman, 1997; Richards, 1998) have highlighted that instruction must be given based on a constructivist learning approach that enables learners to socialize while learning, and to apply various strategies such as problem solving and critical thinking when constructing their own knowledge in order to be able to actualize meaningful technological integration.

One of the practices that facilitates technology integration into education is the use of "*Digital Storytelling (DST)"* which is a process that allows learners to analyze material, enhance their curricular understanding, and enables them to use their creative reflections and multiliteracies (Benmayor, 2008; Bull & Kajder, 2005). DST is continually increasing in popularity in settings such as medicine, museums, industry, libraries and other communities (Robin, 2016), and is fast becoming a global phenomenon providing many opportunities to its practitioners (Yuksel, Robin, & McNeil, 2011). Similarly, within educational environments, DST is currently being used as a beneficial pedagogical tool by students and teachers alike from kindergarten to adult education, including numerous fields such as art, history, technology, literature, writing, science, math, and medical education (Dupain & Maguire, 2005; Robin, 2008a; Standley, 2003). Four major enablers of DST have enhanced its popularity in education, and these are learner engagement, in-depth learning, project-based learning, and meaningful technology integration (Barrett, 2005).

DST can be used in the learning and teaching process in two different ways. The first is the use of DST in an objectivist way with students exposed to previously created Digital Stories (DS) for various course subjects (Dogan, 2010; Dogan & Robin, 2009). Second is the use of DST in a constructivist way, whereby learners have the chance to create content to construct their own knowledge through creating DSs in their subject area of study. In such settings, instructors might use technology more efficiently in the classroom environment, and provide the learner-centered instruction that their learners need. Students can create their own DSs either individually or it can be achieved collaboratively (Smeda, 2014).

Schank (1995) asserts that memory is shaped by indices, and that stories provide many indices related to any case in order to facilitate remembering. In another saying, “the more indices we have for a story that is being told, the more places it can reside in memory. Consequently, we are more likely to remember a story and relate it to experiences already in memory” (Schank, 1995, p. 11). Similarly, Smith (1998) expressed that stories help us store the knowledge that we need for our understanding of the world, and to facilitate remembering and recalling (as cited in Combs & Beach, 1994). Schank, Berman, and Macpherson (1999) considered the explanation and formation of a story under the frame of “case-based reasoning.” They postulated that cases are deeper than the rules and concepts taught by courses, and that cases can be inclusively indexed in the mind, and can then easily be redesigned and thought about. They emphasized the existence of cases in education, and adaption of these cases to the stories rather than focusing only upon the rules and concepts. Hence, when a story is created, basic knowledge that defines our experiences is also created and can be recalled whenever needed.

When reviewing the existing literature for DST, it is easy to find many studies in various fields such as foreign language education (Sadik, 2008; Yang & Wu, 2012), mathematics (Casey, Kersh, & Mercer Young, 2004; Inan, 2015; Starcic, Cotic, Solomonides, & Volk, 2015), science (Hung, Hwang, & Huang, 2012; Kotluk & Kocakaya, 2015), the arts (Chung, 2007), early childhood education (Kocaman-Karoglu, 2015), healthcare (Gubrium, 2009), history (Sanchez & Mills, 2005; Watts, 2006), and teacher education (Coulter, Michael, & Poynor, 2007). These studies have been conducted with almost all kinds of target groups; from kindergarten through to adult education. One of the most important benefits of DST use in education is that it contributes to students’ academic achievement, as concluded by many of the studies (Banaszewski, 2005; Dogan, 2007; Figg, McCartney, & Gonsoulin, 2010; Foley, 2013; Hung et al., 2012; Kahraman, 2013; Smeda, Dakich, & Sharda, 2010; Torun, 2016; Yang & Wu, 2012). In their studies, Wang and Zhan (2010) reported that DST is not only a multimedia component, but that it can also be used as a beneficial tool for learning and teaching processes. Their findings concluded that students could better learn specific course topics when DST is integrated into the educational process, and that levels of motivation, technology usage, and problem-solving skills of students increased with the aid of DST. Additionally, they stated that thanks to storytelling, teachers could help their students learn new information about subjects, and to construct knowledge by organizing complicated subjects.

Furthermore, some researchers reported that DST enables learners to improve various competences such as reading, writing, listening, and understanding (Jakes, 2005; Sadik, 2008; Skinner & Hagood, 2008; Tsou, Wang, & Tzeng, 2006; Verdugo & Belmonte, 2007). Besides, in the findings of Figg et al. (2010), a DST workshop lasting two weeks resulted in DST having afforded some future instructional opportunities to teachers in order to facilitate their students' learning processes, and thereby increased students' motivation levels.

Xu, Park, and Baek (2011) conducted a research study to determine the effects of DST on undergraduate students' writing competencies in a virtual instructional setting. The findings of the experimental study concluded that the virtual use of DST affected students' writing experiences more than its offline use, and the results also suggested that DST could be utilized for teaching how to write in educational environments. Besides, Yang and Wu (2012) carried out a one-year quasi-experimental study with high school students taking a course in English. The aim of the study was to investigate the effects of DST on students' levels of motivation, academic achievement and critical-thinking skills. Their findings concluded that there was a statistically significant difference between students who used DST and those who took traditional lectures with regard to their levels of motivation, academic achievement and critical thinking. This significant difference was in favor of students using DST in their English courses. Moreover, interviews held with both students and teachers revealed DST to be a beneficial instructional tool that enhanced students' levels of knowledge about the course, their eagerness to participate in the course, and which led them to think critically.

Dogan and Robin (2008) performed a study in order to examine the effects of DST, and pre-service teachers' perceptions related to the use of DST in education. Their study results indicated that teacher candidates found DST to be a useful pedagogical tool, and that it increased students' level of motivation, engagement, and use of various 21st century skills. Additionally, Smeda (2014) concluded DST to be a useful instrument for integrating pedagogical messages into learning practices in order to enhance learners' motivation and engagement. Moreover, Jenkins and Lonsdale (2007) tried to figure out whether or not DST encourages students to engage more and to reflect their ideas within an instructional environment. Their findings indicated that students were encouraged more to the learning process, and that their levels of creativity and reflection were positively affected by DST.

On another side, DST can be applied for the enhancement of student learning strategies. According to Schneider and Sodian (1997) and Shlagmüller and Schneider (2002), academic levels or students' age groups might affect their learning strategy use. When Shlagmüller and Schneider (2002) emphasized that elementary school students do not apply sophisticated learning strategies as nearly enough when compared to upper-level students; Paris and Paris (2001) asserted that elementary school students can also be fostered to use such strategies. Although students might be aware of how to use a specific learning strategy, they do not accordingly apply it (Shlagmüller & Schneider, 2002); rather, they use those strategies without concern as to whether or not they are sufficient (Cao & Nietfeld, 2007; Graham, Santos, & Vanderplank, 2008; Rabinowitz, Freeman, & Cohen, 1992). On another side, Alexander, Graham, and Harris (1998) asserted that the level of learning strategy use varies not on a students' age, but their school experiences. The more they find out the importance of learning strategies, the more they are motivated to apply them in their learning process (Paris & Newman, 1990). In this regard, according to several study results, DST leads students to make decisions in order to be able to solve problems and maintain their stories to apply critical and reflective skills (Benmayor, 2008; Maier & Fisher, 2006; Malita & Martin, 2010). A similar finding was also found in the research conducted by Mullen and Wedwick (2008). Additionally, Reyes-Torres, Pich Ponce, and García-Pastor (2012) highlighted that DST arouses students' interest with various learning types, enables them to maintain their group work, and provides them a meaningful way of collaborating on how to organize the knowledge. Furthermore, Paull (2002) and Salpeter (2005) reported that with the help of DST, students who actively engage to the process increase their levels of research and organization skills. On another side, Robin (2006, 2008a) emphasized that students experienced in a DS creating process could represent the knowledge by using different techniques such as asking questions, organizing and expressing their thoughts, analyzing, evaluating, and synthesizing.

Consequently, all such techniques enable students to elaborate the knowledge they constructed, and to have better understanding (Burmark, 2004).

In addition, while different research studies (Ballast, Stephens, & Radcliffe, 2008; Demirer, 2013; Figg et al., 2010; Hung et al., 2012; Kahraman, 2013; Paull, 2002; Robin, 2006; Salpeter, 2005) reported that the educational environments enhanced with DST enhanced students' attitudes toward the related context; some studies (Büyükcengiz, 2017; Crăciun, Crăciun, & Bunoiu, 2016; Dogan, 2010, 2011; Gakhar, 2007; Karakoyun & Yapıcı, 2016; Sadik, 2008; Smeda, Dakich, & Sharda, 2014b; Torun, 2016) concluded that students held positive attitudes toward using DST and creating DSs in their courses. For instance, Yoon (2013) conducted a study examining the effects of DST on 5th grade students' attitudes toward learning English as a second language. The study's results showed that DST enabled students to improve their reading skills, engaged more in the learning process, and had positive attitudes toward both using DST and learning English with DST. Since their levels of motivation and interest increased with the help of DST, their levels of self-confidence to learn English also enhanced. In the same manner, Shin and Park (2008) performed a study to determine the effects of DST on students' attitudes toward engagement to the learning process in a virtual educational environment. Three different study groups participated in this study. While the first group only listened to the course, the second group listened and communicated within the learning environment, and the third group created their own DSs and watched them in a virtual learning setting. The results of the study indicated that the third study group had more positive attitudes toward learning process engagement, and were more willing to learn.

From another perspective, The Digital Storytelling Contest (DISTCO) 2010 reported that while both male and female students had positive attitudes toward creating a DS in different courses, their favorite courses for creating a DS, using DST in their learning process differed from each other (Dogan, 2011). Furthermore, it was found that female students mostly preferred to work with their teachers during DS creation process, whereas male students mostly wanted to be self-learners during this process.

Furthermore, Smeda (2014) reported in her dissertation study that DST provides a constructivist-based learning environment that facilitates teaching and learning process via providing better instructional results for students. They have the chance to construct their own knowledge, and therefore meaningful learning occurs in such a learning environment. In this regard, Dakich (2008) stated that DST gives teachers the opportunity to enhance constructivist-based learning settings, and helps them motivate their students to apply innovative problem-solving strategies via collaborating and interacting with their classmates. Additionally, Mello (2001) found that since DST fosters students to actively engage in the learning process, they have the chance to enhance their thinking, communication, and listening skills, and to make relationships between texts, stories, and narrators; and so their curricular understanding improves.

Lastly, the use of DST in educational settings contributes to both individual and collaborative learning. While Gils (2005), Midland (2008), Sadik (2008), and Smeda (2014) emphasized that DST affords students the opportunity to personalize their learning experiences and communicate with the content they created; it also fosters collaboration and allows students to work with each other during the DS creation process (Behmer, 2005b; Dakich, 2008; Ohler, 2008; Robin, 2006; Smeda et al., 2014a; Standley, 2003; VanderArk & Schneider, 2012; Yuksel et al., 2011). Furthermore, it enables students to improve their various skills.

It can be inferred from the cited literature that DST is studied extensively in the field. However, the number of studies that focus on DST both as the process and the product are scarce. In conclusion, to be able to integrate DST into educational environments effectively, there is a need to conduct more experimental studies within a holistic approach that examines both the DS creation process, and the products created by the students. Additionally, while performing such kind of studies, both individual and collaborative learning environments should be considered in order to see the effects of DST from the larger picture, and to have the opportunity to compare the differences between individual and collaborative use of DST. Lastly, determining different variables such as gender differences, and task value levels of students might also be useful for the effective use of DST in education. By carrying out such studies, it becomes possible to suggest more valuable findings that might help practitioners consider the relevant issues regarding the educational use of DST in different contexts.

1.2. Problem Statement

Despite the fact that the number of studies worldwide related to the use of DST in education is quite high, this is not the case as seen nationally in Turkey, particularly in terms of several issues. As investigating the findings of related existing studies in details, they mostly present the effects of DST on the academic achievement of students. Yet, there is limited research examining the effects of DST from a holistic approach that elaborates on the DS creation phases (story writing, storyboarding, and digital story creation) of the students' learning process. Besides, it is also important to determine why students select certain phases of the DST process as the most contributing factor to their learning. In this regard, the current study may shed light on the effects of DST phases on students' academic achievement, and to reveal the reasons behind their selection.

Additionally, the literature reveals that the use of learning strategies differs in terms of features of learning tasks, age groups of students, and their experiences at school. However, there is a lack of research clarifying how and to what extent middle school students use their learning strategies while performing various learning tasks. In this manner, DST can be used as a pedagogical tool that allows students to use their learning strategies to enhance their understanding of knowledge while performing different learning tasks such as story writing, storyboarding, and digital story creation. In this sense, the current study might contribute to fill the literature gap about the use of middle school students' learning strategies to some extent.

Reviewing the related literature also clarifies that DST leads learners to develop positive attitudes toward different educational contexts. Additionally, various studies reported that students had positive attitudes toward using DST in different educational environments. There are many factors affecting student engagement in learning environments when using DST. Meaningful technology integration, the level of expectations met by the constructivist-learning environment, the motivation levels of students to use various skills such as writing, editing, their competences and prior knowledge to the learning activities, and their prior hands-on activities based on technology are listed among those factors. Also, gender differences might also play an essential role on using DST in education, and there might be relationships between gender factor and different variables such as task value. However, there is insufficient evidence about the effect of gender differences on students' attitudes toward using DST. In the sense of this issue, the current study might provide some valuable insight with regard to the effects of gender and task value on students' attitudes toward using DST in science education.

Furthermore, even though DST provides many advantages in individual and collaborative learning settings, it also brings with it some challenges and makes differences to students' preferences in both learning environments. Besides, the quality of the DSs created individually and collaboratively might have notable differences in terms of various issues. Therefore, conducting an experimental study that examines the differences between individual and collaborative use of DST in terms of various issues such as students' preferences, their reasons behind those selections, the challenges they face during the process, skills improvements, and the quality of the DSs created might suggest notable findings to the related literature.

Lastly, despite DISTCO contests having reported the most popular courses in which students prefer to use DST or create a DS, and various research studies having been conducted through different educational contexts in the scope of DST usage; there is a current need to identify the reasons why particularly middle school students select such courses for creating a DS. Therefore, it is crucial to conduct a study determining those issues in order to help practitioners make better decisions for their teaching practices.

1.3. Purpose of the Study

The main purpose of the current study is to examine the effects of digital storytelling in middle school science education. Specifically, this study will investigate how academic achievement and learning strategies of students are influenced by DST. Additionally, students' opinions based on their experiences during the digital story development process, and their attitudes toward creating digital stories in science course are aimed to be determined in light of the study's results. Lastly, this study aims to examine the quality of the digital stories created by 6th grade students. In regard to those purposes, the current study aims to shed light on the use of DST effectively and efficiently in middle school science education, to contribute to the related literature, and to provide suggestions for other subject areas about the use of DST.

1.4. Research Questions

The current study addresses the following research questions:

1. Is there any statistically significant mean difference within and between the achievement test scores of students in the control and experimental groups of a science course?
    a. Is there any statistically significant mean difference within the achievement test scores of the Control Group, Experimental Group 1, and Experimental Group 2?
    b. Is there any statistically significant mean difference between the Control Group, Experimental Group 1, and Experimental Group 2 in terms of academic achievement after controlling the pretest scores?
2. Is there any statistically significant mean difference within and between the learning strategy scores of students in the control and experimental groups of a science course?
    a. Is there any statistically significant mean difference within the learning strategy scores of the Control Group, Experimental Group 1, and Experimental Group 2?
    b. Is there any statistically significant mean difference between the Control Group, Experimental Group 1, and Experimental Group 2 in terms of their learning strategy scores?
3. Is there any statistically significant mean difference between the experimental groups toward creating digital stories on a science course?
    a. Is there any statistically significant mean difference within the attitude scores of Experimental Group 1 and Experimental Group 2 toward creating a DS on a science course?
    b. Is there any statistically significant mean difference between Experimental Group 1 and Experimental Group 2 in terms of their attitude scores toward creating a DS on a science course?
    c. Is there any statistically significant mean difference between males and females in terms of their attitude scores toward creating a DS on a science course?

4. What are the opinions of students about creating digital stories on a science course?
5. What is the quality of the digital stories created by students?

1.5. Significance of the Study

It is expected that the current study will contribute to four different respects; those being, the current literature, practitioners, instructional designers, and decision makers. The current literature reveals that many studies determine the effects of DST usage in different educational contexts. However, there is limited research examining (a) the effects of DST phases on students' learning from a holistic approach, (b) the effects of DST on students' level and types of learning strategy use, (c) the attitudes of students towards using DST in both science courses and other courses, (d) the preferences and reasons of students for choosing a course for creating a DS, (e) the challenges and differences of DST usage in both individual and collaborative learning environments, (f) the effects of gender differences and task value levels of students on their attitudes and quality of their DSs, and (g) the individual and collaborative skills that students improve or realize during the process. Therefore, the current study will fill the gap in the literature of 6th grade science education in abovementioned issues, and to also provide recommendations for other subject areas.

In the literature, there are some guidelines for using DST in education. However, they do not provide specific considerations for efficiently integrating DST into different educational environments. Hence, this study will provide some practical tips for practitioners that might be applied before, during and after the DS creation process. In this manner, the current study will not only inform practitioners about the requirements before starting their implementations, it will also consider some specific issues for each phase (story writing, storyboarding, and digital story creation) of the DS creation process. Besides, advantages and notable challenges faced in both individual and collaborative working will be provided for practitioners in order to facilitate their implementations, and the importance of variables such as effects of gender differences, homogeneity of the study groups, and students' workload are considered within the help of this study. Additionally, some recommendations about the integration of DST into different courses will be provided for practitioners. Lastly, the current study will provide specific suggestions for practitioners operating collaborative study groups.

It is expected that the findings of the current study will be considered significant for instructional designers in order to encourage them to integrate DST into a constructivist-based educational learning environment, and to help them consider specific subject areas in which students may expect the use of DST to be applied. Additionally, the findings might be seen as useful for instructional designers, particularly while planning science curricula and deciding upon course learning materials to increase levels of student motivation and engagement, thereby enabling students to improve and realize various skills.

Lastly, the findings of the current study may support decision-makers' in any judgment to integrate DST into science education, and to use various digital stories as course materials. Additionally, the findings might lead decision-makers to include DST into other fields of education such as teacher training education programs; resulting in candidate teachers perhaps being more likely to later integrate DST into the classroom as they commence their teaching professions.

1.6. Definition of Terms

Storytelling: "Storytelling is an effective means of imparting knowledge, beliefs and traditions" (Suwardy, Pan, & Seow, 2013, p. 110). For the current study, the storytelling is applied by 6th grade students in the narration of specific science course topics.

Digital Storytelling: Jakes (2005) defines DST as an entire process of narrating a specific subject, and visualizing this narration by using various components such as pictures, sounds, and background music. The students who participated in the current study created two different DSs about two different subjects of a middle school science course.

Constructivist-learning approach: Shepard (2000) describes this learning approach as a social activity-based pedagogy, with continuous interaction between instructor and learner facilitating the learning. Besides, this approach emphasizes learning by applying problem-solving skills in regard to real life experiences. For the current study, the participants created their digital stories by constructing their own knowledge and using their own words, and the interaction occurred between instructor–students, and students–students during the study.

Learning strategy: The idea of learning strategies refers to the actions and ideas applied to accomplish a learning task (Weinstein, Mayer, & Wittrock, 1986). In the current study, the *learning strategies* part of the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & McKeachie, 1991) was employed. The participants utilized different learning strategies while writing their stories and creating their digital stories.

Attitude: This refers to the degree of favor or disfavor that occurs when evaluating a specific case or event (Eagly & Chaiken, 1998). For the current study, the students' attitudes toward creating digital stories in science education were examined.

CHAPTER 2

LITERATURE REVIEW

"We are the stories we like to tell" (Schank, 1995, p. 137)

This chapter introduces the literature review of the current study under the headings of (1) stories and storytelling, (2) digital storytelling, (3) instructional benefits of digital storytelling, (4) educational uses of digital storytelling, (5) writing and digital storytelling in science education based on constructivist learning approach, (6) constructivist learning approach and digital storytelling, (7) learning strategies, and (8) digital storytelling in science education.

2.1. Stories and Storytelling

Stories constitute a considerable part of our lives. Schank (1995) claimed that daily communication of human-beings occur around stories and that the base of thinking mostly depends on explaining and understanding these stories; while Rosen (1986) stated that the human brain can be seen as a narrative machine that runs on stories. Similarly, Schank (1995) stressed that "Human memory is story-based" (p. 12). In this sense, the experiences a person remembers constructs story sets that shape their worldview. Additionally, Schank (1995) stated that "People think in terms of stories. They understand the world in terms of stories that they have already understood" (p. 219). However, people need context in order to make connections between what they have already heard or known, and what they currently hear or know. In this sense, a person's memory helps them remember what was already stored.

According to Schank (1995), another contribution of stories is that when one constructs and tells a story while choosing events to be used in a coherent narrative, it helps to forget other events, thus not only memorizing, but forgetting also becomes more important whilst constructing stories. Furthermore, he considered that stories make people more persuasive. In line with this, it could be said that stories enable learners to use not redundant, but relevant events while creating their own stories, and in doing this it helps them learn in a deeper way as the less distracting events or cases occur, the more meaningful learning transpires.

On another side, Rooks' (1998) action research project indicated that learners were eager to do something new when they shared their own oral stories. "There was evidence to show that in oral stories children were more likely to try new openings, use connectives more frequently, experiment with dialogue and attempt to use different tenses" (Rooks, 1998, p. 25). Additionally, Robin (2008b) attests that DST allows learners to discuss the subjects included within a story and to examine their constructs and concepts in-depth. Lastly, Bendt and Bowe (2000) stated that storytelling helps students enhance their listening and speaking abilities (as cited in Behmer, 2005b), and Craig, Hull, Haggart, and Crowder (2001) highlighted that stories allows children to gain their literacies.

When Pedersen (1995) defined stories as the ancestors of literature, he found storytelling as the initial version of teaching (as cited in Sadik, 2008). Yet, storytelling took its place in education at the beginning of the 1980's, and began to be used by teachers in various contexts as its popularity increased (Thesen & Kara-Soteriou, 2011). Storytelling is a powerful tool that helps learners construct their knowledge via using imagination, express various content in a well-structured organization, and in turn enhances their learning (Pelayo, 2013). Additionally, while Behmer (2005b) defined storytelling as a process in which learners personalize their learning experiences and create meaningful knowledge via hearing and telling stories, Suwardy et al. (2013) stated that "storytelling is an effective means of imparting knowledge, beliefs, and traditions" (p. 110). Lastly, according to Paley (1990) and Cooper (1993), storytelling allows children to know about the aim and process of writing, enables them to express their thoughts and feelings in a creative way, gives them chance to improve their social skills, and fosters studying through their thoughts and background knowledge (as cited in Wright, Bacigalupa, Black, & Burton, 2008).

In addition, one of the essential enablers of storytelling is to provide an opportunity to integrate the gist about any topic into a story. According to Schank (1995), a person might not remember an entire story, but if a gist is indexed to a story via using different indices, it becomes easier for them to remember the events. Otherwise, most of the events experienced are just forgotten. In this manner, dreaming while narrating a story also enables events or experiences to be remembered. As seen, *the gist* and *dreams* are two essential concepts of memory. Since these two concepts can be used while storytelling; learning, understanding, remembering, and recalling knowledge becomes unavoidable for learners.

Wright et al. (2008) likened the dramatization of stories to play-like actions, and stated that this play-based action motivates children and enables them to think sophisticatedly. In this regard, Vygotsky (1987) also emphasized the importance of play on children's imagining, remembering, and recreating skills (as cited in Wright et al., 2008), and that dramatizing stories can be applied as a function of play. Within the help of dramatization of stories, children can concrete the concepts related to any context and can easily represent them to their peers (Wright et al., 2008). Therefore, it can be integrated into various educational fields such as social studies (Harris, 2007), science (Eldredge, 2009), or language arts (Thesen & Kara-Soteriou, 2011).

Eldredge (2009) highlighted that it is useful and important to incorporate storytelling into science in order to lead students to make connections between science and real life. As storytelling is applied in science, it appears more intriguing and understandable for students. In the same manner, the National Council of Teachers of English (1991) highlighted that all children can use stories as powerful tools when they are comprehensively integrated into instructional methods (as cited in Combs & Beach, 1994). Moreover, when Egan (1989) defined teachers as the storytellers, so what happens when children take on the role of teachers?

In line with this, the current study aims to encourage middle school students to integrate storytelling – which is the first step of the digital story creating process – into a science course and to enable them to personalize their learning experiences in order to construct meaningful knowledge about related course subjects. By integrating storytelling into science, children can use basic thinking skills for process evaluation and reflection, and construct and index cases about any topic or concept within their minds. Since they would use only relevant cases in their stories and create the gist by using different indices; learning on a science course in a deeper way, remembering what they are taught, and recalling what they need would be easier thanks to the stories they tell.

2.2. Digital Storytelling

Owing to the dramatic increase in technological advancement, technology-based instruction has continued to take its place in the 21st century. These advancements allow people to easily access information about any subject with the help of various technological devices such as smartphones, mobile computing devices, and digital cameras, and many educational environments are now equipped with such devices. In line with those developments, stories have also been included in these technology-based educational environments and the multimedia form of storytelling, known as Digital Storytelling, has shown up in various contexts.

Digital storytelling started to be used by Dana Atchley and Joe Lambert in the 1980's, and its popularity has increased in recent years (Holtzblatt & Tschakert, 2011; Sylvester & Greenidge, 2009). While many definitions for DST currently exist in the related literature, it can be simply defined as telling stories with digital devices. Some researchers (Haigh & Hardy, 2011; Lowenthal, 2009; Lowenthal & Dunlap, 2010) define DST as an amalgamation of multimedia and software applications that employ using art and techniques of storytelling with new methods in order to incorporate the learner into the teaching and learning environment. On another side, Pounsford (2007) stated DST as a whole process including various multimedia components such as text, sound, and image that provide a deep learning environment for learners.

Additionally, Meadows (2003) expressed DST as a way of creating multimedia stories via different technological tools such as video cameras, and computers, and the Storytelling Association (2002) portrayed DST as the modern appearance of storytelling utilized in various forms for the sharing of knowledge (as cited in Sadik, 2008). Lastly, according to Miller (2007), digital stories are initially created by texts and then integrated into images, videos and background music; with the integration level of those components increasing the power of the stories (as cited in Thesen & Kara-Soteriou, 2011). In this regard, Lambert (2002) focused on seven components of DS to be considered in order to create effective digital stories; which are (1) point of view, (2) dramatic question, (3) emotional content, (4) economic, (5) speed, (6) tone of voice, and (7) background music. The Center for Digital Storytelling (2018) modified and added several components required for an educational DS:

1. The Overall Purpose of the Story
2. The Narrator's Point of View
3. A Dramatic Question or Questions
4. The Choice of Content
5. Clarity of Voice
6. Pacing of the Narrative
7. Use of a Meaningful Audio Soundtrack
8. Quality of the Images, Video & other Multimedia Elements
9. Economy of the Story Detail
10. Good Grammar and Language Usage (http://digitalstorytelling.coe.uh.edu)

Lastly, while types of digital stories are classified under many categories by different authors, Robin (2006) categorized the main types of DSs into the following three:

"Personal narratives" – stories under this category describe a person's experiences, daily life events, or feelings. Such digital stories provide students with the opportunity to learn their peers' experiences, with students from various backgrounds afforded the chance to know more about themselves (Robin, 2006).

"*Historical documentaries*" – this type of digital story determines events that occurred in the past and can be enhanced by relevant images or other sources (Robin, 2006).

"*Stories that inform or instruct*" – as understood from the title, such DSs are created in order to inform audiences about specific concepts or to instruct on particular subjects

(Robin, 2006). This type of digital story is created in the current study in order to lead students to learn certain science course topics.

2.3. Instructional Benefits of Digital Storytelling

Benefits provided by DST constitute its roots in education. In this regard, the instructional benefits of DST for teachers and students are elaborated separately in the following.

2.3.1. Instructional Benefits of Digital Storytelling for Teachers

Simkins, Cole, Tavalin, and Means (2002) highlighted that DST provides a chance to make formative and summative evaluations, and leads teachers to guide their students for their instructional improvement. Similarly, Smeda et al. (2014a) stated that DST provides an opportunity for teachers to engage their students in a constructivist-based learning environment. In these learning settings, within the help of DST, teachers can use different technological devices and software, and can apply other instructional methods in order to allow their students to create their own meaningful knowledge, and to encourage them to express their ideas efficiently (Standley, 2003). For instance, teachers might ask their students to write stories and create their own DSs through a specific course topic as an assignment, and then evaluate their students through their products (Fasi, 2011). In other words, DST provides teachers with an alternative way to evaluate their students' learning process.

Additionally, according to Jenkins and Lonsdale (2007), the learning setting enhanced by DST, which is different from traditional learning environments, enables teachers to draw their students' attention to the course, and maintain their interest throughout the instruction. On another side, Behmer (2005b) expressed that teachers can use the written form of storytelling in order to instruct their students and help them transfer their knowledge; thus, they contribute to their students' reading and writing skills. Besides, as Armstrong (2003) stated, when students integrate related images into what they narrated, teachers have the chance to examine the extent to which their students have learned the topics (as cited in Behmer, 2005b). Finally, when teachers involve their students in the learning process by giving them a chance to self-express through DST (Banaszewski, 2005; Dogan & Robin, 2008; Paull, 2002), they can also use DST for both teaching course content and preparing their students for certain standardized tests (Dogan & Robin, 2009).

2.3.2. Instructional Benefits of Digital Storytelling for Students

In addition to the contributions of DST for teachers, it also provides many benefits from different respects for their students. One of the most important benefits of DST is its' contribution to academic achievement. In this regard, many studies (Banaszewski, 2005; Dogan, 2007; Figg et al., 2010; Foley, 2013; Hung et al., 2012; Kahraman, 2013; Papadopoulou & Ioannis, 2010; Smeda et al., 2010; Yang & Wu, 2012) reported that use of DST increases students' levels of academic achievement. There are various enablers of DST behind this contribution, and those enablers can be listed as follows;

- DST enhances student engagement (Dogan & Robin, 2009; Joseph, 2006; Smeda, 2014; Xu et al., 2011) through an active learning environment (Bromberg, Techatassanasoontorn, & Andrade, 2013; Paull, 2002; Salpeter, 2005; Smeda, 2014). Thus, students have the chance to involve the related content (Midland, 2008; Simkins et al., 2002; Yang et al., 2012), construct their knowledge (Behmer, 2005b; Pelayo, 2013; Robin, 2008b; Standley, 2003), and have meaningful learning (Burmark, 2004; Figg et al., 2010; Jenkins & Lonsdale, 2007; Ohler, 2008; Robin, 2006, 2008b; Smeda, 2014; Wang & Zhan, 2010).
- DST gives students the opportunity to personalize their learning experiences (Gils, 2005; Midland, 2008; Sadik, 2008; Smeda, 2014) and to communicate with the content they created (Miller, 2009) in order that in-depth understanding of the content (Barrett, 2005; Yoon, 2013) is provided during the DS creation process.
- DST increases students' levels of motivation and interests to the related course (Bangert-Drowns & Pyke, 2002; Dogan, 2010, 2011; Figg et al., 2010; Fredericks, Blumenfeld, & Paris, 2004; Hung et al., 2012; Kahraman, 2013). Consequently, students become more eager to learn the course subjects via narrating and digitalizing.
- DST provides a more interesting and entertaining learning environment (Dogan, 2010; Hung et al., 2012; Tsou et al., 2006).
- DST leads students to make real life relationships (Andrée, 2005; Gils, 2005; Hawthorne, 2002; Liu, 2003), so that permanent learning (Di Blas, Garzotto, Paolini, & Sabiescu, 2009; Dupain & Maguire, 2005;) is provided for them, and it

becomes easier for them to remember (Bromberg et al., 2013; Di Blas et al., 2009; Dupain & Maguire, 2005; Wang & Zhan, 2010) the course subjects.

- DST helps students link the narrations to visual information (Burmark, 2004; Ohler, 2008), and promotes their learning via integrating various multimedia components such as texts, visuals, and audio (Gyabak & Godina, 2011; Simkins et al., 2002).
- DST enables learners to gather, evaluate, and transfer the knowledge (Burmark, 2004), and allows them to take roles in reading and writing tasks (Kajder, 2004), and thereby more easily remember and recall knowledge when needed.
- DST facilitates learning and teaching by providing a constructivist-based learning environment (Smeda et al., 2014a) to involve students in the process (Gils, 2005).
- Lastly, DS enables learners to realize complex concepts (Sadik, 2008).

The following contribution of DST is that it leads students to use various learning strategies. The three main phases (story writing, storyboarding, and digital story creating) of the DST process can particularly contribute to various learning strategies used by students. Among those strategies, using DST in different educational contexts can help students realize, learn how to use, and to improve their rehearsal, elaboration, organization, critical thinking, metacognitive, and reinforcement strategies (Benmayor, 2008; Fellows, 1994; Maier & Fisher, 2006; Malita & Martin, 2010; Miller, 2009; Mullen & Wedwick, 2008; Paull, 2002; Robin, 2006, 2008b; Sadik, 2008; Salpeter, 2005; Yang & Wu, 2012; Yore, Bisanz, & Hand, 2003).

The next contribution of DST in education is that it fosters collaboration. As highlighted by Standley (2003); students engage more with the content and learning setting when they collaborate in small groups. Many research studies (Behmer, 2005b; Dakich, 2008; Mello, 2001; Ohler, 2008; Robin, 2008a; Rooks, 1998; Smeda, 2014; Smeda et al., 2014a; VanderArk & Schneider, 2012; Yuksel et al., 2011) concluded that the use of storytelling and/or digital storytelling allows learners to engage in small groups, communicate with each other, express their thoughts, discuss their ideas and make decisions, facilitate collaborative activities, and enhance their collaboration skills.

In addition, Condy, Chigona, Gachago, and Ivala (2012) and Sylvester and Greenidge (2009) emphasize that creating digital stories provides learners with a chance to use their old and new literacies during the creation of a story, and thereby might create and determine different literacies. In the same sense, Robin (2016) and Smeda (2014) state that DST helps learners build literacies such as global, technology, information, visual, and digital literacy. Under those literacies, DST allows students to improve their research, writing, organization, technology, presentation, interview, interpersonal, problem-solving, assessment, critical thinking, reflection, and imagination skills as emphasized by various researchers (Alterio, 2003; Behmer, 2005b; Behmer, Schmidt, & Schmidt, 2006; Benmayor, 2008; Heo, 2009; Howell & Howell, 2003; Jakes, 2006; Maier & Fisher, 2006; Mello, 2001; Menezes, 2012; Midland, 2008; Mullen & Wedwick, 2008; Ohler, 2008; Reed, 1987; Robin, 2008b; Simkins et al., 2002; Smeda, 2014; Sylla, Coutinho, & Branco, 2014; Wang & Zhan, 2010).

Apart from the aforementioned benefits of DST, Simkins et al. (2002) expressed DST encourages students to accomplish particular learning tasks by leading them to use various techniques such as planning, analyzing, investigating, and decision making. Additionally, when students collaborate with their peers during the DS creation process and accomplish their tasks successfully, they better understand the importance of their participation, and become more willing to collaborate (Simkins et al., 2002). As Grisham (2006), Hung et al. (2012), and Simkins et al. (2002) all highlighted, DST is a potent instructional tool that builds self-confidence; with Dogan and Robin (2008) and Salpeter (2005) asserting that DST increases the level of responsibility of students.

Despite the characteristics of learners being crucial to the learning processes, teaching strategies play a significant role, and DST can support the overall teaching and learning process. In this sense, Figure 2.1, which was designed by Robin (2016), provides a clarity of understanding on how DST supports learner characteristics and teaching strategies.

Learner Characteristic	Teaching Strategy	How Digital Storytelling Supports This
Technology savvy	Incorporate technology meaningfully into class activities and assignments.	Digital stories can be used as class activities and/or class assignments.
Relies on search engines for information	Provide assignments that allow students to use search engines, but also critically assess the information they find.	Search engines can be used to research digital story topics, locate images, music, video clips that can be included in the story.
Interested in multimedia	Include music, videos, and other media in assignments.	Digital stories contain a mix of music, video clips and other media.
Creates internet content	Allow students to contribute to websites, blogs, wikis, and create YouTube videos.	Digital stories can be uploaded to blogs, wikis, and other websites, including YouTube.
Learns by inductive discovery	Provide opportunities for students to be kinesthetic, experiential, hands-on learners.	Creating a digital story is a hands-on, experiential process.
Learns by trial and error	Allow students to test their own strategies for solving problems and take control of their own learning.	Digital storytelling allows students to solve problems and take control of their own learning.
Short attention span	Let students use technology to move at their own pace.	Digital storytelling lets students use technology at their own pace
Communicates visually	Allow students to use images, videos and other visual representations in assignments.	Digital stories contain a mix of images, video clips and other visual representations.
Emotionally open	Encourage personal interaction and opinion sharing.	Many of the most powerful digital stories include a personal point of view.
Feels pressure to succeed	Tap students' multiple intelligences and emphasize deep learning experiences and critical thinking.	Creating a digital story allows students to be creative and critically reflect on what they have learned.
Constantly seeks feedback	Provide opportunities for both positive and negative constructive feedback.	Incorporating peer feedback in the digital storytelling process gives students an opportunity to improve their work.

Figure 2.1 - How Digital Storytelling Supports Learner Characteristics and Teaching Strategies (Robin, 2016, p. 21)

Consequently, as can be seen in Figure 2.1, enablers of DST can provide the needs for different learner characteristics, and can be used as a beneficial tool to support various teaching strategies.

2.4. Educational Uses of Digital Storytelling

Digital storytelling is currently used for both teaching and learning processes, and educational uses of DST can be examined for teachers and students separately as also considered by Robin (2016) and announced at (http://digitalstorytelling.coe.uh.edu) to introduce DST to its practitioners.

In this regard, this part of the current study reviews the Digital Storytelling Contests (DISTCOs) held over different years and reports on the important findings for the educational uses of DST for both teachers and students.

The first DISTCO contest was held in 2008 and have continued since. Participants create DSs and submit them to the website of the contest (http://www.distco.org). At the time of writing this dissertation, submissions are being welcomed for DISTCO 2018. The main goals of these contests are "to encourage students and teachers to challenge themselves in an exciting competition where 21st century skills can be enhanced, and to further current research on the effectiveness of digital storytelling in K-12 education" (Dogan, 2012, p. 1354). While the number of contests has increased over the years, the current study reviews the results of DISTCO 2008, DISTCO 2009, DISTCO 2010, and DISTCO 2012.

The number of participants for those contests were reported as a) 174 students and 34 teachers in DISTCO 2008, b) 808 students and 18 teachers in DISTCO 2009, c) 895 students in DISTCO 2010, and d) 1,175 students and 19 teachers in DISTCO 2012. When observing the participants, there has been an increasing trend in the numbers of student entries, but the reverse has been seen for teachers, and DISTCO 2010 investigated only students' results. The findings of these studies are reported as one rather than separate due to the differences of variables such as teachers, students, gender, and grade levels of students examined during the studies.

The results for teachers indicated that most found digital stories easy to use and were eager to use them in their future classes (Dogan, 2010, 2012; Dogan & Robin, 2009). They considered that digital stories increased learners' motivation and engagement level, and they are helpful for learners in order to develop various literacy skills such as writing, research, presentation, organization, and technical skills as also declared by different researchers (Howell & Howell, 2003; Jakes, 2006; Robin, 2008a). According to the teachers' perspectives, "director's chair effect," "chance for self-expressing," "opportunity to use different technologies" and "enhancing creativity" are the main activators of DST in order to fascinate and motivate learners to become involved in the process (Banaszewski, 2005; Dogan & Robin, 2008; Paull, 2002). Additionally, they believe that DST can be used as a beneficial instructional tool for teaching course content, and can allow teachers to prepare their students for certain standardized tests. For instance, DST is a powerful tool that can be applied in examining course content, providing vocabulary for any specific topic, presenting the reasons behind students' test anxiety, and in suggesting solutions. Lastly, the teachers recommended that DST can enable students to create demonstrations to present their knowledge and the way in which they understand the content (Dogan & Robin, 2009). On the other hand, the contests clarified two main challenges for teachers during DST usage; those being obstacles in accessing relevant hardware/technology, and the provision of adequate time.

The results for *students* concluded that even though most of them had never previously experienced DST, they were willing to use DST in their learning process in two different respects. While different percentages of students in each contest preferred to create a DS for different courses, likewise, students preferred to have their teachers use DSs in various course subjects. Additionally, students thought that using digital stories had increased their motivation and engagement levels. Another noteworthy result from these contests was that students found DST usage to be an entertaining process, and they believed that they could learn course subjects as a result (Dogan, 2010, 2011, 2012; Dogan & Robin, 2009). The main motivating factors for students to use DST were reported as (a) the opportunity to utilize multimedia and technology, (b) the opportunity to self-express and enhance creativity, (c) the opportunity to create self-movies, and (d) learning course topics through research.

Particularly in DISTCO 2012, students thought that DST use enabled them to improve their various skills from different literacies. Of those skills, technical, media, presentation, research, organizational, and writing skills were rated from the highest mean scores to the lowest, respectively. The last notable finding of these contests that emerged from the students' responses was their preferences of courses in which they would like to create a DS and in which they would want their teachers to use DST. The results varied in each contest in terms of those two preferences. When asked about in which course they would like to create a DS, the findings indicated the top three were Music, Art, and Computing in DISTCO 2008; English Language Arts (ELA), Music, and Art in DISTCO 2009; Computing, Music, and Art in DISTCO 2010; and Computing, Art, and ELA in DISTCO 2012, respectively. Apart from those courses, when Science was ranked as fourth or sixth, Math was interestingly less popular in these contests. For Social Studies, the results of the contests showed similar a trend to the Science course. When students were asked about which course they want their teachers to use DST, the results indicated both similar and different trends with the previous question. For this preference, the first three ranked were Music, Art, and Computing in DISTCO 2008; ELA, Social Studies, and Music in DISTCO 2009; Social Studies, Computing, and ELA in DISTCO 2010; and Social Studies, Science, and ELA in DISTCO 2012, respectively. When observing other ranks, it was seen that Science and Math was less popular than the aforementioned courses. In investigating the preferences of students in terms of their course selection for DST usage, it is clear that DST can be used for various course subjects, as also emphasized by Robin (2008a).

Unlike other contests, “gender difference” was added to the DISTCO 2010 findings, and “grade level difference” of students were examined in DISTCO 2010 and 2012 in terms of their educational use of DST. According to the DISTCO 2010 findings, while most male and female students had positive attitudes toward creating a DS in different courses, and were eager to use and create DS in their future classes, their favorite courses to create a DS and to use DST differed (Dogan, 2011). For instance, while Computing was the most popular course for males, ELA was the most favored by females. Furthermore, it was found that when female students mostly preferred to work with their teachers during DS creation, male students mostly preferred being self-learners. The top two rated motivational factors of “I liked using multimedia components such as images and music” and “having the chance to use computers when creating digital stories” (Dogan, 2011, p. 4) were common for both genders when creating a DS. Lastly, the levels of learned content differed in terms of gender, with 45% of males considered that they had “learned a great deal,” this option was rated by 42% of females. As seen, educational uses of DST might differ in terms of gender differences of students.

The results for *grade level difference* indicated that middle school (MS) students and high school (HS) students had the most experiences with digital storytelling when compared to elementary school (ES) students. Ease of use levels for DST were very close across all three grade levels. Moreover, DISTCO 2010 and 2012 concluded that there were some differences among grade levels of student in choosing a course for both creating a DS and in expecting their teachers to use DST. For self-creation of a DS, Computing and Science in DISTCO 2010 and 2012 were the most popular courses for ES students; with Science and Computing for MS students; and Art and Music for HS students. With regard to expecting their teachers to use DST, when Computing and Science courses were selected as most popular by ES students in DISTCO 2010 and 2012, respectively; ELA and Social Studies courses were selected by both MS and HS students. Additionally, DISTCO 2010 concluded that 55% of ES, 38% of MS, and 36% of HS students thought that they "learned a great deal" with DST. On the other hand, "learned a little bit" was rated by 9% of ES, 17% of MS, and 20% of HS students. Lastly, while "I liked using multimedia components such as images and music" was the most motivating factor for ES and MS students, "I had a chance to express myself with digital stories" (Dogan, 2011, p. 5) was the most rated motivating factor for HS students.

In conclusion, the DISTCO contests provided noteworthy findings related to the educational uses of DST for teachers and students. The results also support that educational uses of DST might differ in terms of student gender and their grade levels.

2.5. Writing and Digital Storytelling in Science Education based on Constructivist Learning Approach

Writing in science might lead students to connect between what they are doing and what they are learning. Some researchers (Hand, Hohenshell, & Prain, 2004; Langer & Applebee, 1987; Rivard, 1994; Robertson, 2005; Yore, Hand, & Prain, 2002; Yore et al., 2003) have considered the importance of writing in science. On another side, Ambron (1987) discussed that expressive writing – which is more of an informal writing style – might enable students to personalize their learning on a science course (as cited in Rivard, 1994).

Additionally, according to Yore et al. (2002), students writing *to clarify their ideas* learn more comprehensively in science course than those who just write *to note what they know*. Because, the writing process allows students to regulate their thinking, to understand the content in-depth, and to help them remember what they already learned. Similarly, Yore et al. (2003) emphasized that engaging students into the writing process in science helps them to think creatively, and to construct their own thoughts in a well-structured respect. Finally, Midland (2008) argued that even though improving writing skills in science might be long-lasting, students learn scientific content via using their self-methods to enhance their conceptual knowledge during this process.

As seen, writing in science contributes to students' learning in different aspects, and allows them to deepen their understanding of knowledge. In this manner, story writing/telling – which is one of the most important phases of the digital story development process – might be an opportunity for students to apply their informal writing strategies while writing about any subject of a science course, to personalize their learning, and to enhance their conceptual knowledge.

In addition to the enablers of writing in science, DST, as the digital form of storytelling, can be applied as a writing project in science education as the writing part can be seen as the key to a digital story. While storytelling refers to a process of memory structure formation and change, digital storytelling can be defined as short, individual and multimedia stories (Meadows, 2003), as DS combines text, visuals, and sounds in order to help students connect with the knowledge. DST is a way of communicating with the audience in a narrative setting, and visualizing the information (Ohler, 2008). During the story writing process, students become more involved within the science course subjects, and narrate their knowledge by using their own words. The next step is then to reflect and visualize what they narrated and then to share it with their peers. In this regard, creating a DS might be one of the best ways of presenting narrated science content. Since students use their own voices, and visualize their stories by utilizing different images during the digital story development process, remembering what they had already learned becomes easier for them; and when they listen to their own voice narrating the science content, this process encourages them to improve their own strategies for the sake of their own learning

(Midland, 2008). Thus, self-directed learning occurs, and students can gain in-depth understanding of the science content.

Eventually, considering the characteristics of the constructivist learning approach while applying DST in science education becomes essential for its practitioners. According to Maxim (2010), constructivist-learning approach defends that learning occurs by the constructions in a learner's mind, learners link the new information to their prior knowledge, and they construct knowledge rather than taking it with its presented version. Thus, one can assume that the constructivist learning approach covers autonomy, choice, negotiation, reflection, strategic thinking, and personal experiences. Those ideas are also parallel to the statements of Osborne and Wittrock (1985). Moreover, Giambattista Vico expressed that "…'to know' means to know how to make" (as cited in von Glasersfeld, 1998, p. 120). On the other hand, Jonassen (2009) stated that to understand what learning is, is not possible from a single aspect due to its complexity, and various tools or alternatives are needed in order to overcome this complexity. In line with those statements, DST might be one of the tools that Jonassen declared, and can be used in order to know how to make learning as von Glasersfeld had expressed. In another saying, considering the features of the constructivist learning approach, within the help of DST, learners can construct structural knowledge based on their own experiences and prior knowledge, and thereby create their own schemas and concepts related to a science course. Besides, since they are at the core of the learning environment while creating their own stories, they might feel willing to undertake serious work in order to reconstruct their knowledge (Millar, 1989). Lastly, the learners are the knowledge creators in the constructivist use of DST, and can therefore transform complex learning into a more simpler work.

2.6. Constructivist Learning Approach and Digital Storytelling

Constructivism was defined by Dewey (1916) as "a theory of knowledge growth and life-long development built on a philosophy of pragmatism" (as cited in Tobias & Duffy, 2009, p. 34). It is not only an instructional approach, but it also a vision of learning. It allows instructors to consider learners' various skills in order for them to be able to construct new knowledge, even when they are not under instruction or control (Tobias & Duffy, 2009). The constructivist learning approach that mainly deals with the construction of knowledge draws upon key thinkers such as Dewey, Piaget, Bruner, and Vygotsky (Tobias & Duffy, 2009). In this theory, *learning by doing* constitutes its core. The constructivist learning theory argues that people produce knowledge and form meaning based upon their experiences.

In the constructivist approach, as Brown, Collins, and Duguid (1989) discussed, learning is an active, contextualized process of constructing knowledge rather than acquiring it, and knowledge is therefore a product of the learners' activity. In this regard, a term called "structural knowledge" comes into prominence. Jonassen, Beissner, and Yacci, (1993) defined structural knowledge as a mediator among meaningful declarative knowledge or other various knowledge (as cited in Tobias & Duffy, 2009). This term was also defined by Diekhoff (1983) as a knowledge that is interrelated among concepts of a particular domain. In this case, various concepts or schemas can be combined in order to create those interrelations. Lastly, Shavelson (1972) defines structural knowledge as "cognitive structure, the organization of relationships among concepts in long-term memory" (as cited in Tobias & Duffy, 2009, p. 19). As understood from the characteristics of structural knowledge, this kind of knowledge is structured by learners in order to determine to what extent the facts and concepts for a specific topic are interrelated, and this kind of knowledge helps learners know how and where to use such information. During the DS creation process, students undertake relevant research and examine the relationships between the facts and concepts of a specific topic; they create their narrations in a well-structured way, and try to present the knowledge with a meaningful sequence of pictures that narrate their stories. In this regard, Tan, Lee, and Hung (2014) also emphasized that DST leads students to construct a meaningful narration within conceivable solutions in order to coherently solve problems and comprehend the related concepts about a specific topic.

When knowledge has its new form called structural knowledge in the constructivist learning approach, the learner also takes on different roles. Phillips (1995) distinguished three major roles that are (1) the active learner, (2) the social learner, and (3) the creative learner. Accordingly, learners in a constructivist-based learning setting take an active role during their learning process; they search, find, discuss, theorize, and receive opinions rather than just applying routine strategies such as reading or listening. Additionally, Phillips (1995) asserted that knowledge and understanding is not individual, but significantly social. Learners construct knowledge via interacting with each other and sharing their ideas in order to shape the knowledge and thereby gain meaningful understanding. In the same manner, Duffy et al. (2012) expressed that one of the most important contributions of the constructivist-based learning environment is that learners can create their self-interpretations of the universe via applying their experiences and interacting with each other, in order to construct a new sense of understanding by gathering knowledge through different resources (as cited in Smeda et al., 2014b). Lastly, Phillips (1995) defines the learners as creative learners in such educational environments. He highlights that learners create or recreate the knowledge they need; they are at the core of the learning process, and the instructors only guide them to reinvent different concepts in any context. Examining the nature of the DS creation process, students can undertake all three major roles as highlighted by Phillips (1995). They are active learners since they research about the topic upon which they are expected to create a DS, find out the relevant information, discuss the ways followed throughout the process, and finally express their opinions with their peers in order to make decisions about the structure of their stories and digital stories. They are social learners in this process, because they communicate with their classmates, and collaborate with each other while constructing their knowledge in order to find coherent solutions for their problems and gain meaningful understanding (Mello, 2001; Robin, 2008b; Smeda et al., 2014a). Lastly, they are creative learners when creating their DSs, because they are expected to create, gather and evaluate the knowledge (Burmark, 2004), and communicate with the content they created (Miller, 2009) so as to be able to narrate their stories in a well-structured way.

Additionally, according to Vygotsky, language plays a crucial role as a cultural tool in the cognitive development of children. He asserts that children not only perceive the world with their eyes and hands, they also apply their language to understand the events happening around them (as cited in Radford, 2003). He also emphasized that the human mental process is shaped by language (Atkinson, 2011; Vygotsky, as cited in Van der Veer, 1996), and that language is not only connected to culture, but also linked to thought. Additionally, Vygotsky states that children initially utilize their language for social interaction, yet then, they apply it to shape their way of thinking, and to use it for problem-solving activities (Schutz, 2016). In this manner, DST leads children to take roles in reading and writing tasks (Kajder, 2004), and to apply their critical thinking and reflection skills in order to make decisions, to solve their problems and maintain their stories (Benmayor, 2008; Maier & Fisher, 2006). In addition, when students use their own language while scripting their stories, they construct their knowledge and record their own voices while creating their DSs. Thus, self-directed learning occurs and remembering the concepts and knowledge about any topic becomes easier for them (Midland, 2008).

When considering the characteristics of the constructivist-based learning approach, the nature of knowledge and the roles of learners in this learning approach; DST might be one of the beneficial pedagogical tools that enhances the learning and teaching process conducted through the constructivist learning approach. It helps learners integrate the technology into creative learning and teaching activities (Smeda et al., 2014a). Dakich (2008) stated that DST not only improves learners' various skills, it also provides extra pedagogical outcomes, facilitates curriculum development and enables learners to apply their critical thinking skills and deep learning strategies (as cited in Smeda et al., 2014b). Additionally, DST increases students' levels of motivation, and allows teachers to involve their students in a constructivist-based learning setting by leading them to collaborate and communicate with their peers (Smeda et al., 2014a). In this manner, Shepard (2000) described the constructivist-learning approach as a social activity-based pedagogy, thus the continuous interaction and communication between the instructor and learners facilitates the learning process that also appears during the DS creation process.

In addition, DST might be used as a bridge that facilitates the integration of meaningful technology into the constructivist-based learning environment. In this sense, while Dexter, Anderson, and Becker (1999) emphasized that the level of student engagement to a learning environment is mostly influenced by the effective technology integration; Gils (2005) stated that DST might greatly improve the cognitive development of learners, and provide effective technology integration into education for long-term purposes. Moreover, Barrett (2006) stressed that DST contributes to apply effective technology integration into the learning process. When learners are allowed to choose useful technological instruments to be able to gather required information, evaluate and harmonize that knowledge and represent it in a professional manner, the meaningful technology is meant to be provided (Harris, 2005).

In the scope of the current study, relying on the enablers of DST to facilitate a constructivist-based learning environment, students can construct their structural knowledge based on their experiences and prior knowledge, and thus, they can create their own schemas and concepts related to a science course. They are at the core of the learning process and actively (Bromberg et al., 2013; Liu, 2003; Wang, 2009) constructing the knowledge they need. Such a learning environment provides them with some "active learning activities that include planning, creating, sharing, and communicating with content that requires higher order thinking skills (Bloom, 1981). These are different skills from passive learning activities that include listening to lectures and memorizing information for exams" (as cited in Midland, 2008, p. 5). Consequently, through the current study, it is expected that the use of DST in a constructivist-based learning environment will provide meaningful technology integration to a science course, increase students' level of engagement in the course, motivate them more, and encourage students to construct their own knowledge related to specific units via applying their own languages.

2.7. Learning Strategies

Learning strategies typically refer to actions, behaviors and ideas applied for accomplishing a specific learning task (Weinstein & Mayer, 1986, as cited in Malmberg, Järvelä, & Kirschner, 2014), facilitate learning and understanding (Weinstein et al., 2011) within any educational environment, and might differ in terms of achievement goal orientations (Ames, 1992; Hidi & Harackiewicz, 2000; Meece, Blumenfeld, & Hoyle, 1988). For instance,

> Students oriented toward the task goal tended to use deep, metacognitive, and self-regulated learning strategies; they were oriented toward improving new skills and attaining a sense of mastery by their standards. Students oriented toward the performance goal tended to achieve normatively defined goal and focused on public recognition; they were likely to use

> superficial learning strategies such as memorizing and writing down quickly what they learned in class. (Seo & Park, 2001, p. 5)

Additionally, Malmberg et al. (2014) expressed that learning strategies might vary based on the characteristics of learning tasks in a specific learning setting. In this regard, Lodewyk and Winne (2005) stated that, while performing the learning tasks, students need to make serious decisions when adapting their learning in order to achieve the expected learning goals. In this sense, the complexity of the learning tasks plays a significant role. For instance, while simple learning tasks require simple learning strategies such as repeating or recalling; complex learning tasks lead students to use multiple learning strategies like selecting and organizing (Pieschl, 2009).

As investigating the related literature, different researchers have classified learning strategies under various categories. One popular classification was developed by Pintrich et al. (1991), who classified the learning strategies under three major categories, as; (1) cognitive, (2) metacognitive, and (3) resource management strategies. The definitions and characteristics of those learning strategies have been considered separately within their relations to the purpose of the current study as follows:

2.7.1. Cognitive Strategies

Cognitive strategies are defined as the techniques that are mainly applied for storing, organizing and recalling information (Derry & Murphy, 1986; Weinstein et al., 1986). Pintrich et al. (1991) identified four different types of cognitive strategies; (1) rehearsal, (2) elaboration, (3) organization, and (4) critical thinking strategies.

"Rehearsal strategy" is applied to simple tasks and enables learners to just activate the information from their short-term memory. Yet, this strategy is not helpful for learners to link the information with their prior knowledge (Pintrich et al., 1991; Yusri, Rahimi, Shah, & Wah, 2013). Repeating words or highlighting related texts are involved in rehearsal strategy. In relation to the purpose of the current study, according to Yore et al. (2003), writing sessions in a science course enables students to repeat the knowledge, and after they communicate with the content during these sessions, the next step is to start recordings for gaining a conceptual understanding of the knowledge (Fellows, 1994), so that they have chance to repeat the content while recording as many times as they wish (Miller, 2009). In considering those statements, the DS creation process allows students to repeat content while both writing and recording what they narrated. In addition, Burmark (2004) highlights that students perform searches on the Internet in order to find relevant information during the DST process, then they link the information to their prior knowledge, and lastly, they repeatedly review the knowledge they created until completing the writing of a suitable story. As seen, particularly during the narrating and recording sessions in the DS creation process, students mostly employ rehearsal strategy, so that they might improve with the help of DST.

“Elaboration strategy” allows learners to enhance their knowledge by using various methods such as constructing metaphors, rephrasing, summarizing, and note-taking. It also contributes learners to make connections between the new information and their prior knowledge (Pintrich et al., 1991). During the DS creation process, students use their prior experiences in order to make real life relationships (Andrée, 2005; Gils, 2005; Hawthorne, 2002; Kahraman, 2013; Liu, 2003) while they are narrating. In other words, they have the chance to personalize with their experiences (Gils, 2005; Midland, 2008; Sadik, 2008) and communicate with the content (Miller, 2009) they created via using different higher order skills (Hung et al., 2012; Robin, 2008a). Thus, they gain more meaningful and in-depth understanding of the content (Barrett, 2005; Yoon, 2013). Along the same lines, as Robin (2006, 2008a) stressed, students experienced in the DS creation process can represent the knowledge by using different techniques such as asking questions, organizing and expressing their thoughts, analyzing, evaluating, and synthesizing. Consequently, all those techniques enable students to elaborate their constructed knowledge and to gain better understanding (Burmark, 2004). On the other hand, when students collaborate in a learning environment, they communicate with each other in order to solve problems (Bean, 1996, as cited in Laal & Ghodsi, 2012), and they are expected to evaluate themselves, their peers, and their classroom activities (Meier & Panitz, 1996) in order to be successful with regard to specific tasks. Thus, high levels of interdependence and interaction occur between group members, enabling them to gain deep learning (Entwistle & Tait, 1993). Those two variables might also contribute to increase the elaboration strategy use of students.

“Organization strategy” helps learners choose relevant information in order to combine with the knowledge to be constructed. Learners actively spend considerable effort when using this strategy in order to be able to achieve better results for their specific tasks. Gathering, drafting, and choosing the main idea are the major methods of this strategy (Pintrich et al., 1991). According to Paull (2002) and Salpeter (2005), students who actively engage to the process increase their levels of research and organization skills thanks to DST. In this process, students apply different sources such as their self-notes, course books, and the Internet in order to *cluster* the relevant information they need; then they *outline* what they want to narrate, and finally they *select the main ideas* to be able to maintain their stories. By employing these various techniques (Pintrich et al., 1991), they develop their organization skills. Apart from that, DST allows students to come together, collaborate with each other, and encourages them to achieve goals (Robin, 2006; Smeda et al., 2014a) related to specific tasks. Thus, they learn how to organize themselves.

“Critical thinking strategy” enables learners to use their prior knowledge with the new situations so as to be able to overcome the problems, to make decisions, and to critically evaluate the process for reaching the best standards (Lynch, 2006; Pintrich et al., 1991). Schank (1995) emphasized that stories make people more persuasive. Additionally, Sims (2004) noted that if storytellers want to convince their audience, they need to use critical thinking techniques such as inferences, evaluations, and explications (as cited in Yang & Wu, 2012). On the other hand, during the DS creation process, students are expected to make decisions in order to solve their problems and maintain their stories; so that they use their critical and reflection skills (Benmayor, 2008; Maier & Fisher, 2006; Malita & Martin, 2010). They are not only presenting the concepts related to the specific subject, but also reflecting their ideas visually and audibly (Sadik, 2008). Hence, the DST process enables students to improve their critical thinking skills (Yang & Wu, 2012). On the other hand, Webb (1982) stressed that the collaborative learning environment enhances students’ higher order thinking skills. Because students in groups express their ideas, discuss them, self-criticize, give immediate feedback to each other, and evaluate their tasks (Johnson, 1971; Peterson & Swing, 1985), and as a result, their levels of critical thinking strategy improve.

2.7.2. Metacognitive Strategies

Under this category, Pintrich et al. (1991) used the term "Metacognitive self-regulation strategy" and defined metacognition as "awareness, knowledge, and control of cognition" (p. 23), and with three major activities of planning, monitoring, and regulating included in metacognitive self-regulation strategies.

According to Pintrich et al. (1991),

> Planning activities such as goal setting and task analysis help to activate, or prime, relevant aspects of prior knowledge that make organizing and comprehending the material easier. Monitoring activities include tracking of one's attention as one reads, and self-testing and questioning: these assist the learner in understanding the material and integrating it with prior knowledge. Regulating refers to the fine-tuning and continuous adjustment of one's cognitive activities. Regulating activities are assumed to improve performance by assisting learners in checking and correcting their behavior as they proceed on a task. (p. 23)

However, Sungur (2007) expressed task value as one of the main factors that affects the metacognitive strategy use of learners. Many studies (Dembo & Eaton, 2000; Neber & Schommer-Aikins, 2002; Pintrich & De Groot, 1990; Shu-Shen, 2002; Tung-Hsien, 2004; Valle et al., 2003) also supported that metacognitive strategies used by learners are significantly influenced by different motivational beliefs, with task value being one of those major beliefs. Similarly, some researchers (Elliot & Church, 1997; Meece et al., 1988; Wolters, Yu, & Pintrich, 1996) stress that higher levels of intrinsic goal orientation and task value provides higher levels of metacognitive strategy use. Lastly, another important catalyst that increases the level of learning strategy use is the characteristics of the collaborative learning environment (Nichols & Miller, 1994; Stevens & Slavin, 1995).

In the scope of the current study, metacognitive strategies of students are examined by considering their task value levels during the DS creation process of a science course. In addition, the effects of collaborative and individual learning environment on metacognitive strategy usage are also observed.

2.7.3. Resource Management Strategies

Pintrich et al. (1991) divided resource management strategies into four sub-strategies. Those being time and study environment management, effort regulation, peer learning, and help seeking strategies. In the current study, due to the low reliability coefficients of effort regulation, peer learning, and help seeking strategies, only the management sub-strategy of time and study environment is examined.

Time and study environment management strategies mainly "involve scheduling, planning, and managing one's study time" (Pintrich et al., 1991, p. 25). These strategies deal with scheduling time blocks for studying, and using time as effectively as possible. While time management differs in terms of the features of learning tasks (daily, weekly or monthly); study environment management helps the learner set a place for their task (Pintrich et al., 1991).

It is a well-known fact that time is an important restrictor to meaningful technology integration (Hew & Brush, 2007; Keengwe, Onchwari, & Wachira, 2008; Snoeyink & Ertmer, 2001) in a learning setting. In relation to the purpose of the current study, this situation is also the case for DST usage in science education. Robin (2006) highlighted that since different multimedia components are used altogether after writing a story in the DST process, it takes up too much time. Similarly, Dogan (2007) reported that the DST process was time-consuming as a process for some participants. In this regard, Behmer et al. (2006) and Ohler (2008) emphasized that a sufficient orientation should be provided for students in order to enable them to gain the required skills for creating a DS, and that sufficient time should be given during the entire process. Therefore, use of time and study management strategies are of significant importance for learners in the DS creation process.

2.8. Related Research Studies about Digital Storytelling Use

A review of the literature concluded with several research studies related to the use of DST in science education. Various age groups participated in these studies, and different variables have been examined, as explained in this section. Apart from them, some related studies investigated the same variables as the current study – such as academic achievement, learning strategies, or attitudes – and have also been elaborated upon in different contexts.

Sadik (2008) conducted an experimental study with around 180 students aged from 13 to 15 years. The main purpose of Sadik's study was to enable Egyptian teachers to improve their teaching and learning process by using DST with their students. The study was implemented through four different courses, which included science. According to the study results, students did a great job in regard to their digital stories, and they applied various features of DST. Additionally, even though some problems were encountered during the study, the teachers reported that DST was useful for increasing students' understanding of the related content, leading them to alter their pedagogy and curriculum in order to include DST, enabling them to develop their collaborative and communicative skills, and students were eager to use DS for transferring their knowledge.

In Valkanova and Watts' (2007) study, they encouraged 30 primary school students to create digital stories in order to help them understand their self-learning experiences during a science course. The researchers examined the students' self-created digital stories in order to be able to understand their reflective self-learning skills. The results of the study indicated that digital stories might contribute to students' learning experiences during a science course, and also enhance their self-reflective skills.

Gyabak and Godina's (2011) qualitative study – which was conducted with eight students aged from nine to 13 years through four courses including science at public schools – was carried out to examine the pedagogical use of DST to link the digital divide. The study's results concluded that the students felt more comfortable while narrating about their communities, historical traditions, and their culture etc. DST provided them with engagement in technology-based instruction, and the students improved their sense of voice with the help of DST.

Additionally, a project-based quasi-experimental study was applied by Hung et al. (2012) to develop the learning performance of 117 students from a 5th grade science course by using DST. Their results indicated that students' levels of motivation to the science course, their academic achievement, and their problem-solving abilities increased with the help of project-based DST.

Smeda et al. (2014b) conducted a multi-case study to determine the instructional attributes and effectiveness of DST on learning. A constructivist-based learning setting was created for five varied courses including science, and with 150 students from primary and secondary levels who participated in the study. Their findings supported that DST can be used as a powerful tool in the classroom environment, and that it helps learners engage more to the related course. Additionally, since DST increases the engagement of learners, more meaningful learning occurs in such a constructivist-based learning setting.

In other research, Tan et al. (2014) employed an experimental study with 5th graders of a science course in order to determine the learners' understanding and effect of the nature of knowledge on their success by applying a pedagogical approach known as "*edutainment.*" During their study, participant students created digital stories related to scientific concepts with narrative tones. The narrated characters and the quality of the stories written by the students helped the researchers to understand the way in which the students perceived the knowledge and scientific concepts. The results of the study concluded that knowledge forms make a difference in students' understanding after they created their DSs. They reported that not all kinds of knowledge are equal and that horizontal or hierarchical differences help researchers classify the types of knowledge.

Kotluk and Kocakaya (2015) carried out a case study of a physics course with 10th graders (n = 32). The aim of the study was to investigate students' opinions about the effects of DST on their 21st century skills within a school physics course. The results of the study revealed that because the students researched specific topics for their stories, they integrated various multimedia components (sounds, images, background music etc.) for their digital stories, and had different roles such as scripting, dubbing, and evaluating their products; and that their learning and innovation skills, ICT skills, and life skills improved during the study.

Besides, Kotluk and Kocakaya (2016) conducted a qualitative research study with 13 pre-service physics teachers. The major aim of the study was to determine whether or not DST can be used as a distance education tool in physics education. Their findings, based on created DSs and participant opinion, concluded that DST can be used as an effective distance education tool.

Karakoyun and Yapıcı (2016) implemented a qualitative research study (descriptive model) with 16 pre-service biology teachers. The aim of the study being to determine the use of DST as a pedagogical tool in biology based on pre-service teachers' opinions. The results showed that even though restricted information can be delivered via DST, it increases the level of learning, interest to the course, and engagement of students in an active educational environment. It was also seen to make the learning environment more fun, and provides permanent learning by allowing students to learn by doing. Lastly, it helps students visualize the knowledge that they need to learn.

Moreover, Crăciun et al. (2016) applied a project-based survey study for a science course with pre-service teachers (n = 13), academicians (n = 2), and secondary school students (n = 99) participating in the study. The main purpose was to demonstrate the use of DST, particularly in science teacher training. According to the results, most of the participants were eager to use DST in their science courses for different subjects, and that they learned new information about the related topics. Besides, the teachers believed that the use of DST improved various skills such as their digital, communication, and other 21st century skills; and that the process encouraged them to use DST in their future classes.

Lastly, Balaman (2017) conducted a quasi-experimental study with 73 university students through science courses. The study was applied in order to explore the project-based virtual learning qualifications of students by using DST. The results indicated that students' related competencies increased during the process of DST use.

Apart from these various studies, three master's theses and one doctoral dissertation were also reviewed in the scope of using DS in science education in Turkey.

One of the master's theses was titled "The effect of digital storytelling use on 6th grade students' achievements, attitude and scientific process skills," and was conducted by Torun (2016) with 42 middle school students. The aim of the study was similar to the current study. According to the results, there was statistically significant difference seen between the control and experimental groups in terms of their academic achievement and scientific process skill scores. The difference was in favor of the experimental group. Additionally, both study groups had positive attitudes towards using DS on a science course.

Another master's thesis, titled "The effect of digital storytelling method on elementary school students' academic successes, scientific process skills, and attitudes towards the course in the context of science course," was conducted by Büyükcengiz (2017) with 60 students from the 6th grade. The main purpose of the study was to examine the effects of DST on students' academic achievement, scientific skills, and attitudes toward a science course. He reported that the students' academic achievement, and scientific skills were positively influenced by DST usage, and that they had positive opinions and attitudes toward DST use on a science course.

The last master's thesis reviewed was titled "The experiences of 7th grade students in preparing digital stories in science courses," and was carried out by Ulum (2017). The purpose of the qualitative study was to examine 7th grade students' experiences while creating DSs in science courses, with 23 students participating over an eight week period. According to the results of the study, most of the participants enjoyed the story writing phase, felt excited by it, and did not experience any difficulties during this phase. Similar findings were found for the storyboarding phase. On the flipside, during the DS creation phase, the students experienced difficulties in the recording sessions and in using the DS creation program. Additionally, participant interviews revealed that DST enabled students to learn and reinforce the course topics better, and to improve their research skills.

The doctoral dissertation reviewed was titled "The effect of using teaching materials prepared by digital storytelling method at the engagement of learning cycle on physics course achievement and motivation level." The study was carried out by Kahraman (2013) with 9th graders (n = 115) during their physics courses. The purpose of the study was to determine the effect of DST usage on students' academic achievement and motivation. The mixed-method study results revealed a statistically significant difference between the control and experimental groups in terms of their academic achievement and motivation scores. The significant difference was in favor of the experimental group. Moreover, the students thought that DST made their physics course more interesting and entertaining, and provided them with permanent learning because it made relationships to real life. Their motivation and engagement levels to the course also increased during the study.

Furthermore, several studies that were conducted in different contexts and considering same variables such as academic achievement, learning strategies, or attitudes are elaborated in this study. For instance, Demirer (2013) wrote a dissertation titled “Use of e-storytelling in primary education and its effects.” The purpose of the study was to apply a web-based DST application in order to examine its effect on 6th graders’ academic achievement, motivation levels, attitudes toward a social sciences course, and their learning strategies use. His findings revealed that the created web-based DST application contributed more to students’ academic achievement, motivation levels, attitudes toward the course, and their learning strategies use when compared to the control group that undertook traditional teaching instruction. The interviews held with both the course teacher and the students also supported those findings. Moreover, the course teacher expressed that such web-based DST application could be useful in fostering students to communicate with their peers, share their ideas, and to self-evaluate.

Göçen (2014) aimed to investigate the effects of DST on undergraduate students’ academic achievement and learning and study strategies in her dissertation study. A total of 80 students participated in the study through an Instructional Technologies and Material Development Course. While the experimental group received instruction based on DST, the control group used PowerPoint presentations during the process. According to the study’s results, when both the control and experimental groups increased their academic achievement scores, the level of increase seen was higher in the experimental group. Furthermore, a statistically significant difference was found in terms of the study groups’ learning and study strategies scores, and that this difference was in favor of the experimental group. In this regard, Göçen (2014) reported that DST affected students’ levels of academic achievement and learning and study strategies scores more than PowerPoint-based instruction.

Furthermore, Aktaş and Yurt (2017) conducted an experimental study with a mixed-method research design in order to investigate the effects of DST on university students’ academic achievement, motivation levels, and retention. The study was performed with 61 participants through a Turkish Literature course. Their results indicated that the use of DST in the related course increased students' levels of academic achievement, motivation and retention. Furthermore, the students showed positive attitudes toward using DST in their learning process.

Lastly, a quasi-experimental study was carried out by Özerbaş and Öztürk (2017) in order to determine the effects of DST on 5th graders' levels of motivation, academic achievement, and permanence of learning on a Turkish course. A total of 33 students participated in this study, and the findings revealed that while there was a statistically significant difference between the experimental and control groups in terms of their academic achievement scores, no significant effect was found on their motivation or permanence of learning levels scores.

2.9. Summary of the Related Literature

In investigating the existing related research studies, even though the number of studies examining the effects and use of DST in different educational settings appears similar worldwide, this cannot be said in the case of Turkey, particularly for the use of DST in the scope of middle school science education. There have been only three master's theses and only one doctoral dissertation conducted in the scope of science education in Turkey; with the master's theses carried out with middle school students, and the doctoral dissertation conducted with the participation of high school students. Apart from the variables considered by the many studies reported in this part of the current study, there is still a need to conduct experimental studies that examine the use of DST from a holistic approach; that deal with the effects of DS creation phases on students' learning, its effects on students' learning strategies usage, students' preferences while creating DS, the effects of individual and collaborative learning environmental differences, the effects of gender difference on students' attitudes toward creating DS, and students' experiences during this process.

CHAPTER 3

METHODOLOGY

This chapter represents the methodology of the study. It includes the purpose of the study, research questions, research design of the study, researcher's role, participants and sampling procedure, data collection instruments, data collection procedures, data analysis, assumptions, and limitations of the study, as well as the validity and reliability of the study.

3.1. Purpose of the Study and Research Questions

This study aims to compare a Control Group, an Experimental Group 1 (individual digital story development), and an Experimental Group 2 (collaborative digital story development) in regard to their academic achievement and learning strategies; to investigate the experimental groups' opinions and attitudes toward creating digital stories on a science course; and examine the quality of digital stories created by 6th grade students.

In summary of the study, the researcher asserts the following:

> *During the study, the Control Group did not create digital stories, but they had homework assignments related science course topics. While Experimental Group 1 individually created their digital stories, Experimental Group 2 worked collaboratively.*

In the light of those purposes, the research questions of the study are listed as follows:

1. Is there any statistically significant mean difference within and between the achievement test scores of students in the control and experimental groups of a science course?
    a. Is there any statistically significant mean difference within the achievement test scores of the Control Group, Experimental Group 1, and Experimental Group 2?
    b. Is there any statistically significant mean difference between the Control Group, Experimental Group 1, and Experimental Group 2 in terms of academic achievement after controlling the pretest scores?
2. Is there any statistically significant mean difference within and between the learning strategy scores of students in the control and experimental groups of a science course?
    a. Is there any statistically significant mean difference within the learning strategy scores of the Control Group, Experimental Group 1, and Experimental Group 2?
    b. Is there any statistically significant mean difference between the Control Group, Experimental Group 1, and Experimental Group 2 in terms of their learning strategy scores?
3. Is there any statistically significant mean difference between the experimental groups toward creating digital stories on a science course?
    a. Is there any statistically significant mean difference within the attitude scores of Experimental Group 1 and Experimental Group 2 toward creating a DS on a science course?
    b. Is there any statistically significant mean difference between Experimental Group 1 and Experimental Group 2 in terms of their attitude scores toward creating a DS on a science course?
    c. Is there any statistically significant mean difference between males and females in terms of their attitude scores toward creating a DS on a science course?

4. What are the opinions of students about creating digital stories on a science course?
5. What is the quality of the digital stories created by students?

3.2. Research Design of the Study

In this study, a mixed-methods research design was employed since the research questions required both quantitative and qualitative data. While Creswell and Plano Clark (2011) defined this research design as a process in which both quantitative and qualitative methods are used in order to gather, analyze, mix and combine the collected data in a single study or a sets of studies to be able to determine a research problem; Johnson, Onwuegbuzie, and Turner (2007) defined this design as a type of research where both quantitative and qualitative research approaches are combined for examining comprehensive purposes in length and breadth of understanding. Lastly, Fraenkel and Wallen (2009) emphasized that "those who engage in such research argue that the use of both methods provides a more complete understanding of research problems than does the use of either approach alone" (p. 557).

According to Johnson and Onwuegbuzie (2004), designing a research process that enables the researcher(s) to have logical responses to their research questions constructs the core of mixed methods research. In line with this, some critical issues become significant to be considered in order to design the best-fit research design. Those critical issues (Creswell, 2012) can be ordered as the following;

a- The priority or weight of quantitative and qualitative data: which is more emphasized or used?

b- Sequence of collection of quantitative and qualitative data: which data come first and second during the study?

c- Analyzing the data: are the data combined in one analysis or analyzed separately?

d- The place of mixing data: are the data combined, mixed, or linked during data collection, between data collection and data analysis, during data analysis, or in the interpretation of a study? (p. 540)

In light of those critical issues, among the mixed methods design types, “embedded design” was applied for the current study. According to Creswell (2012), embedded design is a research process in which quantitative and qualitative data are collected simultaneously or sequentially, yet one data form plays a supportive role to the other. The second form of data are mostly collected for augmenting or supporting the former dataset. Another reason for using this type of research design, as Creswell, Plano Clark, Gutmann, and Hanson (2003) stated, is to answer supportive questions. In this case, researchers use frequently this design in order to embed qualitative data into quantitative form of data.

Of the two types of embedded designs, “embedded experimental model” was selected for the current study. In this design type, qualitative data is embedded within an experimental design (a true experiment or a quasi-experiment). The priority of this design is to apply quantitative data in an experimental setting, and the qualitative data is used as subservient (Creswell & Plano Clark, 2011). Furthermore, qualitative data may alternatively come during, and after intervention, as seen in Figure 3.1 (Creswell, 2012). Since the researcher did not have the opportunity to assign the subjects randomly to the experimental groups, or to reconstitute them because of school regulations, the study groups were kept as intact groups. Therefore, “nonequivalent control group pretest-posttest design” (Tuckman, 1988), which is one of the quasi-experimental designs, was applied in the case of the current study. By applying this design, the researcher could compare the study groups by conducting pretests before the interventions. Thus, a pretest–posttest control group design was found to be rational for this study, as shown in Table 3.1.

Table 3.1 Quasi-Experimental Design / Nonequivalent Control Group Design

Groups	Pre-measures	Treatment	Post-measures
Control Group	✓	Traditional Instruction + Homework	✓
Experimental Group 1 (Individual)	✓	Traditional Instruction + Digital Storytelling Method	✓
Experimental Group 2 (Collaborative)	✓	Traditional Instruction + Digital Storytelling Method	✓

Figure 3.1 illustrates the design of this study and Table 3.2 presents the whole design of the study including the research questions, data source types, data sources, data collection time, and analyses.

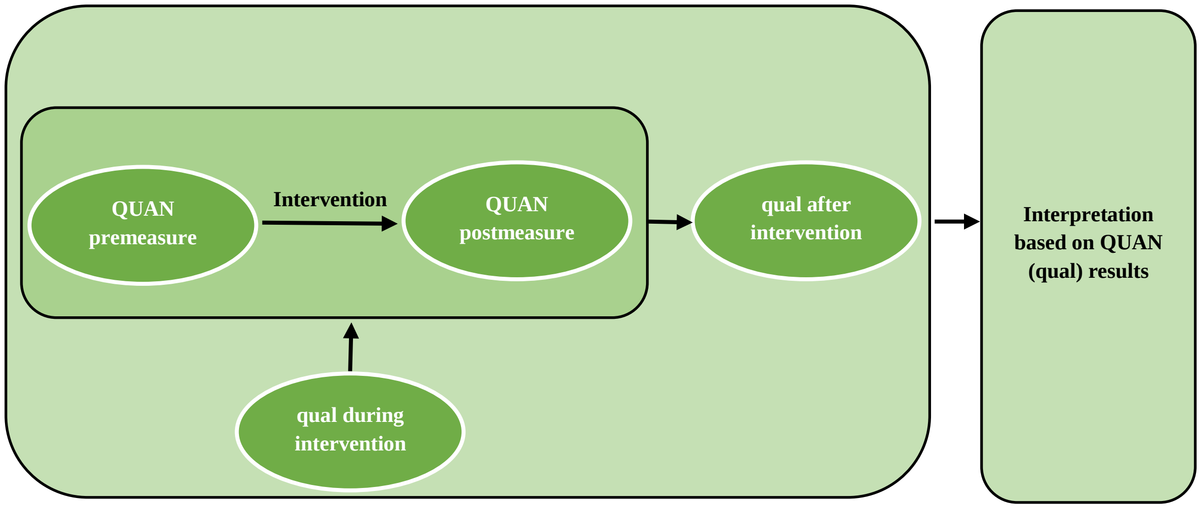


Figure 3.1 - Embedded Design: Embedded Experimental Model (Creswell & Plano Clark, 2007, p. 68)

Table 3.2 Research Questions, Data Source Types, Data Sources, Data collection time, and Analyses

Research Questions	Data Source Type	Data Source	Data Collection Time			Analysis
			Before Intervention	**During Intervention**	**After Intervention**	
1. Is there any statistically significant mean difference within and between the achievement test scores of students in the control and experimental groups of a science course?	Quantitative	Achievement Test	✓		✓	Inferential Statistics: Paired-Samples *t*-tests ANCOVA tests
2. Is there any statistically significant mean difference within and between the learning strategy scores of students in the control and experimental groups of a science course?	Quantitative	Motivated Strategies for Learning Questionnaire (MSLQ)	✓		✓	Inferential Statistics: ANOVA tests Paired-Samples *t*-tests
3. Is there any statistically significant mean difference between the experimental groups toward creating digital stories on a science course?	Quantitative	Attitude Scale (toward using DS on a science course)	✓		✓	Inferential Statistics: ANOVA tests Paired-Samples *t*-tests
4. What are the opinions of students about creating digital stories on a Science course?	Qualitative	Interview Form Observations		✓	✓	Transcript Analysis
	Quantitative	Digital Story Creation Process Evaluation Form				Descriptive Statistics
5. What is the quality of the digital stories created by students?	Quantitative	Digital Storytelling Evaluation Rubric			✓	Descriptive Statistics

3.3. Participants of the Study

As Fraenkel and Wallen (2009) emphasized, for a researcher, the first task in choosing a sample is to define the population of interest. In other words, “in what group, exactly, is the researcher interested? To whom does he or she want the results of the study to apply?” (p. 92). In this manner, the target population for the current study was selected as 6th grade students studying at eight different public schools in the Çankaya district of Ankara, Turkey. One reason for selecting 6th grade public school students from this district as the population of the study was its accessibility to the researcher. Another reason was that a science course is compulsory in the Turkish 6th grade curriculum.

From selection of possible study schools to identification of the study groups, various sampling strategies were employed in this study. First, *Convenience Sampling* was applied in order to identify possible schools where the study could be conducted. Eight different middle schools were identified because of their accessibility to the researcher and which were approved by the ethics committee of the researcher’s university.

Second, *Purposive Sampling* was used in order to be able to select the study school and study groups based on predetermined criteria: (a) school administration’s willingness to allow the study to take place within the institution, (b) willingness of the course teacher to participate in the study, and (c) technological capability of the school’s computer laboratories. In regard to those criteria, one of the eight public schools from the convenience sampling was selected as the study school for application of the research. The selected school had the better technological background with 20 computers that were considered appropriate to conduct the study. Moreover, the school administrators and two science course teachers at the school were willing to participate in the study.

However, it was not possible to randomly assign the subjects to the study groups due to the school’s regulations. The study school had seven 6th grade classes, yet the teacher who participated in this study taught only four of those classes. Therefore, the classes were assigned to the study groups randomly among the four classes. The study groups were selected among those four classes because the researcher needed at least three study groups taught by the same teacher in order to have participants taught with the same teaching method. Other classes were taught by different teachers. Thus, class names were written on small pieces of papers, and then selected at random. According to this random selection, 6A was selected as the Control Group; 6B as Experimental Group 1; and 6C as Experimental Group 2 which were intact groups. While the Control Group was traditionally instructed in their science course, the experimental groups also used digital storytelling method for creating digital stories about related topics. In this sense, the Control Group were set normal homework assignments during the study, whilst students in Experimental Group 1 created their DSs individually, and those in Experimental Group 2 created DSs collaboratively for the same purpose. Students in Experimental Group 2 created their own groups in which to work. Demographics of the groups are presented in Table 3.3.

Table 3.3 Distribution of Participants by Group and Gender

Study Groups	Gender	*f*	%
Control Group (6A)	Female	22	71.0
	Male	9	29.0
	Total	31	100.0
Experimental Group 1 (6B)	Female	14	45.0
	Male	17	55.0
	Total	31	100.0
Experimental Group 2 (6C)	Female	11	42.3
	Male	15	57.7
	Total	26	100.0

Among the study groups, the number of students in the Control Group and Experimental Group 1 was equal (n = 31), whilst there were 26 students in Experimental Group 2. In the Control Group, the majority of the students were female (71%). However, percentages of females were lower than males in both Experimental Groups 1 and 2. Those percentages were 45%, and 42.3%, respectively. A total of 88 students participated in the main study. All of the students had at least one tablet PC, a desktop PC, a notebook, or a smartphone with Internet connection in their homes. Only six of the students required microphones for the purposes of making recordings, and were provided by the researcher.

Although a few of the students experienced some difficulties in using the computers, the technological background of all students were almost equal. Moreover, they had all taken an Information Technologies (IT) course for a period of two semesters. Lastly, the previous science course grades for those in the study groups were checked and no significant difference was found between the groups in terms of their academic achievement.

3.4. Context of the Study

A science course and 6th grade students attending the course constituted the context of this study. One public school out of eight schools located in the Çankaya district of Ankara, Turkey, was chosen at which to conduct the study. Both the pilot and main studies were conducted in the same school, although within different semesters. While the pilot study was conducted at the end of 2014, the main study was carried out in 2016, between March and June for a period of fourteen weeks, which is one semester.

Overall, the middle school had 889 students from 5th to 8th grades. Of those students, 437 were female, and the remainder (n = 452) were males. A total of 59 teachers were working at the school. While there were six science course teachers, the number of IT course teachers was two. There were seven 6th grade classes. Additionally, whilst the IT course was a compulsory course for the 5th and 6th grade, it was elective for the 7th grade, and not applicable for the 8th grade. According to the school management, the socioeconomic status of the school was deemed to be of an average level.

During the study, both the Science and IT courses were used. The science course was a four-hour course, whilst the IT course was held for two hours per week. Since the study was conducted parallel to the science course curriculum, the researcher first attended the course as an observer in order to conduct the study parallel to the curriculum. One hour of the IT course each week was used for the study's implementation. Moreover, the researcher requested additional hours from other teachers as needed. Thus, the study was maintained with the experimental groups for between two to four hours per week.

At the commencement of the study, a USB flash drive including a presentation on digital storytelling, several digital story examples, a story example, a storyboard example, a storyboard template, the software to be used for creating digital stories, a procedure manual introducing how to use this software, and a rubric for evaluating digital stories was distributed to all of the experimental groups' students. In the first two weeks, over a period of four hours, both of the experimental groups were informed about what they would be expected to do throughout the study, a presentation was shown about digital storytelling, the software (Windows Photo Story 3) being used for creating digital stories was introduced, and a digital story sample was created by all students during the IT course hours. Moreover, a story example (see Appendix M) was read by students in the classroom, and a storyboard example (see Appendix N) was introduced to the students with all of the relevant details. During and after reading this story example, the researcher made some explanations about the main points of writing a story and creating a digital story, and then answered the students' questions. When the researcher was convinced that everything was clear for the students about the study, the students were asked to form into their groups for those in Experimental Group 2. Before commencing the implementations, pre-achievement tests and questionnaires regarding the students' learning strategies, and their attitudes toward creating digital stories in a science course were applied, and the required data then collected. Details about the duration of each session are indicated in Table 3.4.

The Control Group was informed that they would have homework assigned about the related unit during the study. The evaluation parts placed at the end of the unit in the course book was given to them as their homework. Those parts included open-ended, multiple choice and matching question types. During this process, the researcher attended course sessions and observed the instructional environment. At the end of the unit, the students' homework in the Control Group was checked by both the course teacher and the researcher, any questions raised by the students were answered, and feedback was provided back to the students by the course teacher.

Table 3.4 Duration of Phases in the Study

Time Period	Tasks (Experimental Groups)	Tasks (Control Group)
March: weeks 1 & 2	• Introducing the study • Introductory presentation about DST, its process, and how to use Photo Story 3. • Pre-measures	• Introducing the study, plus informing what participants would do during the study
March: weeks 3 & 4	• Draft for first story	
April: week 1	• First story	
April: week 2	• First storyboard	• First homework assignment
April: week 3	• Second story	
April: week 4	• Second storyboard	• Second homework assignment
May: weeks 1 & 2	• Creating first digital story	
May: weeks 3 & 4	• Creating second digital story	
June: weeks 1 & 2	• Post-measures • Interviews with students	• Post-measures

At the start of the study, the course teacher would commence with teaching the unit titled "Gamogenesis, Growth, and Development in Plants and Animals." Therefore, this unit was also chosen for the digital stories to be created by students in the experimental groups. Because of the length and academic load of the unit, it was divided into two, as plants and animals. Each student in Experimental Group 1, and each group in Experimental Group 2 was tasked with creating two digital stories; with one about plants, and the other about animals.

As the first two steps were to write a story script and develop a storyboard for a digital story, writing, and storyboarding sessions for each story were held over a period of four weeks. Therefore, mostly a classroom environment was used throughout this process. Students then proceeded to write their stories during their science course lessons. They started writing in class, and if they could not finish the related part of the story, the researcher assigned them that part as their homework. The researcher answered the students' questions and controlled their progress at each course session. Not only was verbal feedback given, but written feedback was also provided to the students. During this process, the researcher provided guidance individually for those who felt unable to proceed further with their stories. In doing so, the researcher tried to ensure that all of the students were able to keep up with the process.

Writing and storyboarding sessions for the two stories were maintained in the classroom environment under the researcher's control. The next step was to create digital stories by using the Photo Story 3 software program, therefore this session was planned to be held in the IT class. However, due to the number of students, and some technical problems experienced in the IT class, most of the implementations were assigned to the students as homework. Therefore, most students started creating their digital stories at home using their own computers and the documents that had already been distributed to them. Some of the students, and the groups, continued their work in the IT class with the computers available. If technical or other problems were experienced, they were resolved during the IT class sessions. Headphones and microphones were provided for those who needed such equipment. The researcher provided both verbal and written feedback (see Appendix L) to each student and each group in order to help them to appropriately create their own digital stories. In total, the digital story creation process lasted for a period of four weeks.

According to the researcher's observations, the digital story creation process was perceived as more difficult for the students than either the writing or the storyboarding phases, and the students wrote their second stories better and easier than the first one. That observation was also the case seen for the students' digital story creation. Those results were as foreseen by the researcher. When the implementations had been completed, posttests and post-questionnaires were applied, and then the required interviews were held. Table 3.5 presents details about the research plan conducted during the study.

Table 3.5 Research plan of the study

Study Group	Prior to the Study	During the Study	After the Study
Control Group	• Pre-Motivated Strategies for Learning Questionnaire (MSLQ) • Pre-Achievement Test	• Observations – in lecture courses • Homework assignments	• Post-Motivated Strategies for Learning Questionnaire (MSLQ) • Post-Achievement Test • Homework analyses
Experimental Groups	• Pre-Motivated Strategies for Learning Questionnaire (MSLQ) • Pre-Attitude toward using DST Questionnaire • Pre-Achievement Test • Use of Photo Story 3 (min. 4 hours) • Digital Storytelling presentation (min. 2 hours)	• Process of creating digital stories (min. 8 weeks) • Observations – in IT Class • Observations – in lecture courses	• Post-Motivated Strategies for Learning Questionnaire (MSLQ) • Post-Attitude toward using DST Questionnaire • Post-Achievement Test • Interviews with students about process of creating digital stories • Digital Story evaluation

3.5. Data Collection Instruments

Data collection instruments for this study are provided under two main sections, as (1) quantitative data collection instruments, and (2) qualitative data collection instruments.

3.5.1. Quantitative Data Collection Instruments

The required quantitative data for this study were collected by using five different instruments; Motivated Strategies for Learning Questionnaire, Attitude Toward Using Digital Storytelling Scale, Achievement Test, Digital Story Evaluation Rubric, and DS Creation Process Evaluation Scale. Among those instruments, the Achievement Test, Digital Story Evaluation Rubric, and the DS Creation Process Evaluation Scale were created by the researcher; whilst the Attitudes Toward Using DST Scale was adapted from an original scale created by Taylor and Todd (1995). Lastly, the translated version of the Motivated Strategies for Learning Questionnaire was used in this study. Permission for using each of these scales were sought and received from their respective developers via e-mail. Details for each of the instruments are provided separately and explained as follows:

A. Motivated Strategies for Learning Questionnaire (MSLQ)

The original version of the MSLQ was designed by Pintrich et al. (1991), and included 81 items under two main domains of *motivational scales* and *learning strategies scales*. All items are scored on a seven-point, Likert-type scale, and range from “1–not at all true of me” to “7–very true of me.” This self-report instrument was originally developed to assess the motivational orientations and learning strategies of college students. For the current study, only the *learning strategies scales* part was used in full. In other words, 50 items from the original scale that measure the learning strategies of students were used in the current study. Additionally, six items under the *motivation scales* part that measured the task value of learners were applied. The learning strategies part of the scale is constructed from nine subscales. Those subscales are Rehearsal (four items), Elaboration (six items), Organization (four items), Critical Thinking (five items), Metacognitive Self-regulation (12 items), Time/study Environmental Management (eight items), Effort Regulation (four items), Peer Learning (three items), and Help Seeking (four items).

Pintrich, Smith, Garcia and McKeachie (1991) determined the reliability and validity issues for the MSLQ instrument by conducting a study with the participation of 380 students (as cited in Artino, 2005). Two different confirmatory factor analyses were completed for the factor validity of the instrument. The results showed reasonable factor validity (Pintrich et al., 1991). On the other hand, they checked the Cronbach Alpha values for the internal consistency estimates of reliability of the instrument, and reported that the Cronbach Alpha values for the learning strategies scales differed from .52 (Help-seeking) to .80 (Critical Thinking). Even though some values were under the .70 level, Pintrich et al. (1991) stated that the MSLQ had comparatively good internal consistency. For validation of the instrument, zero-order correlations between the scales were checked and the results indicated valid measurements between those scales (Pintrich et al., 1991). Finally, the predictive validity was determined with correlations between scales by using students' grades, and "the scale correlations with final grade are significant, albeit moderate, demonstrating predictive validity" (Pintrich et al., 1991, p. 7).

The Turkish version of the questionnaire was adapted for students aged between 12 and 18 years by Büyüköztürk, Akgün, Karadeniz, Kılıç, and Demirel (2007). They conducted their study in two phases. While 1,114 students between 12 and 18 ages from six different schools participated in the first phase of the study; 16,892 students from 42 schools located in seven different geographical regions of Turkey participated in the second phase of the study. After follow-up confirmatory factor analyses (CFA), due to some modification and fit indices, factor loadings, and similar meaning of the items, 10 items were eliminated by Büyüköztürk et al. (2007) in their pilot study. Furthermore, eight more items were removed from their main study for the same reasons. Thus, the Turkish version of the questionnaire was finalized as 63 items. Of those 18 removed items, seven were from the *learning strategies scales*. Therefore, the number of items in this part decreased from 50 down to 43, and those 43 items were used for the current study.

Despite the fact that the validation and reliability issues of MSLQ were checked many times in the literature, CFAs were also applied as part of the current study in order to provide evidence for the validation of the scale for the targeted sample of the current study. Required data for the validation process were collected from 670 students at

6th, 7th, and 8th grades from three different public schools in Ankara, Turkey, and CFAs were performed using the LISREL 8.8 package program.

Before running the required CFAs, the assumptions of CFA were checked. The initial assumption was sample size. For this issue, there are various references to be found in the literature. While Hair, Black, Babin, and Anderson (2010) suggested five subjects per item, whilst MacCallaum, Widaman, Zhang, and Hong (1999) recommend 10 subjects per item. With 49 items to be used in the current study, a minimum of 245 subjects and a maximum of 490 subjects were needed according to those authors' suggestions. Therefore, when considering the participants of the current study (n = 670), the sample size was found to be adequate and this assumption was met. All data were collected face-to-face under the researcher's control. While collecting the data, the researcher ensured that the participants read the items carefully and responded based on what they really thought about them. Yet, there were some students who did not focus adequately on the questionnaire, responding to questions without necessarily reading them. Those participants were identified by the researcher and those cases were instantly eliminated. In addition, 27 of the questionnaires were returned as incomplete. They were also removed by the researcher as an adequately sized sample was still held. A total of 670 cases were therefore used for the required analyses.

Before running the required CFAs, univariate and multivariate normality was checked for the collected data. While univariate normality was checked by using SPSS 23, LISREL 8.8 was utilized for multivariate normality. In observing the univariate normality results, even histograms for most of the cases showed normal distribution, but that there were also some cases indicating negatively skewed distribution. Besides, all Skewness and Kurtosis values were between -3.00 and +3.00 which were normal. Q-Q plots for most cases appeared close to the reference line. Lastly, even though there were some outlier cases, they were not removed from the dataset and analyses were run with those cases. On the other hand, test of multivariate normality was found to be significant (χ^2 = 5059.08, p < .05) and this was the case for all Multivariate Skewness and Kurtosis values, meaning that the basic assumption of multivariate normality was not met. According to Muthén and Kaplan (1985), Maximum Likelihood (ML) estimation method can be applied for CFA even for data non-normally distributed, particularly in studies having a sample size of less than 2,000 subjects (Olsson, Foss, Troye, & Howell, 2000). In light of those references, ML estimation method was used for CFAs in this study, and several fit indices were applied in order to evaluate the goodness-of-fit of the data.

Goodness-of-fit indices used in this study for evaluating the model fit were the Root Mean Square Error of Approximation (RMSEA), Standardized Root Means Square residual (SRMR), Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), and Chi-Square. The RMSEA is applied in order to see how well the model fits the populations' covariance matrix, even where it has unknown but optimally selected parameter estimates (Byrne, 1998). When Steiger (1998) emphasized that values less than .05 indicated a very good fit for RMSEA, Byrne (1998) stated that RMSEA values up to .08 indicated reasonable errors of approximation in the population. Lastly, Hu and Bentler (1999) recommend RMSEA as a good fit when the value is less than .05; and a reasonable fit when it is between .05 and .08. Chen (2007) defined SRMR as an index of average discrepancy of standardized residuals between the observed and predicted covariance matrices by the model. While Byrne (1998) commented that if the SRMR is smaller than .05, it indicates a very good fit, Hu and Bentler (1999) recommended that where the value of SRMR is less than .08 the data indicates a good fit, and that if the value is less than .10 the data fit is reasonable. GFI is an alternative index to the Chi-Square test and is used for measuring the explained variance by the predicted population covariance (Tabachnick & Fidell, 2007). A larger GFI value is the recommended criteria for an acceptable fit (Hu & Bentler, 1999). On the other hand, CFI considers the sample size that works well even when it is small (Byrne, 1998; Tabachnick & Fidell, 2007). "This statistic assumes that all latent variables are uncorrelated (null/independence model) and compares the sample covariance matrix with this null model" (as cited in Hooper, Coughlan, & Mullen, 2008, p. 55). While the suggested CFI value for a good fit is greater than .95, a value of between .90 and .95 indicates a reasonable fit (Hu & Bentler, 1999). Lastly, the Chi-Square statistic is accepted as a measure of fit to evaluate the sample covariance and fitted covariance matrices and non-significance is favored for the value of chi-square. (Hu & Bentler, 1999).

After running the first CFA, the results (RMSEA = .042, SRMR = .052, GFI = .89, CFI = .98, χ^2 = 1729.23, df = 824, p = .00) indicated a good fit when considering the recommended criteria of several authors for acceptable fit. Hence, when modification indices were observed, even though the results showed a good fit, there were some error covariance between three item pairs that likely to be reconsidered. That error covariance was between item 32 and item 1 (organization scale), item 41 and item 28 (rehearsal scale), and item 44 and item 37 (help-seeking scale). Since item pairs were in the same scale, their error terms were combined together and follow-up CFAs were separately run again.

Even though the error covariance between item pairs were not significantly high (i.e., 31.7, 25.1, and 31.3), three more CFAs were run, respectively. The follow-up CFAs' results are depicted in Table 3.6.

Table 3.6 Modification Indices of CFAs

Indices	1.CFA	2.CFA	3.CFA	4.CFA
RMSEA	.042	.041	.040	.040
SRMR	.052	.052	.052	.042
GFI	.89	.89	.89	.90
CFI	.98	.98	.98	.98
χ^2	1729.23	1686.26	1660.93	1623.72
df	824	822	821	820
p	.00	.00	.00	.00

Table 3.6 demonstrates that even error covariance of the three item pairs was added together, and CFAs were run separately, the results of modification indices did not dramatically change.

Furthermore, Alpha Coefficients for each subscale were measured. To be able to help interpret the reliability results and gain a better understanding, the reliability of subscales reported by the developers of the scale (Pintrich et al., 1991), the authors of the translated version of the scale (Büyüköztürk et al., 2007), and current study results are presented together in Table 3.7.

Alpha coefficients of the MSLQ subscales ranged between .52 (Peer Learning) and .79 (Metacognitive Self-regulation). The current study's results concluded that the reliability coefficients of some subscales (elaboration, organization, and help seeking) were found higher when compared to the previous two studies. Yet, there were some subscales which reported reliability values lower than .70 (Hair et al., 2010); as was the case for the three studies (see Table 3.7).

Table 3.7 Reliability Coefficients of MSLQ Subscales

Subscales	Pintrich et al. (1991)	Büyüköztürk et al. (2007)	Current Study
Rehearsal	.69	.63	.68
Elaboration	.76	.75	**.77**
Organization	.64	.63	**.66**
Critical Thinking	.80	.71	.72
Meta. Self-Reg.	.79	.78	.79
Time/Std. Env. Mng.	.76	.68	.69
Effort Regulation	.69	.50	.54
Peer Learning	.76	.52	.52
Help Seeking	.52	.51	**.58**

Lastly, the item total correlations of subscales were calculated and depicted in Table 3.8

Table 3.8 Correlations Between Sub-scales of MSLQ

Scale Name	1	2	3	4	5	6	7	8	9
1. Rehearsal	-	.64**	.66**	.57**	.70**	.59**	.35**	.42**	.37**
2. Elaboration		-	.64**	.70**	.74**	.55**	.35**	.42**	.39**
3. Organization			-	.58**	.65**	.47**	.30**	.43**	.32**
4. Critical Thinking				-	.69**	.51**	.28**	.42**	.38**
5. Meta. Self-Reg.					-	.68**	.38**	.38**	.39**
6. Time/Std. Env. Mng.						-	.33**	.26**	.33**
7. Effort Regulation							-	.19**	.26**
8. Peer Learning								-	.40**
9. Help Seeking									-

**. Correlation is significant at the .01 level (2-tailed).

Table 3.8 demonstrates that correlations between MSLQ subscales differed from .19 (between Effort Regulation and Peer Learning) to .74 (between Elaboration and Metacognitive Self-regulation), and all correlations were found to be significant ($p < .01$).

When taking all the CFA, reliability, and correlation results into consideration, while the CFA results indicated a good structure in terms of modification indices, the reliability coefficients of some of the subscales were found to be lower than .70, and the *effort regulation* scale had only two items. Even though, the reliability coefficients of some subscales (effort regulation, peer learning, and help seeking) were found to be under .70, and they were all used in previous studies. However, those three subscales were removed from the current study in order to realize more satisfactory and reliable results. After the elimination of some subscales and items, the final version of the MSLQ included six subscales (Rehearsal [four items], Elaboration [six items], Organization [four items], Critical thinking [five items], Metacognitive self-regulation [11 items], and Time/study environmental management [five items]) for addressing the research questions of this study, as illustrated in Figure 3.2.

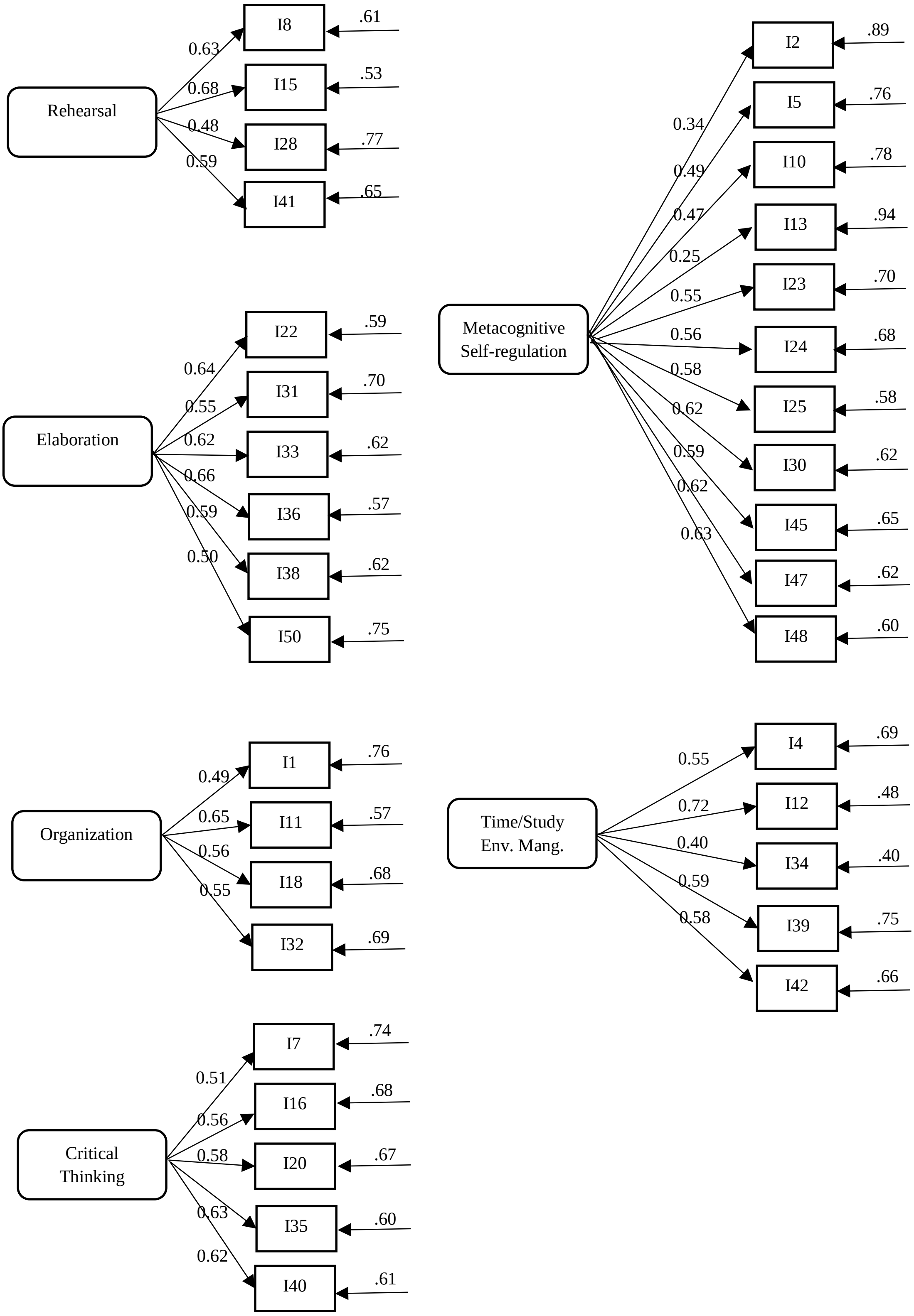


Figure 3.2 - Factor Structure of MSLQ
Note. Latent factor correlations between subscales are not displayed in this figure in order to have a better appearance of the diagram.

Factor loadings varied between .25 (item 13) and .72 (item 12). Although there was one item (item 13) whose factor loading was below .30, this item was not removed from the questionnaire in order not to decrease the reliability of the related subscale. In light of the CFA, reliability, and Pearson's correlation results, the MSLQ scale was found to be sufficiently valid and reliable in its final version (see Appendix C).

B. Attitude toward Using Digital Storytelling Scale

This scale includes four semantic differential items and was developed by Taylor and Todd (1995). Some pairs of adjectives were used in this scale in order to examine the students' attitudes. Reliability of this scale was reported as .85 (Taylor & Todd, 1995). First, those items were adapted by the researcher to measure students' attitude toward using DST in science education for the current study. Then, the scale was translated into Turkish by an instructor from the field of English Language Teaching, and then checked by a field expert to ensure that the scale is adequately consistent for the sample of the study.

Since the items were adapted for this study, the reliability coefficient value for this scale was reconsidered. Data gathered from 50 students in the 6th grader (20 females, 30 males) during the pilot study were analyzed using the SPSS 23.0 package program. Firstly, the univariate and multivariate normality assumptions for the scale were checked. All Skewness and Kurtosis values were found to be between -3.00 and +3.00, Q-Q pilots and histograms showed normal distribution and there were no outliers. Mardia's test was also checked and found to be .77, which is not deemed as significant. All those results showed that the items for this scale showed normal distribution. Finally, Cronbach Alpha coefficient value was found to be .81, which represents a good internal consistency for the scale (see Appendix D).

C. Achievement Test

The researcher aimed to examine the achievement levels of students before and after they created their digital stories, therefore, an achievement test was required. During this study, the students created two different digital stories about one unit of the science course curriculum prepared for 6^{th} grade Science Education Program. The subjects chosen in this unit were (1) Plants' Gamogenesis, Growth, and Development, and (2) Animals' Gamogenesis, Growth, and Development. The reason behind the selection of this unit was the convergence of the time period of the study and the curriculum progress of the course. Three main learning outcomes were determined by the Board of Education and Discipline with regard to the related unit. In light of the course objectives, the table of specifications according to Bloom's revised taxonomy is prepared and can be seen in Table 3.9.

A question pool including various types of questions about related subjects was created by the researcher with regard to the table of specifications. Those questions were chosen from different course books, tests, and Internet resources according to the revised Bloom's Taxonomy, and via canvassing the course teachers' views. Content validity of the test was determined by taking views of three different science course teachers, and one professor instructing in the Science Education Department at a public university. After taking their views, some questions were eliminated and a new question pool including 25 multiple-choice, 15 fill-the-blanks, and 15 true/false questions measuring all sub-topics of the unit was created for the reliability analyses of the test.

Table 3.9 Table of Specifications Based on Bloom's Revised Taxonomy

Learning Outcome (LO)	Remember	Understand	Apply	Analyze	Evaluate	Create
LO1: Comparing gamogenesis types in animals and plants	7	25, 27, 33, 1, 2, 11, 3, 13, 37				
LO2: Explaining the development processes of plants and animals with examples	29, 30, 24, 36, 28, 32, 21, 22, 31,	23, 26, 12, 16, 34, 39, 35, 4, 6, 8, 27, 5, 10, 38	15, 20	18, 19, 9	42	
LO3: Explaining the factors affecting animals' and plants' growth and development.		14		40	41	

Even though there are various ways to evaluate whether or not a test is reliable, Coefficient Alpha Kuder Richardson (KR) was applied for the current study. According to Şencan (2005), if a test has questions at approximately equal difficulty levels, KR21 is appropriate to evaluate its reliability; on the other hand, if the difficulty levels of questions are not equal to each other, KR20 is more appropriate to evaluate a test's reliability. In this sense, because the difficulty levels of questions used in the achievement test differed from each other, KR20 Coefficient Alpha was applied in this study.

One of the most common methods to evaluate the scale validation is the *upper 27%* and *lower 27%* groups method (Baykul, 2000). In this method, the first 27% and last 27% of correct answers of each questions are used, and the two main issues of item difficulty and item distinctiveness are considered (Baykul, 2000). Those criteria and their cutoff points are shown in Table 3.10 and Table 3.11, respectively.

Table 3.10 Item Difficulty Points

	Value	Decision
	0 – .19	Too difficult
	.20 – .39	Difficult
p	.40 – .59	Moderately difficult
	.60 – .79	Easy
	.80 – .99	Too Easy

Note. Adapted from Baykul (2000)

Table 3.11 Item Distinctiveness Points

	Value	Decision
	0 – .19	Distinctiveness is too low, needs to be removed
r	.20 – .29	Needs to be revised, cannot be used in this form
	.30 – .39	Distinctiveness is normal, but can be improved
	.40 – .99	Distinctiveness is too high

Note. Adapted from Baykul (2000)

Since the number of the questions, 55 in total, was high for a one-shot test, the students answered the questions in two phases. While 25 multiple-choice questions were applied in the first phase; 15 fill-the-blanks, and 15 true/false questions were applied in the second phase. In total, 94 students in the 7th grade who took the same course during the previous year participated in the first version of the achievement test during the pilot study. All answers taken from the participants were entered to an Excel spreadsheet, then the number of correct answers for each question was calculated, and the correct answers in the upper 27% and lower 27% groups were filtered. In the next step, *p* and *r* values for each question were calculated separately. For distinctiveness of the item, .3 was taken as a basis according to Baykul's (2000) criteria. Items whose distinctiveness values were lower than .3 were removed from the achievement test.

According to this elimination method, six multiple-choice, four fill-the-blanks, and seven true/false questions were removed from the test, and the KR20 reliability coefficients were calculated separately. While the KR20 value for the first phase was found to be .72, the value for the second phase was found to be .70. A test having a reliability coefficient of .70 and above is generally considered as reliable (Büyüköztürk, Akgün, Özkahveci, & Demirel, 2004; Fraenkel & Wallen, 2009). Therefore, the achievement test for this study can be considered reliable with its reported coefficient reliability values. Finally, an achievement test with 38 questions (19 multiple-choice, 11 fill-the-blanks, and eight true/false questions) was adapted. The *p*, and *r* values for each question are as shown in Table 3.12 and Table 3.13, respectively.

Table 3.12 p and r values for multiple-choice questions

Questions	p_i	r_i
Q1	.55	.62
Q2	.48	.67
Q3	.60	.43
Q4	.62	.48
Q5	.31	.52
Q6	.45	.81
Q7	.62	.76
Q8	.74	.52
Q9	.57	.57
Q10	.52	.30
Q11	.62	.67
Q12	.67	.67
Q13	.43	.57
Q14	.45	.33
Q15	.45	.52
Q16	.29	.30
Q17	.67	.67
Q18	.67	.57
Q19	.38	.38

Table 3.13 p and r values for fill-the-blanks and true/false questions

Questions	p_i	r_i
Q1	.52	.63
Q2	.71	.50
Q3	.73	.46
Q4	.52	.71
Q5	.81	.38
Q6	.56	.63
Q7	.42	.75
Q8	.56	.79
Q9	.52	.71
Q10	.50	.67
Q11	.54	.58
Q12	.27	.38
Q13	.63	.50
Q14	.56	.63
Q15	.60	.63
Q16	.69	.31
Q17	.48	.52
Q18	.67	.33
Q19	.54	.46

While 38 questions previously mentioned were used in the pretest, four more questions related to *analyze* and *evaluate* levels in Bloom's revised taxonomy were also added to the posttest. One question out of four was a multiple-choice question at the *analyze* level, and another three questions were open-ended, of which one was at the *analyze* level and the other two were at the *evaluate* level. Therefore, there were a total of 42 questions used in the posttest (see Appendix E).

D. Digital Story Creation Process Evaluation Form

This form was created by the researcher in order to capture some demographic data of the students, their experiences while creating digital stories, and some aspects of the digital story creation process. The form was developed based on the researcher's observations, and revisions were provided by an expert from the related field. The final version of the form was composed of 21 questions illustrating the demographics (Questions 01-07) of the students, the overall process (Questions 11, 15-18, 20-21), and the phases (story writing [Questions 08, 12-13], storyboarding [Question 09], digital story creating [Questions 10, 14, 19]) of the process. The types of questions were Yes/No (closed), fill-the-blanks, ordering, and checking questions. It was expected that this form (see Appendix F) would support some descriptive information in order to examine the digital story creation process in detail, and would enable the interpretation of the entire study process.

E. Digital Story Evaluation Rubric

The last quantitative data collection instrument applied in this study was a three-point, Likert-type rubric anchored with *poor*, *average,* and *good* options, with 20 items under 14 themes. The rubric was utilized in order to evaluate the DSs created by the students. The themes in this rubric mainly measure the visual quality, technological features, instructional features, and content of the digital stories created by the students. Before creating this rubric, many common digital storytelling rubrics in the literature (Barrett, 2006; Behmer, 2005a; Campbell, 2012; Frazel, 2010; Patton, 2007; Sadik, 2008; Schrock, 2015; Teehan, 2006) were examined, and the most common items selected. For revisions and content validity, the view of an expert from the related field was taken. Finally, a three-point, Likert-type rubric with verbal statements of (1) Poor, (2) Average, and (3) Good was created by the researcher. The minimum score for this scale was 20, with a maximum of 60.

For the reliability of this rubric, inter-rater reliability method was applied. One independent rater who was experienced in evaluating digital stories and the researcher individually scored 20% of the digital stories selected at random. Pearson correlation coefficients were used for the inter-rater reliability of the rubric. According to Fraenkel and Wallen (2009), the higher the correlation, the higher the reliability. The Pearson coefficient value for this rubric was found to be .84, which indicates good consistency between the raters. The themes in the evaluation rubric (see Appendix G) are briefly explained in Table 3.14.

Table 3.14 Digital Story Evaluation Criteria

Themes	Description
Title and Title page	Creative/remarkable title for the story. Cast introduced by writing names to a title page.
Introduction of the story and characters	An effective or intriguing introduction. Story characters introduced by the students.
Dramatic question	Opening statement or question to grabs the audiences' attention.
Creativity	Using the imagination, and different/effective narrations to make stories more fascinating.
Pacing/clarity of speech	Good rhythm and verbal punctuation from the storyteller. Taking care with clarity and pacing of narration.
Quality of the visuals and recordings/sounds	Appropriate resolution of pictures used. Clarity/appropriateness of the recordings and sounds.
Environment	Details given of where and when the events happened.
General structure of the story	Length of the story. Statements used in the story. Amount of details used in the story. Overall organization of the story.
Grammar and use of language	Usage of different words/verbs. Grammatical errors.
Focusing on the subject	Focused on science course subjects. Story included integration of relevant subjects. Being *to the point*.
Content	Stories fully completed. All related content provided.

3.5.2. Qualitative Data Collection Instruments

Qualitative data for the current study were collected using two different instruments. An observation guide, and an interview form was created by the researcher with the help of related literature and expert views. All of the data were collected under the researcher’s control, and a pilot study for each instrument was conducted for the content and construct validity. Details about each instrument are as follows:

A. Observation Guide

Patton (2002) stated that “observation is meant to illustrate what such a descriptive account is like” (p. 23), and observational analysis is applied in order to allow the reader to understand the setting in detail. Therefore, observational data is expected to be sufficiently descriptive. In accordance with this purpose, an observation guide providing descriptive data for the experimental groups was needed. Based on observation forms found in the literature, a purposive observation form was developed by the researcher. The content and construct validity of the form was provided by expert review. The items were selected according to the study setting. The issues taken into consideration in the creation of the observation form were the following:

- Construction of the study groups (in group, and individual),
- Instructional environments (classroom, and laboratory)
- Technological background (school)
- Information given by the students (especially when at their homes)

The themes included in the observation guide were mainly adapted to explore frequently asked questions, and the occurrence of problems, to understand which tasks students could or could not do, to determine motivation of aspects, to examine the effects of feedback, and to elaborate their relations in groups while creating digital stories (see Appendix H). Results taken from the observation guide were used to describe the features of the study groups’ and the study’s settings in detail in order to ensure an in-depth understanding was gained about the study.

B. Interview Form

In order to have an in-depth understanding about the DS creation process, to examine the students’ experiences while creating their digital stories, to learn their opinions about all stages of the study, and to elaborate upon other situations encountered during the study, an interview protocol was also required to collect the qualitative data. Since the wording and order of the questions were predetermined; all questions were asked to the interviewees in the same order; and all questions were worded in an open-ended format using a standardized open-ended interview (Patton, 2002) form developed by the researcher. Expert opinion was also sought with regards to the content validity of the interview form. With the help of this form, it was mainly aimed to

- specify students' opinions about creating digital stories on a science course,
- learn their experiences from this process,
- clarify any difficulties they faced in this process,
- determine the barriers to/enablers of creating digital stories on a science course,
- explore other possible factors affecting this process.

In light of these purposes, 11 open-ended and two demographics questions were used in the interview form during the pilot study. Content and construct validity of the interview form was provided by two experts. The issues considered during the validation process of the interview questions were their clarity, understandability, and suitability to the stated research questions. After a pilot experiment that lasted almost one and half months, interviews were performed with 25 volunteer students (14 from Experimental Group 1, and 11 from Experimental Group 2). The results showed that some revisions and changes were required to the interview form. In particular, additional questions were needed for Experimental Group 2 (collaborative group), and some questions also needed to be divided into two sub-questions. Moreover, two questions were removed due to their redundancy. All of these revisions and changes were applied under the guidance of experts. In the final version of the interview form, there were nine questions for Experimental Group 1, and 12 for Experimental Group 2 (see Appendices I and J).

3.6. Researcher's Role

It is assumed that the researcher's role in quantitative studies is theoretically non-existent. Participants in a quantitative study act as if the researcher is not part of the study setting (Simon, 2011). However, when it comes to a qualitative study, the researcher's role differs. The researcher becomes the main instrument collecting the qualitative data (Marshall & Rossman, 2006; Patton, 2002). While conducting a qualitative research study, the researcher should describe the relevant aspects without bias, assumptions, or expectations (Greenbank, 2003). Furthermore, the qualitative researcher should act as unbiased throughout all phases such as data collection, or data analysis of the study.

In the quantitative phase of the current study, the researcher monitored and guided the story development process, and all data were collected under the researcher's control. Participants independently responded to the data collection instruments, and all the required analyses were run, and results reported without bias from the researcher. The researcher provided feedback to the students, as well as additional information about the implementations when needed. Moreover, the researcher avoided the giving of biased guidance throughout the study. During the qualitative phase of the study, the researcher acted as the main instrument of the study; asking probing questions during the interviews, and listening to the participants carefully in order not to mislead or misunderstand them. At the end of the study, the interviews were performed under the researcher's control, but avoided influencing the responses of the interviewees. All of the interviews were audio-recorded by the researcher, and them transcribed verbatim, and unbiased results subsequently reported.

3.7. Data Collection Procedures

The data collection procedure of this study is detailed under two phases.

3.7.1. Quantitative Data Collection Procedure

All of the data collection instruments were applied at various time periods during the study. In the quantitative phase, five different instruments were administrated. Of those five instruments; the achievement test, MSLQ, and attitude scale were first implemented prior to the application phase of the study. Then, the researcher informed the participants about what they would be doing during the study, and the necessary introductions and presentations made. Next, the participants were involved in an experimental study process by writing stories, designing storyboards, and creating digital stories over a period of three months. During this process, the Control Group were assigned traditional homework (see Appendix R) that was related to the course subjects. After the implementations had finished, the same data collection instruments were readministered as post-data collection instruments.

Apart from those instruments, a digital story creation process evaluation scale was used in order to evaluate the experimental process of the study in detail. All participants in the two experimental groups responded individually to the questions in this scale at the end of the study. Finally, a digital storytelling evaluation rubric was used in order to evaluate each of the digital stories that had been created by the students.

3.7.2. Qualitative Data Collection Procedure

In the qualitative phase of the study, two instruments were administrated. An observation guide was used during the study; which was expected to help illustrate the study setting in detail. At the end of the study, a standardized open-ended interview form was administrated to small focus groups. During focus group interviews; the interviewees can more easily engage with the environment, the qualitative data becomes more useable, interactions amongst interviewees can occur and are influenced by each other, the group dynamic might increase, an idea coming from one group member can be enhanced by another so that more detailed data can be gathered, and the researcher can see the whole picture of the setting (Krueger, 2002; Lewis, 1995). Therefore, before the interviews, the researcher divided the participants into small groups.

At the beginning of the interviews, some time was spent to make sure the students appeared relaxed, and to answer any questions they might have. Then, the researcher informed all of the interviewees about the purpose of the study and the interviews, and also with regard to the importance and benefit of their providing honest responses. The researcher advised the interviewees that they would be voice-recorded as long as they did not object. When the researcher was certain about the convenience of the interview setting, the interviews commenced. During the interviews, the researcher was careful to ask the questions clearly, in a non-leading and open-ended manner, and at a speed and rate that was convenient to the interviewees. Since the interviews were held in small groups, the researcher was careful to allow each interviewee to talk about the question, and listened to them carefully without interrupting them as they responded. Follow-up questions were asked by the researcher when needed in order to gain an in-depth understanding about their responses. The researcher was also careful about body language and gestures made while conducting the interviews.

All interviews were held face-to-face. Because there were two experimental groups in the study, the number of interviewees in each group differed. While interviews for Experimental Group 2 were held with specific students already assigned to their workgroup, some issues existed in order to divide the interviewees into groups from Experimental Group 1. Those issues were a) presence of the interviewees in the class when interviews were held, b) their performance while creating their digital stories, and c) number of all interviewees. One student from Experimental Group 1 did not participate in the interview due to health issues, so that in total there were 30 students interviewed from Experimental Group 1. Interviews for this experimental group were held on a group by group basis with different numbers of interviewees (one group of eight, two groups of seven, one group of five, one group of two, and one individual) because of the aforementioned issues. In Experimental Group 2, three of the students did not attend school when the interviews were held, and one who was an inclusive student (special needs student studying within an inclusive education school); therefore, 22 out of the 26 students in Experimental Group 2 participated in the interviews. The already assigned workgroups had been formed with two, three, or four students, and so there were eight different groups. Interviews were held group by group. Since the number of interviewees in each group differed, interviews lasted from between six to 32 minutes long. After each interview had finished, the researcher made sure that the interview had been successfully audio-recorded. All of the interviews were held in this manner.

3.8. Data Analysis

In this study, the collected data were analyzed separately for the quantitative and qualitative phases.

3.8.1. Analysis of the Quantitative Data

In order to analyze the quantitative data of the study, SPSS 23.0 and LISREL 8.8 package programs were used. While descriptive and inferential statistics were reported by applying the SPSS 23.0 software, CFAs for the instruments were provided by using LISREL 8.8. Reliability of the instruments were checked with regard to Cronbach Alpha, and KR20 Coefficient Alpha values. As a rule of thumb, .70 was taken as a basis for both the Cronbach Alpha coefficients (Field, 2009) and the KR20 Coefficient

Alpha (Büyüköztürk et al., 2004; Fraenkel & Wallen, 2009). Values for each instrument were reported in the Data Collection Instruments part of this study.

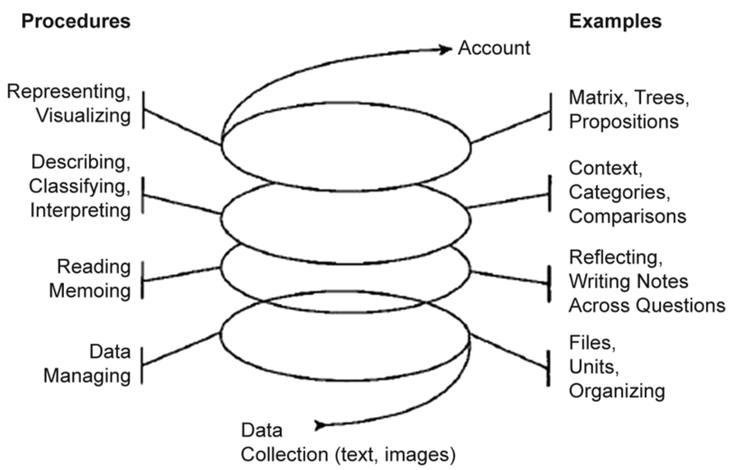
In addressing the first research question, Paired-samples *t*-tests, and Analysis of Covariance (ANCOVA) tests were performed. First, Paired-samples *t*-tests were used in order to check if there was a significant difference within the groups' pretest and posttest achievement scores. Then, ANCOVA test was applied to compare the study groups in terms of their achievement scores. Because it was known that there were some variables (such as pretest scores) influencing the dependent variable (Field, 2009), ANCOVA tests were more appropriate to compare the mean scores of the study groups. In addition to the assumptions of Analysis of Variance's (ANOVA), independence of covariance and homogeneity of regressions slopes (Field, 2009) were checked and reported in the related part of the study.

For addressing the second, and third research questions of the study, ANOVA tests were applied so as to compare the ratio of systematic variance to unsystematic variance (Field, 2009) in the current study. In other words, mean differences between and within the study groups were tested by using those analyses. Required assumptions for ANOVA tests such as normality, homogeneity of variances, and assumption of independence (Field, 2009) were checked and reported in the Results chapter. Furthermore, Paired-samples *t*-tests were conducted in order to respond to both questions. Since the participants were applied the attitude toward using digital storytelling method scale both before and after the study, this analysis method was required in order to be able to see whether this method had any effect on the participants' attitude scores.

Lastly, descriptive statistics were applied in order to address the fourth and fifth research questions. Those questions illustrate the digital story creating process with particularly descriptive items. Therefore, means, standard deviation, and frequencies of the related items in each instrument were calculated and reported in the Results chapter of this study.

3.8.2. Analysis of the Qualitative Data

Collected qualitative data for the current study were analyzed through content analysis. In this regard, Creswell's (2007) qualitative data analysis spiral (see Figure 3.3) guided the researcher. This spiral includes four main steps in order to allow a researcher to walk self-assuredly through the data analysis process and in reporting the results. Those steps are 1) data management, 2) reading and memoing, 3) describing, classifying, and interpreting, and 4) representing and visualizing.



Source: Creswell (2007)

Figure 3.3 - Qualitative data analysis spiral (Creswell, 2007)

The first loop of the spiral is *data management,* which includes the transcription and organization of the recorded data. During this step, the researcher transcribed all of the recorded data, and organized the data. Then, the transcribed data were entered into computer files, and listed according to study groups in order to make the analysis easier. Then, the researcher passed to the second loop once certain that all of the data were ready for analysis.

In the second loop, *reading and memoing,* the researcher is led to read all of the transcribed data several times over, and then to write some related memos about the data. After all transcriptions had been completed, the researcher read them all many times in order to get a real sense of the interviews, and in order to understand the data as clearly as possible. While reading, required memos of possible themes, categories, ideas, and phrases were noted by the researcher.

In the third loop, *describing, classifying, and interpreting*, Creswell (2007) suggested that researchers describe their data in detail, to develop related codes and themes, to place them within appropriate categories, and finally to provide their own interpretations by considering the related literature. Researchers are expected to explain what they see in the data, and how they categorize the data according to the literature. In light of these suggestions, the researcher started coding the data. During this process, the researcher read all of the transcribed interviews very carefully, and highlighted important segments such as sentences or words that could possibly address the research questions of the study. All codes were created by rereading the transcripts many times over. Lastly, the researcher removed any redundant or overlapping codes in order to describe the data more efficiently.

After all the codes were developed by the researcher, the next step was to construct the themes to include related codes. While identifying the themes, the researcher studiously read all the codes and gathered similar codes representing similar issues or concepts in order to find a general theme name to represent them. The researcher also considered the related literature when creating the themes. Another issue that the researcher took into consideration was the internal homogeneity and external heterogeneity of the themes. In other words, the researcher made sure that all of the codes under same theme held together in some meaningful way, and that the differences between the themes were clear and sharp. Lastly, the researcher contributed to the process by applying his own understanding and taking a subject matter expert's views as well. In this manner, the categories were clarified in making final interpretations.

In the last loop of the spiral, *representing and visualizing*, Miles and Huberman (1994) emphasized that using some visual forms (such as tables, graphs, or figures) when displaying results is a good way of allowing the details to be better seen. In line with this recommendation, the researcher provided tables to presenting some of the results (including themes and codes).

3.9. Assumptions of the Study

While reporting the results of this study. It was assumed that;

- The data were collected from each study group under the same conditions, and that their responses were accurate.
- The participants were honest while responding to the data collection instruments.

- All measures of the study were reliable and sufficiently valid to present accurate results.
- Creating small focus groups enhanced the qualitative data.
- The results of the study were assessed and reported unbiased by the researcher.

3.10. Limitations of the Study

- The research results are limited to the responses of the students chosen from a public middle school in Ankara, Turkey.
- The validity and reliability of the study are limited to the honesty of the participants' responses to the data collection instruments.
- The generalizations and implications are limited to the results of this study within the participation of selected public school students.

3.11. Validity and Reliability of the Study

Validity and reliability issues in a study are mainly applied to enhance the accuracy of the results of the study (Tavakol & Dennick, 2011); meaning that such concepts are used in order to increase the value of a study. They may have various meanings in regard to different research studies (Creswell, 2014). While Fraenkel, Wallen, and Hyun (2012) defined validity as "the appropriateness, meaningfulness, correctness, and usefulness of the inferences a researcher makes" (p. 147), Thatcher (2010) stated that validity is "the extent to which any measuring instrument measures what it is intended to measure" (p. 125). Reliability is defined as "the consistency of scores or answers from one administration of an instrument to another, and from one set of items to another" (Fraenkel et al., 2012, p. 147), whilst Twycross and Shields (2004) stated that reliability refers to the consistency, stability, and repeatability of the findings in a study. According to LeCompte and Goetz (1982), mixed-methods research designs can apply various validity and reliability strategies due to their having elements of both quantitative and qualitative data. In line with these definitions and suggestions, various validity and reliability procedures were employed in the current study.

3.11.1. Validity and Reliability of Quantitative Phase of the Study

Measurement validity, internal validity, and external validity were considered in order to shed light on the validity procedures of the quantitative phase of this study.

In order to enhance the measurement validity of the study, valid and reliable instruments most commonly used in the literature were applied in this study. Even for those instruments previously reported as valid and reliable, confirmatory factor analyses were reapplied so as to confirm their factor structure for the current study's sample. Besides, expert views from various subject matter experts were sought in order to enhance the content validity of the instruments developed by the researcher, and the final version of each instrument was reviewed by specific subject matter experts.

Internal validity particularly in experiments refers to the extent to which control was achieved during the data collection process (Ryan et al., 2002, as cited in Ihantola & Kihn, 2011). In other words, possible threats during data collection of a study should be determined and addressed in order to increase the internal validity of the study. In this regard, a pilot study was conducted prior to the main study, the researcher was then able to identify problems likely to occur, and the required revisions, changes, and precautions were then taken.

External validity refers to the generalizability of the results based on population, time, and environmental settings of the study (Ryan et al., 2002, as cited in Ihantola & Kihn, 2011). Demographics of the population, the time period of a study, and its environmental settings should be elaborated upon in the study in order to draw general conclusions by answering questions like whether or not the sample size of a study is adequate, whether or not the study can be conducted in different time periods, and whether or not the results can be generalized according to its environmental settings. Therefore, all of the issues (population, time, and environment) pertinent to external validity were considered by the researcher and details provided in the relevant chapters of the current study.

Lastly, for the reliability of the quantitative results, KR20 Alpha Coefficients (for achievement test), and Cronbach Alpha Coefficients (for the remaining quantitative data instruments) were applied in order to report on instruments' internal consistency. A value of .70 was taken as the basis for both coefficients to indicate good internal consistency (Büyüköztürk et al., 2004; Fraenkel & Wallen, 2009; Hair, Black, Babin, Anderson, & Tatham, 2006). Apart from those reliability types, *inter-rater reliability* was also applied in order to score the digital stories created by participants. Landers (2015) emphasized that when the data are quantitative and there are only two raters, Pearson Correlation can be an estimator of inter-rater reliability. Moreover, Fraenkel and Wallen (2009) stressed that at least .80 or .90 correlation among scorers is accepted as the desired reliability of a study's results, and eight to 12 observation/scoring periods are normally required to obtain adequate evidence. In this regard, an independent rater having experience about scoring digital stories was selected for this process. The researcher and the independent rater separately scored eight different randomly selected digital stories by using a scoring rubric, and then compared their results.

3.11.2. Validity and Reliability of Qualitative Phase of the Study

By taking the validity and reliability of the qualitative phase of the study into consideration, a researcher expects to convince their audience that the research findings are worth paying attention to (Lincoln & Guba, 1985). Therefore, various strategies can be applied so as to enhance the validity and reliability of the qualitative data. For the current study, internal validity, external validity, reliability, and objectivity were explained by applying credibility, transferability, dependability, and confirmability (Guba & Lincoln, 1989; Lincoln & Guba, 1985) factors for the trustworthiness of the qualitative findings. Furthermore, *inter-rater reliability* method was applied in order to prove that the results of qualitative data of the study are reliable.

Credibility is in preference to internal validity (Guba & Lincoln, 1989). As Merriam (1998) stated, credibility deals with the degree of reality for a study's reported findings. To be able to provide credibility for the findings of the current study, the researcher firstly established early familiarity with the participants before collecting any data. In other words, the required amount of time was spent with the participants in order to gain their trust before conducting the interviews. Secondly, the researcher ensured the honesty of interviewees while conducting the interviews. To achieve this goal, each participant was given the opportunity to decline participation in the study, or to take breaks away from the study if needed. Participants were encouraged that within the information they would give, that there would be no right or wrong answers to the questions being asked to them, and it was emphasized that their experiences would contribute to the study. By doing this, it was aimed that the interviewees might feel that they could share their experiences without unnecessary fear or anxiety. Thirdly, frequent debriefing sessions were undertaken with the researcher's colleagues and academic advisors. Such collaborative sessions enabled the researcher to learn about alternative approaches, and to recognize whether or not biases were held while conducting the interviews. Fourthly, member checks were provided by the researcher. For this process, the participants were asked to listen to their recorded dialogue in order to confirm whether or not their spoken words adequately matched what they actually intended to say. Finally, as Silverman (2000) emphasized, examination of previous study results was a key criterion for assessing works of qualitative inquiry. For the current study, the researcher examined previous study's results in order to evaluate the degree to which the results of the current study were congruent with them.

Transferability is in preference to external validity and generalizability (Guba & Lincoln, 1989), and Merriam (1998) stated that external validity is related to the extent to which one study's results can be applied to other situations. In order to provide transferability of the qualitative data for the current study, the researcher informed his audience about the number of participants, sample size issues, sampling type, the employed data collection methods, the number and length of the data collection phases, and the time period over which the data were collected. In doing so, other researchers could more easily decide whether or not they were able to apply the current study's results to other situations.

Dependability is in preference to reliability (Guba & Lincoln, 1989), and it deals with the congruency of the researchers, data across time, and analysis methods (Gasson, 2004; Guba & Lincoln, 1989). To be able to provide dependability for qualitative data in the current study, the researcher considered the research design and its implementation that described what was planned and executed; the operational detail of the collected data that addressed the details of what was undertaken in the field; and the reflective appraisal of the study so as to evaluate the effectiveness of the process.

Confirmability is in preference to objectivity (Guba & Lincoln, 1989), and Patton (1990) defined objectivity as the use of instruments that are independent from human skill and perception. To be able to provide confirmability of the qualitative data, the researcher applied an audit trial that enabled representation of the current study step-by-step via indicating the decisions taken and in describing all of the procedures. This audit trial included the interview recordings and notes, the original transcripts, and the data analysis documents.

Lastly, inter-rater agreement method was applied to enhance the reliability of the qualitative findings of the current study. An independent rater having experience with qualitative data analyses was selected for the current study. From the interviews' qualitative data, 20% was randomly selected, and the independent rater and the researcher analyzed the data separately and created their own themes and codes. In doing so, 12 themes were created between the two inter-raters. In other words, both the independent rater and the researcher reached agreement on all the themes they created. Under those themes, a total of 88 different codes were determined by the inter-raters. While there was agreement on 74 of the codes, the remainder were initially not agreed, and therefore the inter-rater reliability was calculated as being 84%, which indicated a good level of consistency according to the suggested cutoff point (at least 80%) stated by Miles and Huberman (1994). The themes and related codes that were agreed or disagreed by the inter-raters are presented in Appendix K.

After the two raters had determined their own codes, they met to talk about the codes. The main reasons behind disagreements were overlap and having omitted certain codes. In other words, when those codes that were disagreed upon between the inter-raters, both parties reread the data, and realized that they had missed some important codes. Furthermore, some of the codes – particularly codes placed under the *Positive Effects of DST Use in Science Education* theme – had elements of overlap. Even though such disagreements occurred, when the two raters talked about the codes in detail, they were able to reach consensus and agree on a final version of the emerged codes.

CHAPTER 4

RESULTS

This chapter presents the findings in order to address the five research questions of the current study. First, pretest and posttest results of the study groups are examined in terms of their academic achievement during a 6th grade middle school science course. Second, learning strategies used by the students are elaborated upon both within and between the study groups. Third, the students' attitudes toward creating DSs on a science course are presented in terms of the experimental groups, and also on any differential based on gender. Fourth, students' opinions about the use of DST on a science course, their experiences during the process, and frequencies related to the preferences of the students are described. Lastly, the DSs created by the experimental groups' students are evaluated in terms of the various components of a digital story.

4.1. Academic achievement test score differences of Science course students

Research question one has two sub-questions. When Paired-samples *t*-tests were employed in order to address the first sub-question; and Analysis of Covariance (ANCOVA) test was used for the second sub-question. Before reporting the results for the related question, assumptions – Normality, Homogeneity of variance, Independent observation, Interval /ratio scale for dependent variable (DV)/covariate (CV), Linear relationship between DV and CV, Outliers for DV and CV, Homogeneity of regression coefficients – for both tests were checked.

Normality

For normality assumption, Skewness and Kurtosis, histograms, Q-Q plots and outliers were observed. Skewness and Kurtosis values for all groups ranged between -3.0 and +3.0, which are considered normal. Even the researcher was undecided when interpreting the histograms as to whether or not they showed normal or negatively skewed distribution. The researcher decided that the histograms (see Figure 4.1) showed negative, but not extremely skewed distribution. The histograms can be independently interpreted by readers from checking the visuals in Figure 4.1.

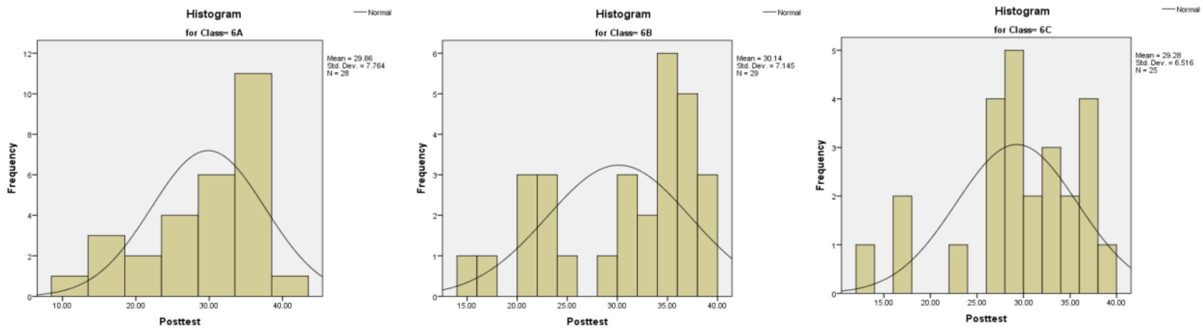


Figure 4.1 - Histograms for independent variables

Moreover, the Q-Q plots presented normal distribution, that is, cases on the Q-Q Plots for the study groups ranged closer to the reference line.

Homogeneity of Variance

Levene's statistics value was observed for homogeneity of variance. This value was found to be .81 which was greater than .05 and therefore non-significant. Since a non-significant result for this value is desirable in ANCOVA tests, this homogeneity of variance result for both tests can be said to be satisfied.

Independent Observation

It was assumed that observations within each group were independent, that is, the collected data from one group did not affect another.

Interval/Ratio Scale for DV and CV

It can be stated that the dependent variable – which was the posttest scores of the participants – were continuous and that this is as desired for ANCOVA. Additionally, the CV – pretest scores of participants – was also continuous, which again is as expected for ANCOVA. Therefore, this assumption was also met for the required analyses.

Linear Relationship Between DV and CV

Scatter graphs were observed to assess the linear relationship between the dependent variable and the covariate. According to the researcher's observations, it may be interpreted that linearity between the posttest (dependent variable) and pretest (covariate variable) was provided.

Outliers for DV and CV

According to the results of this assumption, only one case (Case 82) in Experimental Group 2 appeared as an outlier. The researcher concluded that there were no extreme differences in the results when this outlier case was eliminated, and so it was not removed from the study groups, and the results reported to include this single outlier case.

Furthermore, Cook's Distance and Leverage values were checked for outliers. The results concluded that there were no values greater than 1, a result which supported Cook and Weisberg's (1982) criterion that Cook's D value should be less than 1 in order to indicate the overall influence of a case. For Leverage values, according to Field (2009), all values should be between 0 and 1. For the current study, this was the case and all values for Leverage test were found to be between 0 and 1. Both Cook's D and Leverage values showed that there were no outliers for DV and CV.

Homogeneity of Regression Coefficients

The assumption for homogeneity of regression coefficients is that the slope of regression between the DV and CV within each cell is an estimate of the same population regression coefficient. A significant interaction between the covariate and the factor suggests that the differences on the dependent variable among groups vary as a function of the covariate. Normally, the expected result for this assumption is non-significant interaction between the covariate and independent variables. In this manner, while checking the interaction between pretest scores and study groups for this study, the results demonstrated no significant interaction existed between the two variables ($p = .48 > .05$). Thus, it can be interpreted that the homogeneity of regression coefficients assumption was met for the current study.

4.1.1. Academic achievement test score differences within groups

Paired-samples *t*-tests were conducted in order to compare the pretest and posttest scores within the groups in terms of their academic achievement on a science course. The results presented in Table 4.1 show that the academic achievement scores for all study groups dramatically increased from the pretest to the posttest scores. As can be seen in Table 4.1, the largest mean score difference (16.65) between pretest and posttest belonged to Experimental Group 1. The difference for the Control Group and Experimental Group 2 were 11.57 and 14.72, respectively.

Therefore, creating digital stories in this instance of science education contributed more to the students' achievement scores than did a traditional teaching method.

Table 4.1 Paired-Samples Statistics for Pretest and Posttest Scores

Study Groups	Pretest		Posttest				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Control Group	17.54	4.93	29.11	7.57	27	-9.00*	.00
Exp. Group 1	13.76	6.04	30.41	7.53	28	-8.62*	.00
Exp. Group 2	14.24	4.76	28.96	7.01	24	-8.78*	.00

*$p < .05$, two-tailed.

A Paired-samples *t*-test was conducted in order to compare the pretest and posttest achievement scores of the Control Group before, and after application of a traditional teaching method on a science course. There was a significant difference seen in the scores for the pretest (M = 17.54, SD = 4.93), and posttest (M = 29.11, SD = 7.57; $t(27) = -9.00$, $p < 0.05$). These results suggest that the achievement levels of students in the Control Group increased after they learned the science course topics by way of a traditional teaching method.

Another Paired-samples *t*-test was conducted in order to compare the pretest and posttest achievement scores of the experimental groups before, and after the digital story development process. The findings concluded that there was a statistically significant difference in the scores for the pretest (M = 13.76, SD = 6.04) and posttest (M = 30.41, SD = 7.53) in Experimental Group 1; $t(28) = -8.62$, $p < .05$; and in the scores for the pretest (M = 14.24, SD = 4.76) and posttest (M = 28.96, SD = 7.01) in Experimental Group 2; $t(24) = -8.78$, $p < .05$. These results suggested that creating digital stories individually and collaboratively within a science course contributed to the students' achievement levels.

4.1.2. Pretest score differences between groups

To be able to compare the pretest scores of the study groups, ANOVA test was employed. The descriptive statistics displayed in Table 4.2 reveal that Experimental Group 1 had the smallest mean of the pretest scores (M = 13.76, SD = 6.04) among the groups, and the largest mean of the pretest scores belonged to the Control Group (M = 17.54, SD = 4.93).

Table 4.2 Study Group Means and Standard Deviation Scores

Study Groups	*M*	*SD*	*n*
6A (Control Group)	17.54	4.93	28
6B (Exp. Group 1)	13.76	6.04	29
6C (Exp. Group 2)	14.24	4.76	25
Total	15.20	5.51	82

Based on the one-way ANOVA test results, there was a statistically significant mean score difference revealed between the study groups, $F(2, 79) = 4.20$, $p < .05$. Post hoc tests revealed that pretest achievement scores of the Control Group (M = 17.54, SD = 4.93) were statistically significantly higher than the scores of Experimental Group 1 (M = 13.76, SD = 6.04). On the other hand, there was no statistically significant difference reported between the Control Group and Experimental Group 2; or between Experimental Group 1 and Experimental Group 2.

Table 4.3 One-Way Analysis of Variance Summary Table of Study Groups on their Pretest Scores

Source	*SS*	*df*	*MS*	*F*	*p*
Between groups	236.04	2	118.02	4.20*	.019
Within groups	2222.84	79	28.14		
Total	2458.88	81			

4.1.3. Posttest score differences between groups

Due to the statistically significant mean score difference between the study groups in terms of their pretest scores, an ANCOVA test was employed to compare the study groups in terms of their posttest scores via controlling the pretest scores of the study groups. Before concluding the results of the ANCOVA test, the effect of covariate, which was the pretest score of each participant, was examined. The results presented in Table 4.4 showed that this covariate was found to be significant, $F(1, 78) = 21.79$, $p < .05$, $\eta^2 = .22$. In other words, the pretest scores of the participants were found to be effective on their posttest scores. Therefore, it can be interpreted that this covariate was crucial to the results of the current study. Although, the covariate was found to be significant, the results revealed that the ANCOVA model was found to be non-significant, $F(2, 78) = 1.14$, $p > .05$. This result claimed that there were no statistically significant mean score difference between the study groups in terms of their posttest scores.

Table 4.4 Analysis of Covariance of Posttest Scores as a Function of Study Groups, With Pretest Scores as Covariate

Source	*SS*	*df*	*MS*	*F*	η^2
Covariate	889.87	1	889.87	21.79*	.22
Between	93.17	2	46.59	1.14	
Within (error)	3186.04	78	40.85		
Total	4086.05	81			

$^*p < .05$

Even though no statistically significant difference was found between the study groups, there were small mean score differences seen among the groups. Table 4.5 shows that the number of students in each study group did not vary greatly. While there were 28 students in the Control Group, there were 29 and 25 in Experimental Group 1 and Experimental Group 2, respectively. The total number of participants who took part in the experiments were 88, yet, this number decreased to 82 when the posttests were conducted. As already mentioned, four more questions were added to posttest and required analyses for comparing study groups in terms of their posttest scores were employed based on 42 questions. In other words, if a participant correctly answered the all questions in the posttest, they would receive a maximum score of 42. Among the study groups, Experimental Group 1 had the largest mean score (M = 31.08) with medium standard deviation as 7.67, and Experimental Group 2 had the smallest mean score and standard deviation (M = 29.88, SD = 6.75). On the other hand, the Control Group was situated between the two experimental groups with a mean score of 30.46 and standard deviation of 8.18. Lastly, the total mean score of the achievement test was calculated as 30.50, with a standard deviation of 7.51. In light of these results, it can be said that even though there were no significant mean score differences between the study groups' posttest scores, Experimental Group 1 was more successful than both the Control Group and Experimental Group 2.

Table 4.5 Means and Standard Deviations of Posttest Scores for Study Groups

Study Group	*M*	*SD*	*n*
6A (Control Group)	30.46	8.18	28
6B (Exp. Group 1)	31.08	7.67	29
6C (Exp. Group 2)	29.88	6.75	25
Total	30.50	7.51	82

4.2. Learning strategies differences of students creating digital stories on a science course

In order to address the second research question, Paired-samples t-tests, and ANOVA tests were conducted in order to check whether or not there was any statistically significant difference within and/or between the study groups on their pre- and post-learning strategies scores. Before conducting the required analyses, assumptions for both tests were checked. Those assumptions were Normality, Homogeneity of variance, and Independent observation.

Normality

For normality assumption, Skewness and Kurtosis, histograms, Q-Q plots and outliers were observed. Skewness and Kurtosis values for all groups ranged between -3.0 and +3.0, which indicates they were normal. The histograms (see Figure 4.2) for six learning strategies scores showed both negatively skewed and normal distribution.

Moreover, the Q-Q plots showed normal distribution. In other words, cases on the Q-Q plots of the study groups ranged closer to the reference line.

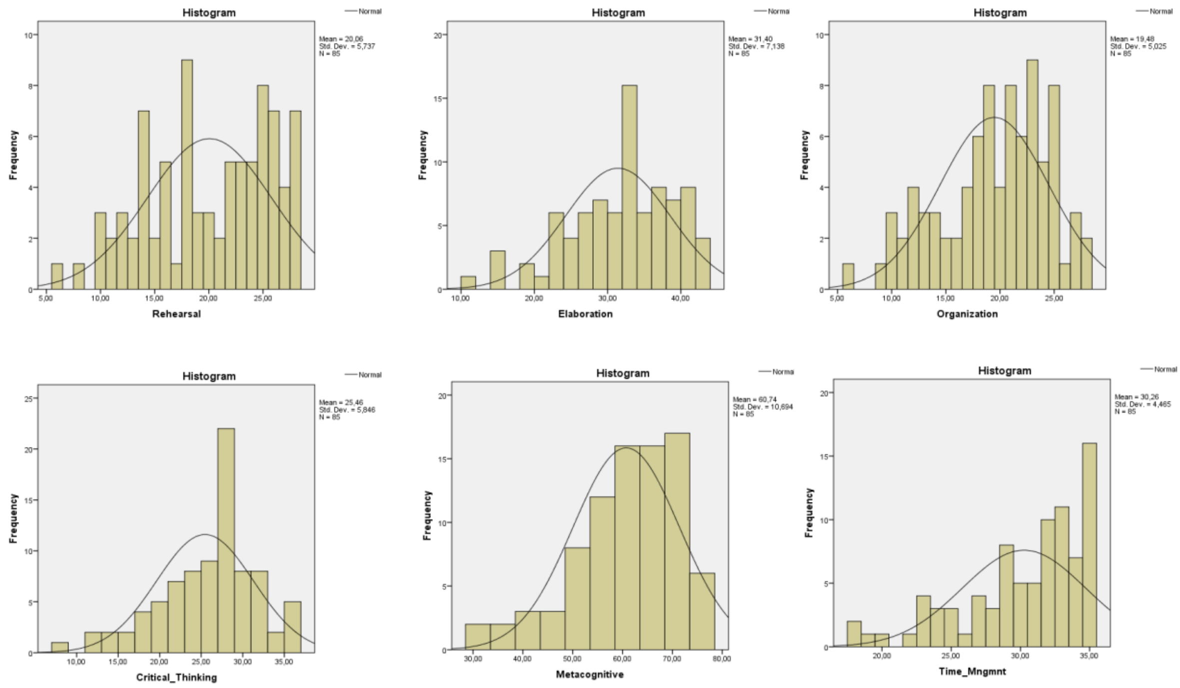


Figure 4.2 - Histograms for six Learning Strategies scores

Homogeneity of variance

Levene’s statistics value for each dependent variable was observed for homogeneity of variance. All values were found to be non-significant. Since non-significant results for this value are desirable to proceed with ANOVA tests, this result claimed that homogeneity of variance assumption for each ANOVA test was satisfied.

Independent Observation

It was assumed that observations within each group were independent. In other words, the collected data from one group did not affect any other group.

4.2.1. Learning strategies score differences of within groups

Paired-samples *t*-tests were applied in order to check for any statistically significant mean differences within the groups' pre- and post-learning strategies scores. The results for each study group are reported as follows, respectively.

Control Group

The descriptive statistics shown in Table 4.6 indicate that there was a very small increase in the mean scores of the metacognitive self-regulation, and time/study environment management subscales of the Control Group. The other subscales showed a reversed situation.

Table 4.6 Paired-Samples Statistics of Pre- and Post-Learning Strategies Scores for Control Group

MSLQ Subscales	Pretest		Posttest				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Rehearsal	4.94	1.69	4.70	1.50	29	.60	.56
Elaboration	4.95	1.36	4.92	1.27	29	.10	.92
Organization	4.87	1.46	4.60	1.24	29	.84	.41
Critical Thinking	4.99	1.22	4.98	1.24	29	.02	.98
Meta. Self-Reg.	5.35	1.27	5.43	1.04	29	-.28	.79
Time/Std. Env. Mng.	5.95	0.97	6.01	0.90	29	-.28	.79

*p < .05, two-tailed.

Results of the Paired-samples *t*-tests concluded that there was no statistically significant mean differences the between pre- and post-scores of the MSLQ subscales. In other words, the traditional teaching method employed on a science course had no significant effect on any of the learning strategies of the Control Group.

Experimental Group 1

Follow-up Paired-samples *t*-tests were run for pre- and post-learning strategies scores of Experimental Group 1. The results depicted in Table 4.7 demonstrate that the mean scores for all of the strategies showed a small increase, with the exception of critical thinking, and time/study environment management in Experimental Group 1.

The Paired-samples *t*-tests results showed no statistically significant mean difference between the pre- and post-scores of the MSLQ subscales. This result reveals that creating digital stories individually had no significant effect on any of the learning strategies of the students on their science course.

Table 4.7 Paired-Samples Statistics of Pre- and Post-Learning Strategies for Experimental Group 1

MSLQ Subscales	Pretest		Posttest				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Rehearsal	5.12	1.22	5.14	1.42	29	-.09	.93
Elaboration	5.18	1.22	5.54	1.07	29	-1.25	.22
Organization	5.11	1.17	5.21	1.22	29	-.30	.77
Critical Thinking	5.32	1.15	5.21	1.13	29	.35	.73
Meta. Self-Reg.	5.55	0.91	5.57	0.93	29	-.09	.93
Time/Std. Env. Mng.	5.93	1.04	5.91	1.00	29	.05	.96

*p < .05, two-tailed.

Experimental Group 2

Lastly, Paired-samples *t*-tests were applied to compare the pre- and post-scores of learning strategies for Experimental Group 2 (see Table 4.8). The results indicated that the mean scores of all learning strategies increased in this experimental group.

Table 4.8 Paired-Samples Statistics of Pre- and Post-Learning Strategies for Experimental Group 2

MSLQ Subscales	Pretest		Posttest				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Rehearsal	4.69	1.35	5.24	1.35	24	-1.66	.11
Elaboration	4.72	1.11	5.24	1.18	24	-1.74	.10
Organization	4.38	1.23	4.79	1.27	24	-1.21	.24
Critical Thinking	4.72	1.24	5.07	1.16	24	-1.24	.23
Meta. Self-Reg.	4.97	1.00	5.57	0.97	24	**-2.38***	.03
Time/Std. Env. Mng.	5.75	1.25	6.26	0.73	24	-1.77	.09

*p < .05, two-tailed.

Even though the mean scores of all the learning strategies increased, the Paired-samples *t*-test results indicated that there was only a statistically significant difference for metacognitive self-regulation strategies of students in this experimental group, $t(23) = -2.14$, $p < .05$. This result claimed that creating a digital story collaboratively on a science course had a significant effect only on the metacognitive strategies of students. A non-significant effect was found for all other learning strategies.

4.2.2. Pre- and post-learning strategies score differences between groups

In addressing this sub-question, ANOVA tests were performed in order to check if there was a statistically significant mean difference between the study groups on their pre- and post-learning strategies scores.

First, ANOVA test results indicated that there was no statistically significant mean difference between the study groups in terms of their pre-MSLQ scores (see Table 4.9).

Table 4.9 Mean Differences on Pre-Learning Strategies Scores

MSLQ Subscales	Control Group		Exp. Group 1		Exp. Group 2				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Rehearsal	4.94	1.69	5.12	1.22	4.69	1.35	87	.61	.61
Elaboration	4.95	1.36	5.18	1.22	4.72	1.11	87	.55	.55
Organization	4.87	1.46	5.11	1.17	4.38	1.23	87	1.01	1.01
Critical Thinking	4.99	1.22	5.32	1.15	4.72	1.24	87	.37	.37
Meta. Self-Reg.	5.35	1.27	5.55	0.91	4.97	1.00	87	2.07	.13
Time/Std. Env. Mng.	5.95	0.97	5.93	1.04	5.75	1.25	87	.34	.34

*$p < .05$, two-tailed.

Because there was no statistically significant difference between the pre-learning strategies scores of the study groups, application of another ANOVA test was found to be relevant so as to examine the post-learning strategies score differences of the study groups. The results concluded that there was no statistically significant difference between the study groups in terms of their post-learning strategies scores (see Table 4.10).

Table 4.10 Mean Differences on Post-Learning Strategies Scores

MSLQ Subscales	Control Group		Exp. Group 1		Exp. Group 2				
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	*p*
Rehearsal	4.70	1.50	5.14	1.42	5.24	1.35	84	1.15	.32
Elaboration	4.92	1.27	5.54	1.07	5.24	1.18	84	2.15	.12
Organization	4.60	1.24	5.21	1.22	4.79	1.27	84	1.87	.16
Critical Thinking	4.98	1.24	5.21	1.13	5.07	1.16	84	.28	.76
Meta. Self-Reg.	5.43	1.04	5.57	0.93	5.57	0.97	84	.19	.83
Time/Std. Env. Mng.	6.01	0.90	5.91	1.00	6.26	0.73	84	1.10	.34

*$p < .05$, two-tailed.

The results revealed that creating digital stories individually or collaboratively had no significant effect on the students' learning strategies when compared to traditional learning on a science course.

4.3. Attitudes of students toward creating digital stories on a science course

The data analysis to address the third research question is threefold. In this regard, Paired-samples *t*-tests and ANOVA tests were applied. Before representing the results for related question, assumptions – Normality, Homogeneity of variance, and Independent observation (Field, 2009) – for ANOVA tests were checked, respectively.

Normality

Normality assumption for the attitude scores of the participants were checked by applying Skewness and Kurtosis, histograms, Q-Q plots, and outliers. Skewness and Kurtosis values for each experimental group participated in pre- and post-attitude scales ranged from between -3.0 and +3.0, which is considered normal. On the other hand, the histograms showed negatively skewed distribution for both pre- and post-attitude scores, respectively (see Figure 4.3).

Additionally, even though the Q-Q plots showed normal distribution for most of the cases, there were a few whose scores moved a little bit away from the reference line.

Lastly, outlier cases were checked. There were a total of four outlier cases; two of which were for pre-attitude scores, and other two for post-attitude scores. In the pre-attitude scores, while Case 12 from Experimental Group 1 and Case 48 from Experimental Group 2 seemed as outliers, Case 11 and Case 50 were the same for post-attitude scores, respectively. Nevertheless, those outlier cases were not removed from the sample because they did not affect the results to a large extent.

Homogeneity of variance

Levene's statistics were observed for homogeneity of variance of both pre- and post-attitude scores of the experimental groups. While this value for pre-attitude scores was found to be .22, it was .06 for post-attitude scores, which were both greater than .05 and therefore non-significant. Since a non-significant result for this value is required to proceed with ANOVA tests, the result claimed that homogeneity of variance for ANOVA test was satisfied.

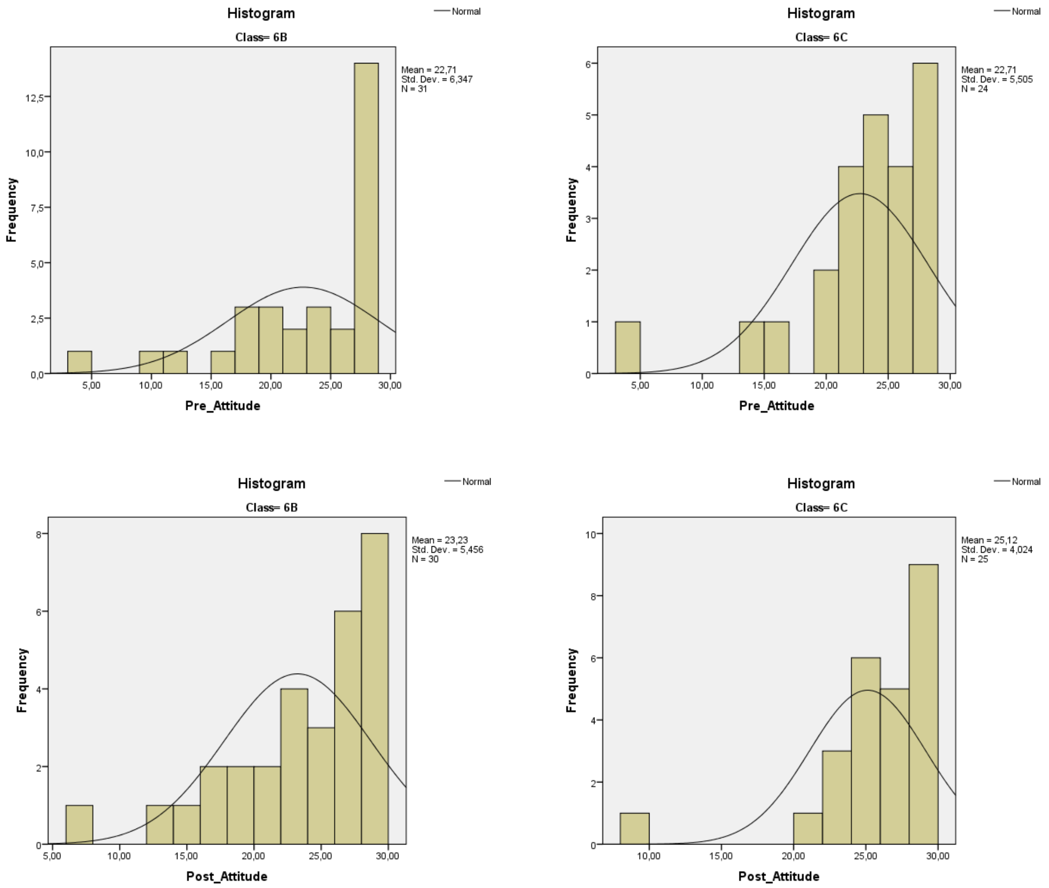


Figure 4.3 - Histograms for pre and post attitude scores in experimental groups

Independent Observation

The observations within each experimental group for both pre- and post-attitude scores were assumed independent. In other words, the gathered data from each group did not affect each other.

4.3.1. Attitude score differences of within groups

Paired-samples *t*-tests were used in order to determine whether or not the participants' pre-attitude scores toward creating a digital story on a science course significantly differed from their post-attitude scores. The attitude score for each student ranged from between 4 and 28. As can be seen in Table 4.11, the attitude scores for both the experimental groups increased. The increase for Experimental Group 2 (from 22.88 to 25.13) was greater than for Experimental Group 1 (from 22.57 to 23.23).

Table 4.11 Paired-Samples Statistics of Pre- and Post-Attitude Scores for Experimental Groups

Study Groups	Pre-Attitude		Post-Attitude				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Exp. Group 1	22.57	6.40	23.23	5.46	29	-.41	.69
Exp. Group 2	22.88	5.50	25.13	4.11	23	-1.64	.12

$*p < .05$, two-tailed.

The Paired-samples *t*-test results indicated that there was no statistically significant difference between the pre- and post-attitude scores of within groups. In other words, creating digital stories individually or collaboratively did not significantly affect the students' attitudes toward creating digital stories on a science course.

4.3.2. Pre- and post-attitude score differences between groups

A one-way ANOVA test was conducted in order to compare the mean differences between Experimental Group 1 and Experimental Group 2 in terms of their pre-attitude scores toward using DST in science education. As indicated in Table 4.12, the results concluded that there was no statistically significant difference between the two experimental groups in terms of their pre-attitude mean scores, $F(1, 53) = .04$, $p > .05$. In other words, the pre-attitude scores of the experimental groups were almost equally distributed.

Table 4.12 One-Way Analysis of Variance Summary Table of Experimental Groups on their Pre-attitude Scores

Source	*SS*	*df*	*MS*	*F*	*p*
Between groups	1.34	1	1.34	.04	.84
Within groups	1904.00	53	35.93		
Total	1905.34	54			

The pre-attitude scores of the experimental groups did not statistically significantly differ from each other. Hence, another one-way ANOVA test was found appropriate in order to see whether or not there was any post-attitude mean score differences between the experimental groups. Table 4.13 shows that there was no statistically significant difference between the experimental groups in terms of their post-attitude mean scores, $F(1, 53) = 2.06$, $p > .05$. In other words, the post-attitude scores of the experimental groups were pretty close to each other.

Table 4.13 One-Way Analysis of Variance Summary Table of Experimental Groups on their Post-attitude Scores

Source	*SS*	*df*	*MS*	*F*	*p*
Between groups	48.54	1	48.54	2.06	.16
Within groups	1252.00	53	23.62		
Total	1300.54	54			

Even though the pre- and post-attitude scores of each experimental group did not statistically differ from each other, there were some mean score differences in the pre- and post-scores for both groups. In the attitude scale, there were four items rated from 1 to 7, with the total attitude score for participants varying 4 to 28. Experimental Group 2 ($M = 22.88$, $SD = 5.46$) had greater pre-attitude scores than Experimental Group 1 ($M = 22.57$, $SD = 6.40$) with a very small mean score difference. The total mean score was 22.71 with a standard deviation of 5.94. The same was found for the post-attitude scores as well, with Experimental Group 2 ($M = 25.12$, $SD = 4.02$) revealing greater post-attitude scores than Experimental Group 1 ($M = 23.23$, $SD = 5.46$) with a considerable mean score difference. The total mean score increased to 24.09 with a decreasing standard deviation of 4.91 (see Table 4.14).

When comparing the pre- and post-attitude scores, the attitude scores increased for both experimental groups with small differences. It can be interpreted that the participants had more positive attitudes after they created digital stories, both individually and collaboratively on their science course.

Table 4.14 Means and Standard Deviations for Attitude Scores of Experimental Groups

	Experimental Groups	*M*	*SD*	*n*
Pre-Attitude	6B (Exp. Group 1)	22.57	6.40	30
	6C (Exp. Group 2)	22.88	5.46	25
	Total	22.71	5.94	55
Post-Attitude	6B (Exp. Group 1)	23.23	5.46	30
	6C (Exp. Group 2)	25.12	4.02	25
	Total	24.09	4.91	55

4.3.3. Attitude score differences in terms of gender

The attitude scores were also examined in terms of the participants' gender. According to Table 4.15, the mean scores for females showed an increase from their pre-scores (M = 21.23) to post-scores (M = 25.96). On the contrary, mean scores for the males decreased from 24.03 to 22.41.

Table 4.15 Descriptive Statistics of Gender on Pre- and Post-Attitude Scores

Gender	Pre-Attitude		Post-Attitude		
	M	*SD*	*M*	*SD*	*n*
Female	21.23	6.99	25.96	2.69	26
Male	24.03	4.54	22.41	5.82	29

*p < .05, two-tailed.

Additionally, a one-way ANOVA test was conducted in order to compare the pre- and post-attitude scores in terms of gender. While no statistically significant difference was found between males and females in terms of their pre-attitude scores; there was a statistically significant difference seen between males and females in terms of their post-attitude mean scores, $F(1, 53) = 8.18$, $p < .05$. This significant difference was in favor of the females, who had greater post-attitude scores compared to the males (see Table 4.16).

Table 4.16 One-Way Analysis of Variance Summary Table of Gender on their Pre, Post-Attitude Scores

Attitude	*SS*	*df*	*MS*	*F*	*p*
Pre-Attitude					
Between groups	107.77	1	107.77	3.18	.080
Within groups	1797.58	53	33.92		
Post-Attitude					
Between groups	172.55	1	172.55	**8.18***	.006
Within groups	1127.99	53	21.28		

*p < .05, two-tailed.

4.4. Students' opinions about creating digital stories on a science course

In order to answer the fourth research question, both quantitative and qualitative data were employed. The quantitative data collection and analysis phase for this question was applied to specifically describe the participants' thoughts/evaluations about the DS creating process from beginning to end. That information was provided through the application of a DS creation process evaluation scale including various questions types. In addition, qualitative data were collected by using a standardized open-ended interview form. In the quantitative phase, there were a total of 57 participants in the experimental groups. Of those participants, 31 were in Experimental Group 1, and the remainder (n = 26) were in Experimental Group 2. However, one participant from each group did not participate in this phase of the study, with one suffering health problems and the other was an inclusive student. Thus, the required data were collected from 55 participants in this phase of the study. Since each participant or study group created two different stories (see Appendix O), prepared two storyboards (see Appendix P), and created two digital stories (see Appendix Q), the number of total participants responding to the questions in the scale might not be 55 in total for all questions; a notable point when interpreting the results. In addressing the research question, the quantitative data results are provided in small measures that combine similar data forms as follows.

4.4.1. Quantitative phase of students' opinions about creating digital stories in science course

In this part, sufficiency of the provided information, documents, feedback and time, preferences of participants while writing their stories, resources used by participants while writing their stories, difficulty level of each phase in the DST process, contribution levels of DST phases to participants' learning, the most challenging tasks in the DS creation process, and participants' willingness and preferences about the DST process were investigated. Each theme is provided under related sub-headings as follows.

4.4.1.1. Sufficiency of provided information and documents

Under this part, participants answered three questions asking whether or not the information given about DST, the information provided for using the Photo Story 3 software, and the documents given with the USB flash drive were adequately sufficient before the experiments began. The results concluded from the students' responses are presented in Table 4.17.

Table 4.17 Frequencies for Information and Document Sufficiency

	Information provided about DS	Information provided about Photo Story 3	Documents provided
	f	*f*	*f*
Enough	55	53	54
Not enough	0	2	1
Total	55	55	55

All participants thought that the provided information by the researcher about DST was adequate to understand what they would be doing. On the other hand, two students thought that the information given by the researcher about how to use the Photo Story 3 software was inadequate and that they needed more guidance about using this program. Lastly, while almost all of the students agreed with the idea that the documents included in the USB flash drive were adequately sufficient, one student thought the opposite. When the question "Is using Photo Story 3 difficult or easy?" was asked to the students, the majority (n = 45) responded that it was easy to use. Yet, 10 students stated as having had difficulties in using the program on occasion.

4.4.1.2. Sufficiency of given time and feedback for three phases of DST

The DS creation process has three main phases which are (1) story writing, (2) storyboarding, and (3) digital story creation. In this manner, the students were asked whether or not the time allocated to each phase, and the feedback for the whole process was sufficient. The results for this question are shown in Table 4.18.

Table 4.18 Frequencies of Responses for Given Time and Feedback

	Time			Feedback
	Story writing	Storyboarding	DS Creating	DS Creating
	f	*f*	*f*	*f*
Enough	49	49	51	52
Not enough	6	6	4	3
Total	55	55	55	55

Most of the students (n = 49) were likeminded, stating that the time allocated for writing their stories was sufficient. The same was the case for the storyboarding phase as well. On the other hand, four of the students thought that the time given for creating their DSs was inadequate.

Additionally, the students were asked whether or not the researcher had provided them with sufficient feedback throughout the whole DST process. According to the results, 52 of the 55 students thought that the feedback provided by the researcher throughout the DS creation phases was sufficient.

4.4.1.3. Preferences of students while writing their stories

While the students wrote their stories, they applied various strategies in order to commence or continue their writing. To be able to specify their responses, six different strategies and an *Other* option were included in the scale. The students were then asked to select one or more of the strategies they used. As each student or group created two digital stories, it should be noted that the total frequency for each strategy may exceed the total number of students (N = 55). The results are shown in Table 4.19.

Table 4.19 Frequencies of Participants' Preferences While Writing Stories

Applied Strategies	*f*
First, I identified my characters in my story.	47
First, I identified my scenario for my story.	41
I started writing my story according to the table of contents.	41
First, I wrote my story, then I added related science course subjects to my scenario.	18
I started writing my story by using storyboard.	15
I started writing my story by using the course subjects randomly.	14

As an applied strategy, identifying the story's characters before writing the story was rated by most of the students (n = 47); then, identifying the scenario before writing the story, and considering the table of content were rated second (n = 41 for both). For 18 students, they first wrote their stories and then added related science course subjects to their scenario; whilst 15 students wrote the story by using storyboard; and lastly, 14 students wrote the story by using the course subjects at random.

Under this part, the students were also asked the question, "What kind of way did you follow when writing your story?" There were four different ways and an *Other* option to help the students answer the questions. The students could choose more than one way when answering the question, and the results are as shown in Table 4.20.

Table 4.20 Frequencies of Ways Followed by Participants While Writing Stories

Ways Followed	*f*
I used my imagination while writing my story	47
I was inspired from a movie/cartoon/video game/book while writing my story.	24
I wrote my story in regard to my future plans	4
I wrote my story by based on an event I had already experienced	1

From Table 4.20, it can be deduced that using imagination while writing the story was the most favored (n = 47); whilst being inspired from a movie/cartoon/video game/book while writing the story was the second most favored (n = 24). In addition, four of the students applied their future plans while writing their stories, and one student stated having applied an event already experienced in life when writing the story.

4.4.1.4. Used resources by students while writing their stories

The students were also asked to specify the most frequently used resources when writing their stories. In this regard, four resources and an *Other* option were given as options for this question, with the students expected to select one or more of the options. The results are shown in Table 4.21.

Table 4.21 Frequencies of Resources Used by Participants While Writing Stories

Resource used	*f*
Self-notes, notebook	50
Course book	42
Internet	41
Reference book	19

Table 4.21 demonstrates that using self-notes or a notebook while writing their story was rated 50 times; whereas course book was chosen 42 times, the Internet 41 times, and reference books 19 times. Other than the stated resources, the researcher observed that some of the students did not use any kinds of resource for some parts of their story writing. When the students were asked what they were using while writing their stories, the answer was, "I was writing my story by using the subjects I already memorized in class."

4.4.1.5. Difficulty level of each phase in DST process

In considering the three main phases of the DST process, the researcher wondered about the difficulty level of the phases as experienced by the students. Therefore, the students were asked to rate the difficulty level of the phases as either 1 = Difficult, 2 = Medium, or 3 = Easy. The results for this question are shown in Table 4.22.

Table 4.22 Frequencies of Difficulty Levels of DST Phases

Phases	Difficult *f*	Medium *f*	Easy *f*
Story writing	11	23	21
Storyboarding	11	23	21
Digital story creation	24	15	16

According to Table 4.22, the digital story creation phase was found to be the most difficult (n = 24) among the three phases. In addition, 11 of the students rated story writing and storyboarding phases as their most difficult. At the medium difficulty level, 23 of the students agreed that it represented their experience for both story writing and storyboarding, whereas 15 stated medium for the digital story creation process.

Furthermore, the students were expected to order these three phases according to their perceived level of difficulty. The results varied as indicated in Table 4.23.

Table 4.23 Perceived Order of Difficulty Level of DST Phases

Order	Study Groups	
From difficult to easy	Exp. Group 1 *f*	Exp. Group 2 *f*
SW–SB–DSC	2	4
SW–DSC–SB	3	8
SB–SW–DSC	5	1
SB–DSC–SW	1	0
DSC–SW–SB	4	6
DSC–SB–SW	15	6

*SW: Story writing, *SB: Storyboarding, *DSC: Digital Story Creation

As can be seen in Table 4.23, the order for difficulty levels of the DST phases differed between the experimental groups. According to the results, while the *most frequently rated* ordering for Experimental Group 1 (n = 15) was DSC–SB–SW; whereas the most frequently rated ordering for Experimental Group 2 (n = 8) was SW–DSC–SB. The *least frequently rated* ordering was the same for both groups, which was SB–DSC–SW.

The next two questions in this scale aimed to determine whether or not the DS creation process helped the students to learn science course subjects in depth, or to repeat or reinforce them. The results concluded that 50 of the 55 students stated the DS creation process did contribute to them learning, repeating or reinforcing the science course topics. On the other hand, five of the students thought that there was no contribution of the DS creation process to their learning.

Table 4.24 Contribution of DS Creation to Learning Science Course Subjects

	Yes	No
Contribution provided	50	5

4.4.1.6. Contribution levels of DST phases to students' learning

First, the students were expected to rate the contribution level of each DST phase to their learning process. In this manner, there were three different levels from the most contribution to the least, and the results varied as can be seen in Table 4.25.

Table 4.25 Learning Contribution Levels of DST Phases

Phase	Most contribution *f*	Medium contribution *f*	Least contribution *f*
Story writing	33	16	6
Storyboarding	11	20	24
Digital story creation	25	17	13

Table 4.25 shows that whilst 33 students thought that the story writing phase provided the most contribution to their learning, only six believed that this phase provided the least contribution. For the storyboarding phase, most of the students (n = 24) stated

that this phase provided the least contribution to their learning. Moreover, 25 of the students thought that the digital story creation phase provided the most contribution to their learning. When the contribution levels for three phases are observed, it can be seen that the story writing phase was the most rated by the students as providing the most contribution, and the least contribution belonged to the storyboarding phase level.

Second, the researcher asked the students to order the phases according to their contribution levels to their learning on a science course. The results are shown in Table 4.26.

Table 4.26 Order of Learning Contribution Levels of DST Phases

Order	Study Group	
From the most to least contribution	Exp. Group 1 *f*	Exp. Group 2 *f*
SW–SB–DSC	5	8
SW–DSC–SB	13	14
SB–SW–DSC	1	0
SB–DSC–SW	1	0
DSC–SW–SB	9	3
DSC–SB–SW	1	0

*SW: Story writing, *SB: Storyboarding, *DSC: Digital Story Creation

As demonstrated in Table 4.26, the most rated ordering for both experimental groups was SW–DSC–SB (n = 13 for Experimental Group 1, and n = 14 for Experimental Group 2). On the other hand, nine students in Experimental Group 1 ordered the three phases according to their contribution levels as DSC–SW–SB. Notably, three order types, SB–SW–DSC, SB–DSC–SW, and DSC–SB–SW, were not rated by any students in Experimental Group 2. Lastly, eight participants in Experimental Group 2 believed that the ordering of the three DST phases was SW–SB–DSC for their learning on a science course.

4.4.1.7. Most challenging tasks in the DS creation process

The next question aimed to determine the most challenging tasks that students experienced when they created their digital stories. Seven various tasks, and one *Other* option were included in the scale. Students were expected to mark one or more task that they found challenging. Table 4.27 displays the frequencies of the tasks considered as challenging by the students.

Table 4.27 Most Challenging Tasks in DS Creation Process

Challenging Tasks	Exp. Group 1	Exp. Group 2	Total
	f	*f*	*f*
Recording the digital story	14	13	27
Finding visuals related to the story	16	8	24
Adjusting the time for each scene in the digital story	14	10	24
Adjusting the duration of the entire digital story	15	9	24
Ordering the visuals according to the digital story flow	11	11	22
Adding sound/music to the digital story	9	4	13
Adding text to the digital story	3	1	4

As can be interpreted from Table 4.27, five of the seven tasks were found to be challenging by almost half of the students (as the total number who took the survey were n = 55). Only four students experienced difficulties in *Adding Text to the Digital Story* while using the Photo Story 3 software program. After that, 13 of the students found *Adding Sound/Music to the Digital Story* as challenging. Table 4.27 also indicates that frequencies of challenging tasks differed between the experimental groups.

4.4.1.8. Students' willingness and preferences about the DST process

Last two questions in the scale were applied in order to examine the students' willingness and their preferences about the DS creation process. Several items were added for this question, and the results are shown separately as follows.

Table 4.28 Participants' Willingness about DST

Participants' willingness	Exp. Group 1 *f*	Exp. Group 2 *f*	Total *f*
I want to **both** create and watch a DS about any subject on a Science course	17	15	32
I want to **watch** a DS about any subject on a Science course	8	6	14
I want to **create** a DS about any subject on a Science course	4	2	6
I want to neither create nor watch a DS about any subject on a Science course	1	2	3

As indicated in Table 4.28, only three students (one in Experimental Group 1, and two in Experimental Group 2) were unwilling to create or watch a DS on a science course; whilst six of them just wanted to create a DS, and 14 students (n = 8 for Experimental Group 1, and n = 6 for Experimental Group 2) were just willing to watch a DS as part of a science course. Finally, more than half of the students (n = 32) were satisfied with the DST process they had experienced, and they both wanted to create and watch a DS on a science course in the future.

Table 4.29 Participants' Preferences about DST

Preference	Exp. Group 1 *f*	Exp. Group 2 *f*	Total *f*
I want to create a DS about a unit that I like in a science course	19	14	33
I want to create a DS about a unit that I like as a **performance homework** at the end of the semester	15	7	22
I want to create a DS about every unit of a science course	6	6	12

Table 4.29 illustrates that only 12 of the students preferred to create a DS about every unit on a science course. On the other hand, more than half of the students (n = 19 for Experimental Group 1, and n = 14 for Experimental Group 2) wanted to create a DS about a unit which they liked from a science course. Lastly, 22 of the students (15 in

Experimental Group 1, and seven in Experimental Group 2) wanted to create a DS about a unit that they liked as a performance homework at the end of the semester.

4.4.2. Qualitative phase of students' opinions about creating a DS on a science course – Both experimental groups

In this phase of the study, 12 semi-structured interview questions were asked to 52 of the participants. Nine of the questions were common to both of the experimental groups, and three questions were addressed only to the students of Experimental Group 2 (group collaborative working). In this regard, results of the common questions were reported for both experimental groups in this section, and findings for the three questions applied only to Experimental Group 2 are reported in the next section.

After content analysis of the qualitative data, four main themes emerged for both experimental groups. Those themes are (1) Effects of DST in science education, (2) Difficulties faced in DST process, (3) Preferences of students, and (4) Suggestions from students. The findings are reported in the following sub-sections,

4.4.2.1. Effects of DST in science education

Many effects of DST in science education (SE) were specified by the interviewees. Those effects were mainly categorized under two subthemes, as *Positive Effects of DST in Science Education*, and *Negative Effects of DST in Science Education*.

4.4.2.1.1. Positive effects of DST in science education

According to the results, DST was seen by the students as having had mostly positive rather than negative effects in their science education. The positive effects varied for both of the experimental groups, and were gathered under common subthemes of *cognitive strategies*, *enablers for learning*, *enhancing the knowledge gain*, *making real life relationships*, and *contribution to individual skills*. Findings related to the positive effects of DST in SE are shown in Table 4.30 under each emerged theme.

Table 4.29 Positive Effects of DS in Science Education

Theme	Subtheme	*n*
Cognitive Strategies	Reinforcement	18
	Rehearsal	12
Enablers for Learning	Supporting the exams	27
	Enabling to remember the subject	18
	Leading to use imagination	15
	Learning by using different ways	7
	Leading to study	6
	Increasing motivation to the course	6
	Learning by entertaining	4
Enhancing Knowledge Gain	Increasing knowledge about course	39
	Learning better	18
	Enhance knowledge retention	5
Making Real Life Relationships	Inspiration	26
	…from a book	8
	…from a movie	6
	…from a cartoon	6
	…from a game	4
	…from nature	2
	Using real/daily life events (school, family)	12
	Using real life names in DS	8
Contribution to Individual Skills	***IT skills***	
	Improving ICT skills	35
	Improving drawing skill	4
	Cognitive Skills	
	Improving story writing skill	11
	Improving memorization skill	3
	Improving organization skill	2
	Improving critical thinking skill	1
	Improving researching skill	1
	Improving concentration skill	1
	Learning how to concretize knowledge	1
	Self-Realization	

Table 4.29 (cont'd)

	Realization of ability to create a DS	10
	Realization of story writing skill	7
	Realization of self-dubbing skill	5
	Realization of imagination skill	4

Cognitive Strategies

Of the various cognitive strategies, students who participated in the interviews talked about two of them. While 18 students remarked that they applied *Reinforcement Strategy* when creating their digital stories, *Rehearsal Strategy* was another used by 12 of the students during this process.

The two strategies were mostly declared together by some of the interviewees. For instance, they said that when they were creating their digital stories, this process helped them to rehearse the course topics so that they could reinforce them. Because they were both writing a story and creating a digital story about the same topic, they had chance to rewrite and reread the topics many times over. Besides, visualizing, recording, and watching the DSs enabled them to rehearse and reinforce the topics. Some of the students stated that:

> When I was creating my DS, story writing, visualizing, and recording allowed me to reinforce the subjects that I had difficulties in understanding.
>
> [Anlamadığım konularda dijital hikâye yaparken hem hikâye yazarak, resimleştirme ve ses kayıtları yaparak dersi pekiştirmemde yardımcı oldu.]
>
> As I am creating my digital story, I feel like I am studying for the exam, then when I watch my DS, it provides me the information about the course so that I have the chance to rehearse.
>
> [Ben dijital hikâye yaptığım zaman böyle sınava çalışıyormuş gibi oluyorum sonra çalışırken izliyorum orda zaten bilgileri veriyor bu sayede tekrar da etmiş oluyorum.]
>
> For instance, when we create our digital stories, once we record, and then rehearse what we have written. We are both story writing, and rehearsing.
>
> [Mesela şimdi çok fazla dijital hikâye yaptıktan sonra bi kere ses kaydı yapıyoruz o yazdığımız şeyleri tekrar ediyoruz, hem yazıyoruz hem tekrar ediyoruz.]

Enablers of Learning

Learning in science education while creating digital stories was one of the most mentioned issues during the current study. In this context, several codes were categorized under Enablers of Learning in the light of interviewees' responses. Those codes are *Supporting the Exams*, *Enabling to Remember the Subject*, *Leading to Use Imagination*, *Learning by Using Different Ways*, *Leading to Study*, *Increasing the Motivation to the Course,* and *Learning by Entertaining*.

The most frequently declared code under this theme was *Supporting the Exams*. A total of 27 interviewees, out of 52, stated that creating digital stories about a subject in a science course helped them to remember the related subject in their exams, enabled them to easily answer the questions in their exams, achieve high grades in the course, and provide them with extra course material (digital stories) in order to prepare for their exam. One of the students in Experimental Group 1 stated that,

> I was better prepared for my exam. When I had difficulties in answering the questions, I just thought about my story.
>
> [Sınava daha iyi hazırlandım. Bazı sorularda takıldığımda hikâyem aklıma geliyordu.]

Another student in Experimental Group 2 expressed that,

> For example, sometimes I couldn't understand the questions in my exam, so I just remembered my story in such moments, and then I could easily answer those questions. Because, we can easily remember the subjects thanks to the visuals in our digital stories.
>
> [Mesela sınavda benim anlamadığım sorular oluyor, dijital hikâyeyi aklıma getiriyorum ve soruları cevaplayabiliyorum. Görseller sayesinde de konuyu daha iyi ve rahat hatırlayabiliyoruz.]

Of the 52 interviewees, 18 students thought that creating digital stories in their science course *Enabled them to Remember the Subject* during the lectures, exams, and when doing their homework. When they recorded and used some visuals, and created their own words during the DST creation process, remembering the course subjects became easier for them. One student from each experimental group said that,

> ...there are visuals in digital stories. When we use those visuals, they help us to remember the subjects, and we might keep some keywords in our minds.

[Dijital hikâyede görseller oluyor bunları yaparken hatırlamamız kolaylaşıyor ve aklımızda anahtar kelimeler kalabiliyor.]

...and also I could remember some parts of the subjects in my exam. I could remember with the help of recording and story writing rather than the visuals in my digital story.

[...bir de dijital hikâye sayesinde sınavda hatırlamadığım bazı şeyleri hatırlayabildim, görsellerden ziyade daha çok ses kaydı ve hikaye yazma aşamasında yaptıklarım sayesinde hatırladım.]

Another enabler of learning when creating digital story revealed by 15 students was *Leading to Use Imagination*. Those students said that they had the chance to use their imagination skill while writing their stories, and also that they improved their imagination skill. They learned how to integrate the course subjects to real life by using their imagination. The interview results concluded that since they used their imagination, they could more easily remember and understand the course subject better. For instance, two students said that,

My mum had given me a flower for my birthday. I was inspired by this flower and used it in my story by applying my imagination.

[Annem bana doğum günümde çiçek almıştı ordan biraz esinlendim ve hayal gücümü kullanarak yazdım.]

I integrated three things – my future job, one of my favorite books, and a cartoon – into my story.

[Ben üç şeyi birleştirdim. Hayalimdeki mesleği koydum, sevdiğim bir kitabı koydum bir de sevdiğim bir çizgi filmi birleştirdim.]

According to the responses of seven students, creating digital stories in a science course afforded them *Learning by Using Different Ways*. They could learn the related course subjects through story writing, visualizing, recording, and searching on the Internet while creating their own digital stories. These various methods helped them to learn and understand the subjects better. One student from Experimental Group 1 stated that,

I had difficulties in understanding some of the subjects. While I was creating my DS for these subjects, story writing, visualizing, and recording helped me to learn it better.

[Anlamadığım konular olmuştu benim. anlamadığım konularda dijital hikaye yaparken hem hikaye yazarak, resimleştirme ve ses kayıtları yaparak dersi daha iyi öğrenmeme yardımcı oldu.]

Another student from Experimental Group 2 expressed that,

Since we learn by writing, it (DS) allowed us to concentrate while studying, and contributed to having a better understanding.

[Derslerimize çalışırken yoğunlaşmamıza, daha iyi anlamamıza katkı sağladı, yazarak öğreniyoruz ya o yüzden çok katkısı oldu.]

The next code under this subtheme was *Leading to Study*. Six students shared their ideas about how creating digital stories led them to study the course subjects. One of them said that,

...and also, for instance I do not like studying that much, but when I was creating my digital story, I felt like I was studying.

[...bir de mesela ben ders çalışmayı pek fazla sevmem ama dijital hikaye ile uğraşırken hem de ders çalışmış gibi oluyordum.]

And another student declared that,

...it (DST process) helped us to study for our science course.

[Çalışmamıza yardımcı oldu fen konularını.]

Additionally, six students believed that their *Motivation to the Course Increased* during this process, and creating digital stories in their science course increased their participation in the course. They said that since this process increased their motivation and participation, they learned the course subjects better and achieved higher grades. Two of them declared that,

Learning the subject becomes more entertaining when creating a DS, therefore our level of interest to the course increases so that we receive higher grades.

[Dijital hikaye yapınca daha eğlenceli oluyor konuyu öğrenmek, eğlence kattığı için ilgimiz artıyor konuya ve bu sayede daha yüksek alıyoruz.]

...moreover, thanks to digital storytelling, I was engaged more in the science course.

[...ayrıca fen dersine biraz daha iyi bağlandım.]

Lastly, *Learning by Entertaining* was emphasized by four of the students. They said that they had fun, particularly during the digital story creation phase, so that they learned better, reinforced and remembered the subjects easily. While one of them said that,

> To me, I studied for the exam not in a tedious mood, but in an entertaining mood by creating my digital story, so I learned better and achieved a higher grade in the exam.
>
> [Bence sınavlara girerken daha böyle ciddiyet taşımadan daha eğlenerek hikaye yazarak daha iyi öğrenerek, çok daha iyi notlar almamı sağladı.]

Another student declared that,

> Digital storytelling process not only motivates us by providing learning with entertainment, it also makes us happy by helping us to get higher grades.
>
> [Hem eğlenerek öğrenmemizi sağladığından dolayı hem bize keyif veriyor hem de notlarımız arttığından dolayı iyi oluyor.]

Enhancing Knowledge Gain

Most of the students spoke about their knowledge gain during the DS creation process. In taking their opinions into consideration, this theme emerged with three codes, which are *Increasing Knowledge about the Course*, *Learning Better*, and *Enhancing Knowledge Retention*.

Increasing Knowledge About the Course was the most commonly mentioned code under this theme (n = 39). According to the student responses, while they were writing their stories, they had chance to use their course books, self-notes, and also the Internet. Thus, not only could they find additional information about the topics, but they could also learn some parts of the topics that they had missed during the lectures. By applying their course materials, and searching the Internet, their level of knowledge increased. For example, one student from Experimental Group 1 said that,

> It (the process) contributed to my knowledge more than enough. Because, when I was writing my story, I researched a lot on the Internet, and much of that information was not learned during the lectures, so therefore it increased my knowledge about the course.

> [Bana fazlasıyla katkı sağladı. Çünkü hikayemi yazarken Internetten kitaplardan baya araştırma yaptım ve bu bilgilerin çoğunu derste öğrenmemiştik ve bunlar bana bir sürü artı katkı sağladı.]

Another student from Experimental Group 2 expressed that,

> In my story, there were some knowledge areas that I had to learn about, so I used both my notebook and course book while I was writing my story. Since you use different resources, you can learn different information about the topic.
>
> [...hikayede bilgi kısımları vardı, onları yazarken hem defterden hem kitaptan faydalanınca ordaki bilgileri alırken değişik bilgiler de öğreniyorsun farklı kaynaklardan yararlanarak.]

The next emerged code was *Learning Better*. Some of the students (n = 18) declared that they learned the course subjects better when they created their digital stories. According to their statements; when writing the story, preparing the scenario, and also creating the digital story, they not only learned the subject better than they had in the class, but they also learned better other parts of the subject that they had missed during lectures. For instance, one student in Experimental Group 1 stated that,

> ...when I was writing my story, I used some books and searched on the Internet, and I learned some new information about the subject that we did not learn in class.
>
> [Hikayemi yazarken Internetten kitaplardan baya araştırma yaptım ve bu bilgilerin çoğunu derste öğrenmemiştik.]

Another student in Experimental Group 2 said that,

> ...the statements that I used in my scenario enabled me to learn the subjects better.
>
> [Senaryoyu yazarken ordaki cümleler benim daha iyi öğrenmemi sağladı.]

Enhancing Knowledge Retention was the last code that emerged from the students' responses. Five of the students stated that when writing their own stories and converting them into digital formats using various recordings and visuals, their knowledge retention enhanced so that they could more easily remember the related information when needed. The related statements of two students are as follows:

> When I was writing my scenario, the statements allowed me to learn better, and enhanced my knowledge retention.

> [Senaryoyu yazarken ordaki cümleler benim daha iyi öğrenmemi ve aklımda daha kalıcı olmasını sağladı.]
>
> The knowledge become more permanent thanks to the visuals and recordings.
>
> [Daha kalıcı olur konular, görseller ve ses kayıtlar sayesinde.]

Making Real Life Relationships

Another positive effect of the DST process in SE was to make real life relationships. In another saying, students reflected their real life experiences to their stories during this process. Three codes were found associated with this theme, which were *Inspiration, Using Real Life Names in DS,* and *Using Real/Daily Events (School, Family etc.).*

Inspiration was one of the most mentioned concepts among the students. Half of them (n = 26) declared that they were inspired from a game (n = 4), a movie (n = 6), a book (n = 8), a cartoon (n = 6), or from nature (n = 2) when writing their own stories. Characters or scenarios/events from video games, books, cartoons, or movies inspired the students to write their own scripts in their stories. With regard to this, two students shared the following opinions:

> ...I got started with my own story by imagining some treasure, and chose my characters as treasure hunters. I was inspired by a movie I had previously seen. In this movie, the hunters were prospecting for treasure in a cave.
>
> [...öğretmenim ben hikayemi yazarken böyle defineden hazineden yola çıktım, hikayemdeki karakterleri böyle define avcısı gibi yaptım, ben bunu daha önce izlediğim bir filmden esinlenerek yaptım böyle mağaranın içerisinde hazine arıyorlar falan.]
>
> …for example, there was a book written by a famous writer, and we integrated his book (the events in the book) into our story The last page was missing from the book, about European wolf spiders, and our character didn't know about that. Thus, he started to find out about the missing parts of the book by overcoming certain obstacles during his journey, then he understood about the missing page with the help of the information he found during his journey.
>
> [...mesela adamın (ünlü yazar) yazdığı kitabı bizim yaptığımız bi tane esrarengiz kitap vardı daha heyecanlı olsun diye, onun kitabını bizim kitabımıza geçirmiş olduk. Bir de mesela son sayfasının eksik olmasının yanında tarantulalarla ilgili bir sayfanın eksik olduğunu bilmiyor mesela ve karşısına çıkan engellerle tarantulayı gördüğünde

onlara karşı yaptığı şeyleri araştırmaya başlıyor ve tarantulalarla ilgili eksik olan sayfayı fark ediyor.]

Eight students said that they *Used Real Life Names in Their DSs* because they found it easier to use those names for their story's characters. Especially, they used their own names or some favorite names in their stories. One student from each experimental group stated,

> …and also the name of my character was Dolunay. I do not know why, but this is my favorite name, and therefore I wanted to use it for my character.
>
> [...bir de benim karakterimin ismi Dolunay'dı. Nedendir bimiyorum ama o benim en sevdiğim isimdir o yüzden karakterimde kullanmak istedim.]
>
> We used our own names for our characters.
>
> [Biz karakterlerimiz için kendi adlarımızı kullandık.]

Lastly, 12 of the students stated that they used *Real/Daily Life Events (School, family etc.)* in their stories. The dialogues in a family, in a routine day, or in a lecture at school were used by the students. Some events/scenarios taken from books or cartoons were also narrated in the students' stories. Because, this way (using real/daily life events) was also found easier for them to use in their stories. For instance, one student from Experimental Group 1 said that,

> When I was writing my stories about animals and plants, I personalized my characters by mostly using daily dialogue between people.
>
> [Ben bitki ve hayvan hikayelerini yaparken daha çok insanlar arasındaki ilişkileri düşünerek karakterlerimi konuşturdum.]

Another student from Experimental Group 2 stated,

> ...and also we were inspired from a cartoon, Alice in Wonderland. Even though there was a rabbit in that cartoon, our character was a man, and he had a page missing from his book, and then started his journey to find that page. While he was walking around, he suddenly fell into a hole, and that's the moment that our adventure began.
>
> [...bir de biz bir çizgi filmden yararlandık, Alice harikalar diyarından. O filmde bir tavşan vardı ama bizde de adamın son sayfası eksik olduğu için kendisi araştırmaya gidiyor ve o sırada bir çukura düşüyor o şekilde bir macera vardı.]

Contribution to Individual Skills

The last theme under positive effects of DST in SE was *Contribution to Individual Skills*. Because the students wrote their own stories first, then storyboarded, and finally created their digital stories, it was assumed that the students' individual skills might be affected by this process. When asked whether or not they realized or improved any individual skills during the DST process, their responses were seen in three different subthemes which were *Information Technology (IT) Skills*, *Cognitive Skills*, and *Self-Realization*.

Information Technology (IT) Skills

The most frequently declared code under this subtheme was *Improving ICT Skills*. A significant number of the students (n = 35) shared their ideas about improvement of their ICT skills during the DS creation process. Because the students searched the Internet to find relevant information and pictures for their digital stories, edited their pictures, recorded their voices by using headphones/microphones, found background music and edited their music, utilized their PCs (use of keyboard, USB flash drive, software programs etc.), and used a new program (Microsoft Photo Story 3), they believed that their ICT skills improved while creating their own DSs. Although there were some students who were not using PCs or such programs in their routine lives, they also became engaged to this process and thereby improved their ICT skills to some extent. As stated in their interviews, two students said,

> I can say that my use of computers and programs improved a bit more; inserting USB flash drive, turning on/off PC, using and saving files, etc.
>
> [Biraz daha bilgisayar ve program kullanma becerim gelişti diyebilirim, USB takma, PC açma kapama, dosya kullanmada kaydetmede vs biraz gelişme oldu.]
>
> For example, I was not good at using PC programs, my brother helped me (during this process), and my use of the PC, the program (Photo Story 3), and technology skills have improved.
>
> [Ben de mesela bir program kullanmada fazla iyi değildim ama abimden de yardım alarak programı kullanma becerim gelişti, teknolojiyi, pcyi kullanma becerim gelişti.]

Another individual skill mentioned by four of the students was *Improving Drawing Skill*. This skill, in particular, was used during the storyboarding sessions. Students were expected to develop their storyboards through visualizing the scenes in their DSs. Whereas some students did a very good job during the storyboarding sessions, others just drew stick men. Those four students stated that they had the chance to improve their drawing skills whilst storyboarding their stories. As an example, one student said that,

> My drawing skill improved a bit more. I was already talented at drawing, and it improved even more. I realized that I could draw better pictures, and also I saw that I could draw animal pictures as well.
>
> [Resim yapma becerim biraz daha gelişti, resim konusunda zaten yetenekliydim daha da gelişti, daha güzel resimler yaptığımı gördüm. Bir de artık hayvan resimleri çizebildiğimi anladım.]

Cognitive Skills

Seven codes emerged under this subtheme. Even though four of them were only mentioned once, they were also categorized under this subtheme because the researcher considered them to be important for the DST process. The most addressed code under the *Cognitive Skills* theme was *Improving Story Writing Skill* (*n* = 11). Some students had previously experienced story writing, and those students said that they could improve their story writing skills through the DST process. For instance, one student from Experimental Group 1 stated that,

> I could not write a good story in the past, but now I am better, my story writing skill has improved.
>
> [Eskiden iyi hikaye yazamıyordum ama şimdi daha iyi yazıyorum, hikaye yazma becerim gelişti.]

Another student from Experimental Group 2 emphasized that,

> I used to write stories, but thanks to this process, my story writing skill has improved a little bit more.
>
> [Ben daha önce de hikaye yazıyordum ama bu sayede biraz daha gelişti bu becerim.]

The next cognitive skill that was emphasized by three students was *Memorization Skill*. Those students stated that they improved their memorization skills during the DS creation process. Using their own words, and rephrasing during both story writing and the digital story creation processes helped them to improve their memorization skills. According to one of those students,

> My memorization skill improved as well. Apart from that, I can remember the things easier.
>
> [Benim de ezber yeteneğim arttı. Onun dışında biraz da daha kolay hatırlama becerim gelişti.]

Students working in the collaborative group (Experimental Group 2) distributed roles to each member in the group, therefore they somehow had to organize what each should be doing, and in doing so, their organization skill was expected to improve. This was also the case for those who were in Experimental Group 1, because they could also organize themselves in order to make the process easier. However, the *Improving Organization Skill* code was only emphasized by one student from each experimental group. One of them mentioned that,

> ...Besides, my organization skill also improved, because I invited many people to my home while creating my DS. When two people were recording, another was taking care of the baby; I mean it was difficult to manage (the process).
>
> [...öğretmenim bunların yanı sıra organizasyon becerim de gelişti, çünkü hikayemi yaptığım zaman aynı anda birçok kişiyi eve çağırdım, iki kişi orda ses kaydı yaparken biri çocuğa bakıyordu falan, zordu yani.]

The following four cognitive skills were declared by only one student each. One code named *Learning How to Concretize the Knowledge* was stated by a student from Experimental Group 1, with other codes mentioned by three students from Experimental Group 2. Since each student or group wrote two stories and created two digital stories; after gaining experience with their first stories, they started thinking critically when it came to their second task. In observing the two stories for each student or group, the researcher was readily able to distinguish the difference between the DSs in terms of timing, visuality, design, and scripting. In line with this, *Improving Critical Thinking Skill* was a code declared by one student from Experimental Group 2 with a statement saying,

> Ordinarily, if one wants to write a story, s/he needs to think deeply. Yet, we did not think very much for our second story; not as much as we did for the first one, and we came up with more creative elements to our second story. Therefore, I think, my critical thinking skill improved.

[Hikayeyi yazarken mesela hikayeyi normalde düşünmek gerekir baya bi, ama biz birinci hikayede düşündüğümüz kadar ikincide düşünmedik, ve daha yaratıcı birşey bulduk. Yani yaratıcı düşünme becerimin geliştiğini düşünüyorum.]

Improving Researching Skill was another code mentioned by one student. During the DS creation process, students not only used their course books and self-notes, they also used the Internet to research the topics on which they would create a DS. Thus, researching skill was another expected skill to be improved by the students. However, only one student stressed that his researching skill improved during this process, stating,

...and also, we conducted research, so that our researching skill improve.

[...bir de mesela araştırmacılık yaptık o da araştırma becerimizi geliştirdi.]

The final code emphasized by Experimental Group 2 students related to the *Cognitive Skills* subtheme was *Improving Concentration Skill*. As with most educational tasks, good story writing also requires concentration. A writer should expend a certain amount of effort in order to concentrate on the job while scripting scenarios to produce a good story. In this regard, one student stated that his concentration skill improved while writing his story, saying that,

I think that my concentration skill improved, because I tried to concentrate on my story while I was writing.

[Benim odaklanma becerimin geliştiğini düşünüyorum, çünkü hikayemi yazarken odaklanarak yazmaya çalıştım.]

Finally, the code named *Learning How to Concretize the Knowledge* was declared for one student from Experimental Group 1. In considering his statements, making relationships between real life experiences and story topics allowed this student to concretize the knowledge, and integrate it into real life. In line with this, he said that,

...also, in our stories about plants and animals, there were some parts that we could use in our daily lives. We learned how to integrate these parts to our stories by concretizing them. For instance, we applied the vegetative reproduction to our own plants while writing our stories.

[...Bir de bitki ve hayvanlar bölümünde günlük hayatta kullanabileceğimiz şeyler vardı, bunları kullanarak somutlaştırarak, mesela bitkilerde vejetatif üreme bunun gibi konuları daha çok kendi bitkilerimize uygulayarak yani kendi hayatımıza entegre etmeyi öğrendik.]

Self-Realization

None of the students who participated in the current study had previously created a DS. At the beginning of the process, some of the students were worried about whether or not they could even write a story or create a DS; however, the results of the study claimed that a great number of the students achieved that goal. Thanks to this first experience, some of them realized various skills, and their statements regarding this subtheme were categorized under four different codes, *Realization of the Ability to Create a DS*, *Realization of Story Writing Skill*, *Realization of Self-Dubbing Skill,* and *Realization of Imagination Skill.*

Realization of the Ability to Create a DS was the most mentioned code under the *Self-Realization* subtheme, with 10 of the students expressing their ideas in this manner. In other words, they realized that they could write a story and create a DS. One student from Experimental Group 1 shared his ideas as,

> Like Ahmet, I was also thinking that I could not use Photo Story and create a DS, but when I examined the program, I realized that I could do it. It was also the case for the story, I was supposing that I could not write a story and would get a low grade, yet I did it.
>
> [Ben de Ahmet gibi mesela başta ben Photostory'i nasıl kullanıcam yapamam demiştim ama biraz kurcalayınca yapabildiğimi anladım. Hikayeyi de öyle zannetmiştim, ben yazamam düşük alırım demiştim ama yazdım yani.]

Another student from Experimental Group 2 said that,

> …My cousin had already created a DS. I kept asking myself how they could do all of those tasks, how they could make recordings, or present the pictures. I thought that I wouldn't be able to do the same, but then I realized that I could.
>
> […benim kuzenim daha önce dijital hikaye yapmıştı, ben diyordum bunları nasıl yapıyolar, ses kaydı yapıyorlar resimler falan çıkıyor ben hayatta yapamam demiştim ama yapabildiğimi gördüm.]

The next code under this subtheme was *Realization of Story Writing Skill*. Seven students stressed that they were supposing not being able to write a story before starting this process, and then they realized that they were good at writing a story by the time that the experiment had finished. One student from each experimental group shared their ideas on this as follows;

> Sir, I was supposing that I couldn't write a story, but I realized now that I can.
>
> [Öğretmenim ben hikaye yazmadığımı sanıyordum ama yazabildiğimi anlamış oldum.]
>
> Also, I could not write a good story, I believed that I was bad at writing an essay, but I realized that I can.
>
> [Bir de ben hikaye falan yazamazdım, kompozisyonda kendimi kötü olarak görüyordum, ama yazabiliyormuşum.]

Perhaps the most interesting code that emerged from the students' responses was *Realization of Self-Dubbing Skill*. Five students were said to have realized during the recording sessions that they could in fact dub different sounds (animal or high-pitched sounds etc.), and that this realization made the process more entertaining for them. In this regard, two students stated that,

> Sir, I even realized that I could self-dub in different tones, and I had never tried to do that before.
>
> [Öğretmenim ben değişik sesler çıkarabildiğimi fark ettim. Hiç farklı sesler çıkartmayı denememiştim.]
>
> Sir, I made up some crazy things in the recording, because, I also never thought that I could dub such different tones. I realized that I could dub sounds like various animals.
>
> [Öğretmenim ben de ses konusunda acayip bişey oldum çünkü ben de kendimin böyle farklı sesler çıkaracağımı fark etmemiştim. Çeşitli hayvan sesleri çıkarabildim.]

Realization of Imagination Skill was the last emerged code under this subtheme. Four of the students expressed that when they were writing their stories, they realized that they had a good imagination, and that this process contributed to their imagination skill. As stated by one student from Experimental Group 1,

> Sir, they were saying that I have a good imagination skill, but I did not believe them till I realized my imagination skill when I was writing my story.
>
> [Öğretmenim bana diyorlardı ki senin hayal gücün çok fazla ben hiç inanmıyordum ama hikaye yazarken ben de bunu fark ettim.]

Another student from Experimental Group 2 said,

> For example, I have not created a DS before, I mean I've not had such experience, so I was not supposing that I could write a good story. Yet, not only did I improve my story writing skill, but I also improved my imagination skill. I could use it (while writing my story).
>
> [Mesela daha önce hiç dijital hikaye yapmamıştım o yüzden deneyimim yoktu, yani bir hikayeyi güzel yazabileceğimi düşünmüyordum o yüzden hem hayal gücüm biraz daha gelişmiş oldu, yani hayal gücümü konuşturmuş oldum hem de hikaye yazabildim.]

4.4.2.1.2. Negative effects of DST in science education

The results of the study concluded that the negative effects of DST in SE could only be categorized into one theme which was *Time Management*.

Table 4.30 Negative Effects of DS in Science Education

Theme	**Codes**	***n***
Time management	Affecting other exams negatively	14
	Affecting other homework negatively	8
	Affecting other courses negatively	8

Time management

Of the 52 participants, 30 of them stated that the DST process negatively affected them in terms of time management. While considering their responses, complaints about the process emerged into three main codes, that were *Affecting Other Homework Negatively*, *Affecting Other Exams Negatively*, and *Affecting Other Courses Negatively*.

Due to the fact that the current study (DS creation process) lasted for a period of almost three months, the process overlapped with the students' exams at certain times. Since the students wrote their stories and created their digital stories about science course topics, they somehow studied for the science course exam at the same time; but that was not the case for their other courses. Therefore, some of the students (n = 14) had difficulties in preparing for *Other Course Exams*. They stated that neither was the story writing easy, nor the digital story creating. Even those students who declared that they enjoyed the process said that managing their time for other exams was quite challenging for them. One student from each experimental group highlighted this as, I had difficulty when the process conflicted with my exam times. For example, the creation of my DS overlapped with the second exams time, therefore I had some difficulties, and could not create a good DS, so that I was late. To me, that was the only negative side of the process.

[Bazen süreçler sınavlarımızın olduğu sürece denk gelince biraz sıkıntı yaşıyorum, mesela ikinci sınavların üzerine geldi dijital hikayenin hazırlanması, ben o yüzden biraz sıkıntı yaşadım. O yüzden çok fazla hikayemi oluşturamadım, geç oluşturmak zorunda kaldım, bence tek olumsuz yönü bu.]

I had many exams when we were creating the DSs, and it was very difficult to leave enough time for the exams. That was not always the case, but sometimes.

[Dijital hikaye yaparken çok fazla sınav vardı ve başka sınavlara zaman ayırmak zor oluyordu. Belli zamanlarda oldu ama her zaman olmadı.]

The same difficulty applied to some of the students' homework that they had to prepare for other courses. Eight students stated that the DST process *Affected Their Homework Negatively*. Finding pictures, recording, and creating a digital story took a long time for them, as well as the initial writing of the story. Hence, they experienced difficulty in managing their time alongside their other homework. Sometimes, they had to study until midnight, or they could not prepare their homework because of writing their stories or creating their digital stories. As an example, one student from Experimental Group 1 said that,

Sir, some setbacks occurred with my other homework. Because, for instance we had homework, but when I got home, I had to start my DS. Since the school days lasted for so long, I felt tired and was falling asleep.

[Öğretmenim benim ödevlerimde biraz gerileme oldu, diğer ödevlerimde. çünkü mesela ödev alıyoruz ama eve gittiğimde ben direkt DS'in başına oturduğumda zaten dersler de geç bitiyor o yüzden uykum geliyor ve uyuyorum.]

Another student from Experimental Group 2 stated that,

To me, studying for exams and doing other homework sometimes became problematic.

[Benim için de bazen sınavlara çalışmamda ve ödevleri yapmamda zaman sorunu oldu.]

Lastly, some of the students were negatively affected by the DST process in regard to study for other courses. Eight students expressed that when they were story writing and creating their digital stories, they could not leave enough time to study for their other courses. In summary, spending time on the DST process *Affected Their Other Courses Negatively*. According to one student from Experimental Group 1,

> It (the DST process) negatively affected our other courses. For me it was the Turkish course, as when I was writing my story, my motivation for the Turkish course decreased due to spending time on this process instead.
>
> [Diğer derslerdeki başarımızı olumsuz etkiledi, mesela beni türkçede olumsuz etkiledi, çünkü mesela hikayemi yaparken daha da türkçeye bakma azmim indi mesela, zamandan ötürü.]

The following statement was highlighted by one student from Experimental Group 2,

> Supposing that we had no science exam, but a social science exam, and we had to create a DS. In that case, since we had to spend time for the DS, we might study less for the social science course.
>
> [Diyelimki fen sınavımız yok sosyal bilgiler sınavımız var ama DS yapmak zorundayız, dijital hikayeye zaman ayıracağımız için sosyal dersine daha az çalışmak zorunda kalabiliriz.]

Other than the results mentioned here, 15 of the students emphasized that they were able to manage their time efficiently during the DST process, and that they were not negatively affected by the process in terms of their other homework, courses, or exams.

4.4.2.2. Difficulties faced in DST process

The second main theme that emerged from the interviews includes several difficulties faced in the DST process. As a process, DST has three different phases, with the students working both individually and collaboratively. The difficulties that they stated during the interviews were labelled under four subthemes, that are *Difficulties Faced in Story Writing Phase*, *Difficulties Faced in Storyboarding Phase*, *Difficulties Faced in DS Creation Phase*, and *Difficulties Faced in Collaborative Groups*.

Table 4.31 Difficulties Faced in DST Process

Subtheme	**Code**	***n***
Difficulties faced in story writing phase	Finding/naming characters	6
	Creating the scenario	5
	Ordering/integrating story topics	4
	Arranging the length of story	4
	Scripting	2
Difficulties faced in storyboarding phase	Storyboarding	6
Difficulties faced in DS creation phase	Finding/choosing pictures	17
	Recording	15
	Adding music	2
	Ordering the pictures	1
	Scene duration	1
Difficulties faced in collaborative groups	Distribution of roles	4
	Time management	4
	Meeting for group work	3
	Dichotomy	2

4.4.2.2.1. Difficulties faced in story writing phase

The most frequently faced difficulty in the story writing phase for the students was *Finding/Naming Characters*. Six students stated that they had difficulty in finding appropriate characters or naming them for their stories. But, this difficulty especially appeared during the first story writing phase. In other words, since it was the first time that those students had written a story about science course topics, finding or naming their first story's characters was not so easy for them, but that was not the case for their second story. For the second story, they had the experience from the first story writing phase to refer back to, so naming or finding characters for their second story became that much easier. In this regard, one student from each experimental group shared their experiences as follows,

> Because I used my imagination while writing my story, I had difficulty in finding my characters and the place where the events would happen.
>
> [Hikayemde hayal gücümü kullandığım için hikayemde neler yaşanacağını bulmada ve karakter bulmada zorlandım.]

> We had difficulty in finding a character name while writing our story indeed. For example, when Ilayda (group member) found a name, Ilgın (group member) had another, and I had also found a totally different name; but eventually we agreed with the most rational one, even though it was so hard to decide.
>
> [Biz aslında hikaye yazarken karakter ismi bulmada çok zorlandık. Mesela ilayda başka birşey ben başka birşey ılgın başka birşey diyordu ama en sonunda en mantıklısına karar verip öyle kullandık ama biraz zorlandık.]

The second difficulty was labelled as *Creating the Scenario*, and was expressed by five students. It was particularly seen that the students who had difficulties in creating a scenario mostly applied mutual dialogues, or question/response conversations in their stories. Their stories were quite limited in terms of plotlines. According to one of those students,

> At first, I had difficulty in selecting the characters, naming them, and specifying the scenario of the story, and the place where the events would happen, but then I overcame those difficulties by myself.
>
> [Karakter seçiminde ve karakterlere adını koymada, bir de hikayenin konusu nasıl olacağı ve nerde geçeceğinden başta zorlandım. Ama bu zorlukları kendim üstesinden geldim.]

Another student said that,

> Sir, I had difficulty in designing the scenario of my story, but then I used my imagination, and found the solution without any help.
>
> [Öğretmenim ben senaryoda biraz zorlandım ama daha sonra düşünerek hayal gücümü kullanarak buldum. Başkasından yardım almadım.]

Ordering/Integrating Story Topics was another difficulty faced in the story writing phase. Four of the students declared this as a problem during the interviews. Two units from the science course were specified for the stories, and the students were then free to use any topics from the two units. In other words, they did not have to follow the topics according to the curriculum. They might therefore change the order of the topics in relation to their story lines. However, those four students had difficulty in ordering the topics in their stories or integrating those topics into their story events. One student from Experimental Group 1 said,

> Sir, I didn't know how to order the topics while I was writing my story, I had difficulty in ordering, and I really struggled to overcome this problem.
>
> [Öğretmenim ben hikayemi yazarken konuları nasıl sıralayacağımı bilemedim, sıralamada zorluk yaşadım, üstesinden gelmek için yine kendim uğraştım.]

Another student from Experimental Group 2 stated that,

> Sir, sometimes it was difficult to integrate the topics into the story scripts. For instance, a certain topic should followed this other one, but I was doing it vice versa; I mean I was confused in ordering the topics.
>
> [Öğretmenim ben mesela bazen konuyu hikayeye koymada zorlandım, mesela önce şu konu oluyor ondan sonra diğer konuya geçiyoruz ben tam tersini yapıyordum, konuların sırasını karıştırıyordum.]

Another difficulty that emerged in this phase was *Arranging the Length of Story*, and was emphasized by four students. Those who did not particularly focus on the course topics but on the story lines were seen to have faced this difficulty. It was noted that the students who used course topics and story lines together while writing their stories did not experience such difficulties. Two students shared their ideas on this as,

> We tried to shorten the introduction of our story, but we could not, and it took us three pages.
>
> [Giriş bölümünü kısaltmaya çalıştım ama çok kısaltamadım 3 sayfa sürdü.]
>
> …and also, some parts of the story were too long, and I had difficulty in removing those parts.
>
> […bir de hikayede bazı kısımlar çok uzundu onları çıkarmaya çalışırken zorlandım biraz.]

The last difficulty reported in the story writing phase was coded as *Scripting*. Only two students faced such a difficulty. Since the students were expected to integrate the course topics into their story lines in order to write a good story, dialogue between topics and story lines became important. One of those students declared that he could not find such dialogue in order to complete his story; therefore, his story turned into a lecture given in a class. In this sense, he highlighted that,

> To me, it was difficult to find the dialogue between the topics. For instance, the father (one of the characters in the story) was always explaining the topics (like lecturing in a class) to his child (another character) without any additional dialogue.

[Olaylar olurken ara konuşmaları yapmada zorlandım. Yani mesela baba sürekli çocuğa anlatıyordu ara konuşmalarım pek olmadı.]

4.4.2.2.2. Difficulties faced in storyboarding phase

The difficulties faced in the storyboarding phase were gathered under a code named *Storyboarding*, with six students having expressed that this phase was quite difficult for them. Even though storyboard examples were shared with the students, and a template was provided for them, those six students faced some difficulties, especially in drawing the related pictures for their stories. Statements from one student in each experimental group on this were as follows,

> Sir, I had also difficulty in storyboarding. I cannot draw good pictures, even I cannot draw a man, therefore I drew, deleted and redrew many times over.
>
> [Öğretmenim ben de storyboardda zorlandım, benim resmim o kadar zordurki bir adam bile çizemem, o yüzden çiz sil, çiz sil çok zorlandım.]
>
> …for instance, while storyboarding, I was trying to draw a penguin, but it looked like a bear, or when I wanted to draw a crocodile, it turned into a worm; I mean it was weird, therefore I had my friends draw them.
>
> […mesela resim çizerken penguen çizicem ayıya benziyor ya da timsah çizicem solucana benziyordu, çok değişik oluyordu, ben de o yüzden arkadaşlarıma çizdirdim.]

4.4.2.2.3. Difficulties faced in DS creating phase

Of the five difficulties reportedly faced during the DS creation phase, *Finding/Choosing Pictures* was the problem most mentioned. This difficulty was highlighted by 17 students. While some complained about the quality of the pictures, others were frustrated at not finding the pictures that they wanted on the Internet. Furthermore, unique characters created by some students were unavailable on the Internet, therefore those students tried to draw their characters and used their own pictures in their DSs. As stated by one student from Experimental Group 1,

> I had difficulty in finding pictures. Because, I did not need real life pictures, but cartoon pictures, I searched on the Internet for a long time. Then I used different keywords to find the pictures, and I eventually did it.

> [Ben de resim bulmada zorlanmıştım. Çünkü ben gerçek hayattan alınan resimler değil de çizgi film resimleri lazımdı onları çok aradım, sonra farklı şeyler yazarak yanlarına buldum. Üstesinden gelebildim yani.]

The following statement was provided from another student in Experimental Group 2,

> It was difficult to find pictures of a high quality. Hence I had to take some of them by myself, but I could not.
>
> [Biraz resim bulmada zorlandım, çünkü çok kaliteli resimler yoktu. Bazılarını kendim çekmeye çalıştım ama çekemedim o yüzden zorlandım.]

The second difficulty faced in this phase was *Recording*, with 15 students complaining about the recording part of the DS creation phase. While some of them experienced some technical problems during the recording sessions, other students complained about the environment (noise, overcrowdedness etc.) that they were recording. Two of those students complained in this sense as follows,

> Because I did not have a microphone, I used my camera for recording, but it was so small, therefore I really had to speak up. Other than that, my aunt had come to our home with her baby, and the baby was always crying; therefore, I often had to delete my recordings and start over, but eventually I overcame this problem.
>
> [Bizim mikrofonumuz olmayınca ben kamera kullanmıştım ve kamera da çok küçüktü sürekli bağırmak zorunda kalıyordum. Ve teyzemler de gelince bebek de getirmişlerdi ve bebek sürekli ağlıyordu bağırıyordu o yüzden sürekli ses kayıtlarını silmek zorunda kalıyordum ama sonunda üstesinden gelebildim.]
>
> While we were recording, there were some noise behind us, therefore we had to rerecord.
>
> [Seslendirme yaparken bazen arkadan sesler geliyordu. O yüzden silip tekrar yaptık.]

Additionally, *Adding Music* was found to have been difficult by only two of the students. One of them shared his ideas as,

> Sir, when I finished my story, I had difficulty in adding some background music, I could not do it and had to delete it. Then, I retried adding some music, but then my recordings disappeared, and the music was so bad. However, I finally managed it.
>
> [Öğretmenim ben ilk başta hikayemi yaptığımda daha sonra müzik koyayım nasıl olacak diye ama müziği ekleyemedim ve hepsini silmek zorunda kaldım. Daha sonra

> yine müzik eklemeyi denedim ama bu kez ses kaydı çıkmadı, müzik çok kötü çıktı ama en sonunda yaptım.]

Apart from those difficulties, while two students stated that they experienced difficulty in *Ordering the Pictures* while creating their DSs using the Photo Story 3 program; only one student reported problems with the *Scene Duration*. The statements below describe those difficulties experienced by the students, respectively.

> …for instance, I was checking the pictures when ordering them, but sometimes there was a missing picture. Before recording, I had to go back to the pictures again and again, and had to check all of them since I'd forgotten to add the related picture.

> […mesela resimleri koyarken arada bakıyorum bir tane resim arada yok. Tam sesi kaydedicem resim yok o yüzden tekrar oraya gidiyorum tekrar resmi koyuyorum, bakıyorum onu unutmuşum o yüzden öyle döne döne yaptım.]

> Our digital story was done, but it was not ready because we had difficulty in setting the scene duration. One page was too long and we couldn't shorten it, therefore we had to meet up again.

> [Dijital hikaye bitti ama aslında bizim için bitmemişti çünkü biz sayfa süresini ayarlamakta zorlanmıştık. Bir sayfa çok uzun sürmüştü onu bir türlü çözememiştik o yüzden tekrar buluşmamız gerekti.]

4.4.2.2.4. Difficulties faced in collaborative groups

Since the difficulties listed under this subtheme were raised only in Experimental Group 2, and occurred in all of phases of the DST process, this subtheme was created by the researcher.

In general, one of the most important problems that might occur in group works for any study is *Distribution of Roles*. This was also the case for the collaborative working group of the current study. Some of the collaborative subgroups had problems with distributing their roles. They stated that they could not manage this process, and that there was unfair distribution among some subgroup members in terms of the tasks. Hence, they had difficulties with completing their self-tasks on time due to this perceived unfair distribution. Some students even suggested having roles distributed by the course teacher or the researcher. Four students from two different subgroups highlighted this difficulty, with one of them saying that,

> In my opinion, the distribution of our roles was not fair. If we could distribute the roles equally, we could finish our tasks in a shorter time.
>
> [Bence görev dağılımında bazılarımız fazla aldı bazılarımız az aldı. Görev dağılımını tam olarak eşit bir şekilde yapabilseydik daha kısa sürede bitirebileceğimizi düşünüyorum.]

Another difficulty faced in the collaborative group was *Time Management*. This problem was also related with the distribution of roles. Or to put it another way, for those who had excessive workload compared to other subgroup members, they felt unable to complete their self-tasks on time. On the other hand, some of the subgroups could not efficiently organize the group works, and therefore experienced issues with time management. Four students from different subgroups emphasized this problem, and one of them shared their experience as follows,

> Sir, I had problems about time because the time given to me was too short to do my tasks. For the second DS, the pictures were not given to me, and I had to find them in a limited time.
>
> [Öğretmenim ben zaman konusunda sorun yaşadım. Çünkü bana verilen zaman kısıtlıydı biraz. Resimlerde ise ikinci hikayede bana hiç resim verilmemişti, hiç resim bulunmamıştı falan onları bulurken zorlandım biraz.]

The next difficulty was coded as *Meeting for Group Works* under this subtheme. Three students from two different study subgroups experienced such a problem. One of those students explained their experiences about this difficulty as,

> For example, we had different roles in the group. Since Dila (group member) and I took the storyboarding part, we had to meet on both weekdays and weekends. Yet, sometimes we did not have enough time to meet, so we were nervous about the due date.
>
> [Mesela bizim hani ayrı ayrı görevlerimiz olduğu için mesela Dilayla ben senaryoyu yazmakla görevlendirildik o yüzden bunu haftasonu veya haftaiçi buluşmak zorunda kalıyoruz bazen zamanımız olmuyor ve yetiştiremeyeceğimiz korkusuyla yapıyorduk.]

The last difficulty faced in the collaborative groups was labelled as *Dichotomy*. This problem was raised in only two of the subgroups, and mentioned by one student in each. According to their statements, the disagreements mostly occurred about determining the story characters and the scripts (ideas about story events). In this regard, one of those students stated that,

> Sometimes, we (Dila and I) had disagreements. For example, if we did not have an idea while writing our story, it became problematic, or when we had different ideas, we were trying to link them to each other in order to overcome those disagreements.
>
> [Bazen Dilayla anlaşmazlıklarımız oluyordu. Mesela hikayeyi yazarken fikir bulamadığımızda sorun oluyordu ya da hani ikimizin de fikri olduğunda ikisini birleştirip yazmaya çalışıyorduk böylece anlaşmazlık kalkıyordu ortadan.]

4.4.2.3. Preferences of students

This main theme involves the preferences of students in terms of two subthemes, which are *Reasons for Choosing a DST Phase That Provides Better Learning* for them, and *Reasons For Choosing a Specific Course* – apart from the science course – in which they want to create a DS.

4.4.2.3.1. Reasons for choosing a DST phase that provides better learning

As previously declared, the digital storytelling process includes three main phases which are (1) story writing, (2) storyboarding, and (3) digital story creation. In this manner, when the students were asked "Which phase of DST process helped them learn the course subjects better, and why?" they highlighted eight various reasons. Since the number of reasons and participants differed for each experimental group, results are presented separately as follows.

The number of students (n = 14) who chose the SW and DSC phases was equal for Experimental Group 1.

Over half of them (n = 6) chose the SW phase because they felt they learned better whilst writing, with one of them stating,

> SW phase contributed more to my learning. Once we wrote the subjects that we were not good at, it seemed rational, and I reinforced them.
>
> [Bence en çok hikaye yazma aşaması katkı sağladı. anlamadığımız konuyu bir kere yazdığımız için, birer kere yazmak daha mantıklı oldu ve daha pekiştirici oldu benim için.]

Table 4.32 Reasons for Choosing DST Phases – Experimental Group 1

Phase	*f*		Reason
SW	14	–	I learn better by writing (6)
		–	Using books, self-notes and other resources while story writing (4)
		–	Searching the Internet while writing a story (3)
		–	I use my imagination while writing a story so I learn better (1)
SB	2	–	I learn better when I visualize what I am studying. (2)
DSC	14	–	Because a digital story has both visuals and sounds/recordings (8)
		–	Recording while creating a digital story (5)
		–	Visualization while writing and reading the story (1)

*SW: Story Writing, *SB: Storyboarding, *DSC: Digital Story Creation

Four students stated that they learned better since they used their books, self-notes, and other resources while writing their stories. The more varied the resources, the better learning for those students. According to one of them,

> Sir, to me, SW phase was more useful to my learning, because, when I was writing my story, I would use both my books, and other resources. I worked hard to make sure that the information I would give was correct, and to make the process better. In doing so, I can remember the subjects wittingly or unwittingly.
>
> [Öğretmenim bence hikaye yazma, çünkü hikayemi yazarken hem kitaptan baktım hem de diğer kaynaklardan baktım. Doğru olsun diye hikayem baya çalıştım, gidişat yoluna gelsin diye. bu sayede ister istemez konular insanın aklına kazınıyor.]

Besides, three students said that searching the Internet while writing a story helped them to learn the course subjects better. In particularly, they tried to find additional information that they did not know or learn at the school, so that as a result, they learned more. In this sense, one student shared her ideas as,

> SW phase. Because, we get some information from the Internet when we are writing a story, so that this process contributes to our learning more.
>
> [Bence hikaye yazma aşaması çünkü hikaye yazarken konuyla ilgili bilgiler ediniyoruz, Internetten de bilgiler araştırıyoruz o yüzden en çok katkı sağlayan oydu.]

On the other hand, of the 14 students who chose the DSC phase, most of them (n = 8) declared that it was because a digital story has both visuals and sounds/recordings, and that this process helped them learn the course subjects better, and because they could easily remember what they learned thanks to the different components of DST. The following statement by one student supports this result;

> Sir, the DSC phase was more useful for my learning. When we were writing a story, we were doing it from our mind/memory, I mean we were writing what we knew about. Yet, when we create a DS, we both used recordings and visuals, so it contributed more to my learning.
>
> [Öğretmenim bence dijital hikaye oluşturma aşaması daha katkı sağladı. Öğretmenim, hikaye yazarken kendi kafamızdan yazıyorduk, yani bildiğimiz şeyleri yazıyorduk ama dijital hikaye hazırlarken hem ses kaydı hem de resimler olunca daha iyi öğrenmeme katkı sağladı.]

In addition, five of the students thought that they learned better in this phase because they recorded their own voices while creating their digital stories. They had the chance to repeatedly record their own voices and listen back to what they had recorded, so that in this way it enabled them to learn the subjects better. In this manner, one student stated,

> Sir, the DSC phase was more effective for me. Because, we self-dubbed our stories, and we can add the information as soon as we remember it, so we can repeat it. For instance, let's say after did the storyboarded there are some missing parts. We can add these missing parts in the DSC phase. Therefore, this phase is more effective for me, and so we can learn better.
>
> [Öğretmenim bence son aşama (dijital hikaye oluşturma) daha etkili. Çünkü öğretmenim kendimiz hikayeyi konuşturuyoz, aklımıza gelen bilgileri kulanarak tekrar onları ekliyoruz. Mesela senaryo yazdık diyelim eksik birşeyler olursa dijital hikayede ekleyebiliyoruz. Bence bu yüzden daha etkili, bir de ses kaydı da yapıyoruz o yüzden daha iyi öğreniyoruz.]

Lastly, only two students chose the SB phase in Experimental Group 1. They stated that they learned better in this phase because they could visualize by themselves what they had written in their stories. One of them highlighted her experiences as follows,

> To me, the SB phase contributed more to my learning, because I can learn better when I draw things related to the information needed. Besides, when I use colorful pencils to draw, it helps me to concretize the knowledge in my mind; because I visualize it.

[Bence storyboard aşaması bana daha çok katkı sağladı. Çünkü belirli bilgileri kağıda çizerek ben daha iyi öğreniyorum hem de renkli kalemlerle yaptığımda bence aklımda daha kalıcı oluyor çünkü resimleştiriyorum.]

Table 4.33 Reasons for Choosing DST Phases – Experimental Group 2

Phase	***f***	**Reason**
SW	13	– I learn better by writing (7)
		– Searching the Internet while story writing (4)
		– Using books, self-notes and other resources while story writing (2)
SB	0	N/A
DSC	9	– Because digital story has both visuals and sounds/recordings (4)
		– Visualization while writing and reading the story (3)
		– Digital story creation is entertaining, so I easily remember it (1)
		– Searching the Internet while creating a digital story (1)

*SW: Story Writing, *SB: Storyboarding, *DSC: Digital Story Creating

In Experimental Group 2, no students thought that the SB phase helped them to learn the course subjects better. While 13 students chose the SW phase, the remainder (n = 9) thought that they learned better in the DSC phase.

Similar to Experimental Group 1, most of the students (n = 7) in Experimental Group 2 chose the SW phase, declaring that they learned better while writing, and therefore it facilitated more to their learning of the course subjects better. One student from this group stated,

> I think that we learn better when we write a story. Because, once you integrate the subjects to your story and then start writing it, you learn better.
>
> [Hikaye yazarken daha iyi öğrendiğimizi düşünüyorum. Çünkü önce konuyu hikayeye katıyorsun ve yazıyorsun falan o yüzden daha iyi öğreniyosun.]

Four students stated that they searched the Internet while writing their stories, so they learned better in this phase. They also stressed that thanks to the Internet, they learned additional information about related course subjects. In this regard, one student shared his ideas as,

> The SW phase; because when I was writing my story I both searched on the Internet, read it, and wrote it. By doing so, I learned better.

> [Hikaye yazma aşamasında. Çünkü hikayemi yazarken hem Internetten araştırdım hem okudum ve yazdım böylece daha iyi öğrendim.]

On the other hand, four students expressed that they learned better in the DSC phase, because a digital story has both visuals and sounds/recordings, and those components helped them to memorize and better remember the subjects. They also had the chance to repeat what they had recorded in this phase, therefore they believed that they learned better as a result. Along these lines, one student said,

> DSC phase. Because, thanks to both recordings/sounds, and visuals, I could repeat the subjects and therefore learned better.
>
> [Dijital hikaye oluşturma aşaması. Çünkü hem resimler hem ses kaydı olduğu için konuyu tekrar ederek daha iyi öğrenebildim.]

Lastly, three students highlighted that that had the chance to visualize what they were learning in this course during both writing and reading sessions. Using pictures for their stories allowed them to concretize the knowledge so that they could easily remember what they had learned. According to one of them,

> DSC phase. Because, you can see everything in that phase. You are both visualizing, and creating the scenes, so you focus more by using them.
>
> [Dijital hikaye oluşturma aşaması çünkü o aşamada görüyorsunuz, hem resimleri yapıyorsunuz hem sahneleri oluşturuyorsunuz böylece beyniniz daha çok odaklanıyor.]

4.4.2.3.2. Reasons for choosing DS development for a specific course

Initially, when students were asked whether or not a science course is appropriate to create a DS, all of the students (*N* = 52) emphasized that a science course was the most appropriate for writing a story and creating a DS. On the other hand, when they were asked to choose a course other than science in which they would like to create a DS, five different courses were specified from their responses, and four main reasons emerged behind those selections. In this sense, Table 4.35 provides the findings about the reasons why students would choose a course other than science in which to create a DS.

Table 4.34 Reasons for Choosing a Specific Course to Create DS – Both Experimental Groups

Reasons	**Course**	***f***
Courses in which students have difficulty understanding	– Turkish (6) – Math (11) – Social Sciences (3) – English (1) – Any (2)	23
Courses whose subjects are appropriate to digital story creation	– Turkish (6) – Math (5) – Social Sciences (7) – English (1)	19
Favorite courses (of the student)	– Social Sciences (2) – English (1) – Math (1)	4
Other	– Social Sciences (2) – Physical Education (1) – Math (2) – English (1)	6

According to Table 4.35, the reason of choosing *Courses in Which Students Have Difficulty Understanding* was rated by 23 students, which has the largest percentage (44%) of the students. The second rank with 37% belonged to the reason of choosing *Courses Whose Subjects are Appropriate to Digital Story Creation*. Additionally, while four students chose a course that was their *Favorite Course*, six students selected *Other* courses in which to create a DS with different reasons reported. Finally, the related results were separately analyzed and indicated in tables for each experimental group (see Tables 4.36 and 4.37, respectively).

Table 4.35 Reasons for Choosing a Specific Course to Create DS – Experimental Group 1

Course	***f***	**Reasons**
Turkish	10	Subjects of this course are appropriate to create a digital story (6)
		I have difficulties in understanding this course (4)
Math	10	I have difficulties in understanding this course (6)
		Subjects of this course are appropriate to create a digital story (3)
		Math is frequently encountered in daily life (1)
Social Sciences	6	Subjects of this course are appropriate to create a digital story (3)
		I have difficulties in understanding this course (1)
		To get a high grade from this course (1)
		This is my favorite course (1)
English	3	Subjects of this course are appropriate to create a digital story (1)
		I have difficulties in understanding this course (1)
		This is my favorite course (1)
Physical Education	1	To make this course more entertaining (1)

Most of the students (n = 20) in Experimental Group 1 chose Turkish and Math courses with equal numbers (n = 10) as a course in which they would like to create a DS.

Six of the students stated that they chose Turkish because they thought that the subjects of this course were appropriate to create a digital story. The following statement supports this reason,

> Sir, I would like to create a DS for the Turkish course as well. It would help me to write a story for that course since the subjects are appropriate to creating a DS.
>
> [Öğretmenim ben de türkçeden yapmak isterdim. Hikayeyi yazmada yardımı olsun diye, çünkü bence hikaye yazmak Türkçe dersine de çok yatkın.]

The reason for four students who chose Turkish was that they had difficulties in understanding this course. They believed that if they had the chance to create a DS for their Turkish course, that learning the subjects of the course would be easier for them. One of them shared his ideas as,

> In the Turkish course, because I have difficulties with this course more than others.
>
> [Türkçe dersinde. Çünkü Türkçe dersi diğer derslere göre biraz zorlandığım bir ders olduğu için.]

The same reasons also applied to the Math course, but with different numbers of participants. Three students believed that the subjects of the Math course to be appropriate to the creation of a digital story; whilst six students had difficulties in understanding the Math course. Statements taken from two students are as follows,

> Sir, it would be better to create a DS in a Math course, because the numbers could 'talk' in our DSs. For instance, while 4 was walking along the road, it suddenly crashed into 6, and they turned to 24 (representing 4 x 6 = 24).
>
> [Öğretmenim matematikte hikaye daha iyi olur çünkü mesela sayılar konuşabilir, mesela 4 yolda giderken 6 ya çarpmış 24 olmuş.]
>
> Math. Because Math is one of the most difficult courses for me. Thanks to DS, we might use visuals to learn it better.
>
> [Matematik, çünkü matematik çok zor. Hikaye sayesinde görseller de kullanarak daha iyi öğrenebiliriz.]

Apart from the courses and reasons stated, one student said that she would choose Social Sciences course in order to get a high grade from the course, another student declared that he would also choose the Social Sciences course to create a DS because that course was his favorite. According to their opinions,

> Social Sciences. Because, I am not good at this course. I would like to create a DS for this course to understand the subjects better and to get higher grades.
>
> [Sosyal bilgiler. Çünkü bu dersim çok iyi değil benim. Dersi daha iyi anlamak ve sınavlardan daha iyi notlar almak için isterdim.]
>
> Sir, I would choose Social Science. Because, preparing some materials related with our history contributes to both other people's and our own lives. Besides, I am interested in this course, therefore I would choose it.

> [Öğretmenim ben sosyal bilgileri seçerdim, çünkü tarihimizle ilgili bazı şeyler hazırlamak hem insanlara hem de bize katkı sağlar, bir de öğretmenim benim sosyale tarihimize ilgim var, o yüzden onu seçerdim.]

Similar reasons with the Social Sciences course were also stated by three students for the English course as supported with these statements,

> English. For example, we might write stories to learn some new English words, and to keep them in our minds. Story writing is appropriate for this course.
>
> [İngilizce. Mesela İngilizce hikaye yazabiliriz bazı kelimeleri öğrenebilmek ve aklımızda tutmak için. Hikaye yazmak İngilizcede yatkın.]
>
> English. Because this course is my favorite, and I am very good at this course.
>
> [İngilizce. Çünkü en iyi bildiğim en iyi yaptığım ders olduğundan.]

Lastly, only one student in this experimental group chose the Physical Education course to create a DS in order to make the course more entertaining; saying,

> Sir, I would go for the Physical Education course. Because, for instance we could write some stories introducing some physical exercises. That would be entertaining.
>
> [Öğretmenim, ben beden eğitimini seçerdim, çünkü mesela beden dersinde bi hikaye yapardık, hani değişik spor hareketlerini falan böyle bir hikaye içerisinde anlatabiliriz. Eğlenceli olurdu.]

When the same question was asked to the students in Experimental Group 2, the results showed that most of the students (*n* = 17) in this group chose the Math and Social Sciences courses.

Table 4.36 Reasons for Choosing a Specific Course to Create DS – Experimental Group 2

Course	***f***	**Reason**
Turkish	2	I have difficulties in understanding this course (2)
Math	9	I have difficulties in understanding this course (5) Subjects of this course are appropriate to create a digital story (2) This is my favorite course (1) To make this course more amusing (1)
Social Sciences	8	Subjects of this course are appropriate to create a digital story (4) I have difficulties in understanding this course (2) This course is my favorite course (1) To make this course more amusing (1)
English	1	To improve my English (1)
Any	2	Any course that I have difficulties in understanding (2)

Five students chose Math as a course in which to create a DS because they had difficulties in understanding the course; that same reason was also stated by two students for Turkish, and two for Social Sciences courses. Three students shared their ideas with regard to this as,

> I would choose Math because there are some subjects in that course that most of us have difficulties to understand. If we created a DS for that course, it would help both others and me to understand those subjects.
>
> [Bence çoğunlukla herkesin anlamadığı konular matematikte olduğu için böylece hem kendimin hem de başkalarının daha iyi anlayacağını düşündüğüm için matematik derdim.]
>
> Sir, I would go for Social Sciences because I cannot understand some subjects on that course, therefore I would like to create a DS for such a course that I have difficulties with.
>
> [Öğretmenim ben sosyal bilgiler dersinde yapmak isterdim çünkü sosyal bilgilerde bazı konuları pek anlamıyorum, zorlandığım bir derste olmasını isterdim.]

Turkish. Because, I have difficulties in understanding some subjects on that course. Therefore, story writing would be more effective, and enable me to understand it better.

[Türkçe. Çünkü bazı konuları anlamakta zorlandığım için. Bu yüzden hikaye yazmak daha etkili olabilir, kolaylaştırabilir.]

Five students believed that the subjects of Social Sciences are appropriate to create a digital story, and the same reason was also given for Math by two students. Two of these students stressed the following,

Social Sciences. Because there are some appropriate subjects on that course to create a DS. For example, when we look at our history, or Middle Asia, we can see lots of subjects. I mean, it is easier to write a story about history subjects.

[Sosyal. Çünkü sosyalde daha güzel konular var gibi geliyor, mesela tarihimize baktığımızda orta asyaya baktığımızda daha çok konular görüyoruz. Yani tarih konularında hikaye yazmak daha kolay bence.]

Math might be appropriate. The shapes of a parallelogram, square, or cube can be created by each student, and a story might be written about them. By doing so, the Math course would be more entertaining, and since there are a lot of subjects in this course, no one would get bored.

[Belki matematikte olabilirdi. Paralelkenarı, kareyi, küpü falan başka kişiler yapıp bir hikaye oluşturabilirlerdi. Çünkü daha eğlenceli olabilirdi matematik dersi bu şekilde. Konular daha fazla ve geniş olduğu içi sıkmazdı yani.]

Other than those reasons, one student expressed that he would choose an English course for creating a DS in order to improve his English, indicating,

Sir, I would like to create a DS in my English course. Because we could make the English words speak in our stories, they would become more concrete and our language would improve.

[Öğretmenim ben İngilizce dersinde olmasını isterdim. Çünkü İngilizce kelimeleri hikayede konuştururduk ve daha kalıcı olurdu yabancı dilimiz gelişirdi.]

Finally, two students stated that if they had the chance, they would choose any course in which they had difficulties in understanding the course to create a DS. One of them stated that,

> No specific course comes to mind right now. But, I would like to create a DS for any course and subjects that I have difficulties to understand. During this process, all phases would enable me to reinforce the subjects, and contribute to my learning.
>
> [Şu an bir ders gelmiyor aklıma ama ben anlamadığım anlamakta zorlandığım bir derste ve konuda dijital hikaye yapmak isterdim o konuları daha iyi anlamak ve pekiştirmek için hem hikaye hem storyboard hem de dijital kısmı bana katkı sağlar o derste.]

4.4.2.4. Suggestions from students

The students were also asked whether or not they had any suggestions to make in order to improve the DST process. Several codes emerged from their opinions.

Table 4.37 Suggestions from Students

Suggestions	***n***
Role-playing	10
Working in a group	6
Removing storyboard phase	4
Creating DS for other subjects in a science course	4
Distribution of roles	3
Creating a DS for a course that the students are not good at	2
Wanting more classmates to help with recording	2
Collaborating with the course teacher/researcher	2

The first and most stated suggestion from the students was *Role-Playing*. Ten of the students highlighted that if they had different roles as a character of the story, and they could role-play the story on a stage as a theatre, the process would be more effective and instructive for other students as well. Some of them also stated that being on stage, not only being a character of the story, but also using different pictures of the objects (each student would hold a picture of the story on the stage, while another student narrated) in the stories would be better, like a live DS. In this regard, two of the students shared the following ideas,

> Maybe, if we had roles in a theatre, that might draw attention of the younger students (4th, 5th grade), so we could instruct them about science course topics.

[Bir de belki bir tiyatro falan olsaydı, bizden daha küçük sınıfların dikkatini çekerdi belki, onları tiyatroda fen dersi ile ilgili eğitebilirdik belki.]

For instance, several students would stand on the floor holding pictures from the story (about the course subjects), and while another student narrates the story, others would arise with a related picture, like a live story.

[Mesela tahtaya çıkıp birkaç kişi seçip onlar böyle o kişinin anlatacağı şeylerin resimlerini tutsa o arkadaş da normal photostory yerine hikayeyi anlatsa olabilir. Canlı photostory gibi.]

The next suggestion came from six students in Experimental Group 1 (whose students created their DSs individually). After the experiment had finished, they thought that *Working in a Group* would be better for them; in particular, to have the advantage of sharing ideas and distributing roles within a group. Their idea being that the process would be easier and more effective for them, with two students expressing that,

I think it would be better if we worked in a group. Because, when you work alone, it means that you have to do all the tasks on your own. For instance, do you want to load 50 tasks to one student, or just two tasks to 25 students? That is what I mean.

[bence gruplaşarak yapsaydık daha iyi olurdu. Yani herkese sonuçta tek görev düşüyor yani mesela bir kişiye 50 görev mi yüklemek isterdiniz yoksa 25 kişiye 2şer görev mi, öyle düşünürsek öyle oluyor.]

To me, I wish we worked in a group. Thus, we would both have fun and share our ideas, and in doing so, we would produce better material.

[bence gruplaşarak yapsaydık. Yani hem daha eğlenirdik hem de mesela birisinden çıkan fikir diğerini etkiler ve daha güzel şeyler çıkardı.]

Additionally, four students interestingly suggested to *Remove* (the) *Storyboard Phase* from the process. They thought that since they used pictures in the DSC phase, they would not need to draw these pictures in the storyboard phase. Therefore, they suggested to remove this process phase altogether. A statement taken from one of those students supports this suggestion as follows,

That would be fine if the storyboard phase was not included in the process. Because, since we are writing the story, then finding the pictures in the digital phase, we did not need the storyboard phase.

[Storyboardlar olmayabilirdi, çünkü hikaye yazdığımız için ve dijital kısmında resimleri kullandığımız için storyboard aşaması olmasaydı olurdu.]

At the same time, four students came up with the idea of *Creating DS for Other Subjects of Science Course*. Those students created two different DSs during this process, and the subjects for those DSs were those that matched the science course curriculum named as "Growth, reproduction and development." Yet, the students declared that they would like to create a DS for other subjects of the science course too. One student from Experimental Group 1 said that,

> We just created DS for the reproduction subject, but we could also work on other subjects.
>
> [Biz üreme konusunu ele aldık (dijital hikaye yaparken) ama farklı konuları da ele alabilirdik.]

Another suggestion came from three students in Experimental Group 2, coded as *Distribution of Roles*. In the collaborative working group, the students formed their own subgroups, chose a leader, and the subgroup leader assigned the team's roles. However, one subgroup especially experienced some problems in terms of the distribution of roles. They thought that they could not equally distribute the roles for each member of the group, and that some tasks were not sufficiently carried out. Therefore, they believed that although distributing the roles by themselves would ideally be better for them, they preferred that the roles be distributed by the researcher. In this regard, one of them stated,

> As Mehmet said, we experienced a role distribution problem. If everyone had equal tasks, we would distribute more tasks. So that, for instance, when we found the pictures, then we could assign another task to someone to go and find some better pictures, and so we could create a better DS as a result. Distributing the roles by ourselves would ideally be better for us, but because we could not deal with that, we wish you could assign our roles instead.
>
> [Mehmet'in de dediği gibi görev dağılımı sorunumuz vardı eğer herkes eşit görev alsaydı başka görevler de dağıtırdık. Mesela resimleri bulduğumuzda daha sonra mesela daha canlı daha iyi resimler için başka birini yine görevlendirebilirdik bu sayede daha iyi bir dijital hikaye yapabilirdik. Bence görev dağılımını bizim yapmamız daha uygun ama biz beceremediğimiz için siz yapsaydınız daha iyi olabilirdi.]

Apart from those suggestions, while two students (in Experimental Group 1) wanted to have *More Classmates for Recording*, two students suggested to *Create a DS for a*

Course that Students are Not Good At. Lastly, two students wanted to *Collaborate with the Course Teacher/Researcher*, that is, they wanted to work not individually, but alongside the course teacher or the researcher in each phase of the study.

4.4.3. Qualitative phase of students' opinions – *Collaborative group*

The results presented in this part were only concluded from the interviews conducted with the students in Experimental Group 2, which was the only study group to work collaboratively. In order to examine the differences between individual and collaborative group works, three additional questions were asked only to the students of Experimental Group 2. The results were categorized under four main themes, which are *Advantages of Collaborative Work, Disadvantages of Collaborative Work, Preferences of the Students*, and *Skills in Collaborative Groups*

Table 4.38 Students' Opinions – Collaborative Group

Theme	Code	*n*
Advantages of collaborative work	Distribution of roles/(Easiness)	9
	Exchange of ideas	8
	Learning to take responsibility	8
	Time factor	6
	Having experiences in working in a group	4
	Improving socialization	3
	Understanding the importance of collaboration	2
	Learning to respect others' opinions	1
Disadvantages of collaborative work	Divergence	6
	Workload	2
	Communication problems	2
	Distraction occurs when collaborating	1
Preferences of Students	Learning better in a group	11
	Learning better individually	8
Skills in Collaborative Groups	Communication skill	4
	Collaboration skill	2
	Criticizing skill	1
	Ability to work in a group	1

4.4.2.1. Advantages of collaborative work

According to the students' responses, one of the most important advantages of group work was *Distribution of Roles*. Nine students agreed that having different roles in the group made the process altogether easier, and that because they shared the tasks, the workload decreased for each of them. Otherwise, they thought that experiencing this process by themselves would be very difficult. In this sense, one of those students shared his ideas as follows,

> Each member in the group had a different role, but if we had to work individually, everybody would have to have done everything by themselves, and that would be more difficult. Yet, since we distributed the roles, each member had an equal job.
>
> [Herkesin bir görevi oldu, ama bireysel olsaydı herkes kendisi yapmak zorunda kalırdı ve daha çok zorlanırdık ama görev dağılımı olunca herkes eşit iş yaptı.]

The next advantage mentioned was coded as *Exchange of Ideas*. Eight of the students emphasized that when they worked in a group while creating their DSs, they had the chance to share their ideas with other group members. By doing so, they had various ideas about all phases of the process, and they could then select the best of those ideas. This advantage also made the process easier for them. According to one of those students,

> You can gather lots of opinions from your group mates. For instance, our first story was too long, and we shared our ideas so that we did a better job with the second story. Imagine that there is a wall over there and furniture all around, everybody can see different things on that wall, so all of these things come together, and a better job can then be done.
>
> [Çok fazla insandan görüş alabiliyorsunuz. Mesela birinci hikayede bizimki çok uzundu orda görüş aldık falan böylece bir sonrakinde daha iyi iş çıkardık. Mesela bir duvar var orda eşyalar falan, o duvarda hepimiz farklı şeyler görürüz bu sayede farklı görüşler biraraya gelerek ortaya daha güzel birşey çıkabilir.]

Additionally, *Learning to Take Responsibility* was also named as an advantage of working in a group by eight of the Experimental Group 2 students. They stated that, during the DS creating process, they were expected to take on some responsibilities, and to complete tasks on time. When group members came together, they all took some responsibility for the group tasks, and tried to do them to schedule; because, they were all aware of what would happen if they did not do their self-tasks. In doing so, while some of them had their first experiences in taking responsibilities in a group work situation, some students improved their responsibility taking awareness. In this sense, statements provided by two of the students were,

> For instance, we had due dates, I mean we could not deliver our DSs whenever we wanted, so we took on responsibilities and we knew that if we could not do our tasks on time, there would be some drawbacks. Therefore, all of the group members knew themselves, and were doing their best.
>
> [Mesela hani belli bir zamanı var bunun (dijital hikaye) öyle her istediğimiz zaman getiremiyoruz bu yüzden bir sorumluluk almış oluyoruz ve bunu zamanında getirmediğimizde de bunun bize etkisi oluyor o yüzden de herkes kendini biliyor ve zamanında yapmaya çalışıyor.]
>
> Our self-responsibility skill improved. For example, I used to take responsibilities about 60%, but this percentage increased in this process.
>
> [Kendi sorumluluğumuz gelişti. Mesela bende eskiden sorumluluk alma %60 falandı ama bu süreçte daha fazla sorumluluk bilincim gelişti.]

The first advantage (*Distribution of Roles*) brought about another. In other words, the advantage of *Time Factor* was mentioned by six students thanks to having their roles distributed within the subgroup. Since they divided the tasks up among themselves, they could easily handle the process, and finished their tasks in a shorter time period when compared to Experimental Group 1, who each worked individually. They believed that they were lucky because of working in a group during the process. The following statement taken from one of those students supports this situation,

> We were luckier than 6B (individual study group) in terms of time, because we were three in our subgroup, and every member had different tasks. Yet, they (6B) had to do everything individually, so the process took longer for them.
>
> [Zaman bakımından daha bir üstünüz 6B sınıfına göre. Çünkü üç kişiydik herkese farklı görevler verildi ama tek yapan kişilerde zaman bakımından bizden daha uzun sürüyor.]

Besides, four students expressed that *Having Experiences in Working in a Group* was another advantage of this process for them. Those students had never experienced group work before, and they said they were able to learn how to work with others during the DS creation process. One of them said that, I have never experienced group work before, and I understood that working in a group is better. I believe that I can easily do group tasks from now on.

[Ben daha önce grup halinde çalışmamıştım hiç. Bu şekilde daha iyi olduğumu anladım. Artık başka grup çalışmalarını da rahatlıkla yapabilirim.]

The next advantage emerged under this theme was *Improving Socialization*. Three students thought that they knew more about their friends, and socialized more with them during the group works. In all phase of the DS creation process, the students helped each other, and shared their ideas. Thus, they also had the opportunity to improve their friendships while working together. In this regard, one student stated,

For example, Ilayda (group member) did something incorrect, we checked her job, and corrected it so we got closer and also socialized more.

[Mesela İlayda birşeyi eksik yaptı biz hepimiz bakarak onu düzelttik böylece aramızda kaynaşma ve yakınlaşma oldu.]

While two students pointed out that they could *Understand the Importance of Collaboration*, one student thought that he *Learned to Respect Others' Opinions* during the DS creation process. The following statements support these results as concluded through the interviews,

I learned that everything can be done with the help of collaborative work. I understood the importance of collaboration. It was like 'two heads are better than one.'

[Birlikte takım çalışması yapınca herşeyin yapılacabileceğini öğrendim öğretmenim. İşbirliğinin önemini anladım. Hatta bir elin nesi var iki elin sesi var gibi oldu.]

We helped each other, we listened to each other, and we learned to respect each other's opinions, so we could overcome the problems.

[Birbirimize yardım ettik, birbirimizin fikirlerini dinledik ve birbirimizin fikirlerine saygı göstermeyi öğrendik ve sorunları yenebilmeyi öğrendik.]

4.4.2.2. Disadvantages of collaborative work

Despite the fact that there were some advantages of working in a group, several disadvantages were also mentioned by some students. The most declared disadvantage was coded as *Divergence,* and six students highlighted this problem. Since sharing ideas and having different opinions in group work is inevitable, students sometimes had disagreements while discussing what they should do. However, the researcher observed that only one subgroup were unable to manage this problem successfully when an issue occurred. They often had disagreements during the study, but they did eventually manage to write their stories and create their DSs. One of those students shared their experiences as,

> Divergence occurred in our group, that was very difficult. Because, divergence might cause major debates, and this is a bad situation. The group might divide into two due to this divergence.
>
> [Fikir ayrılığı yaşandı, bu çok zor birşeydi. Çünkü fikir ayrılığı bazen tartışmanın da ötesine geçebiliyor, kötü oluyor, gruplaşmanın içerisinde gruplaşma oluyor falan. 3 e 1 ya da 2 ye 2 ayrılıyor grup.]

Another disadvantage of working in a group was seen as *Workload*, although only two students expressed this problem. They thought that if a group member is capable of doing a specific job in the group, other members will do nothing to help, and so the workload increases for that member. On the other hand, sometimes group members might not do what they should be, and therefore the workload becomes unfairly balanced for some group members. In this regard, one student stated that,

> For example, while one of the group members has the ability to write a story, and others do not; in that moment, workload might increase for that member (who is writing the story). That was the only disadvantage for me.
>
> [Mesela bir kişinin hikaye yazma becerisi varken diğerlerinin yoksa bu durumda o arkadaşa fazla yük binebiliyor. Bence başka zorluğu yoktu.]

Apart from those disadvantages, while *Communication Problems* were mentioned by two students, the disadvantage coded as *Distraction Occurs when Studying with a Close Friend* was stated by only one of the students. The statements related with these problems are as follows,

> Sometimes you have communication problems in group, so you also have to solve these problems, but if we worked individually, I would learn better.
>
> [Grupta bazen iletişim sorunları oluyor bir de onları çözüyorsunuz falan, ama bireysel yapsak daha iyi öğrenicem.]
>
> To me, working individually is more efficient. When you work in a group, particularly with a close friend, you might be distracted and start talking with your friend. Yet, when I am alone, I work more efficiently.

> [Ben tek çalışırken daha verimli oluyor. Neden çünkü mesela bir arkadaşın olduğunda heleki onunla yakınsan samimiysen dikkatin başka yerlere dağılıyor, onunla konuşmaya başlıyorsun falan ama ben tek olduğumda daha verimli çalışıyorum.]

Even though the last three problems were emphasized by only a few students, the researcher found them significant for group working, as the lesser such problems are faced, the better the group works.

4.4.2.3. Preferences of students

In this part, since the students in Experimental Group 2 worked collaboratively, unlike Experimental Group 1, they were also asked whether they would prefer to work individually or collaboratively for better learning during the DS creation process. Where three students were undecided for this question, 11 students shared their ideas in parallel as *Learning Better in a Group*. They especially highlighted the importance of sharing ideas with other subgroup members during their collaborative group work. Therefore, they thought that they could learn better when they were working in a group for the DS creation process. They also expressed that they had the chance to learn information about the subjects that they did not already know within the help of other subgroup members. In this sense, two of those students stated that,

> I would learn better in a group during this process. Because, my friend would let me know about something that I did not, so that I could learn. Therefore, group work is better.
>
> [Bence grup olarak çalışmada daha iyi öğrenirdim bu süreçte. Çünkü mesela benim bilmediğim birşeyi arkadaşlarım söyleyebilir ve bu sayede öğrenebilirim o yüzden bence grup daha iyi.]
>
> To me, we learn better in a group. Because, if we had to work individually, we would not have any friends to help us. For instance, when you have a difficulty during story writing and you cannot proceed further; in this moment, your group members can help you so you can accurately move on with writing your story.
>
> [Bence grupla daha iyi öğreniyoruz. Çünkü mesela bireysel çalıştığımız zaman sizin bilgi alacağınız arkadaşınız olmuyor ama mesela bir konuda şurda takıldınız mesela hikaye yazarken bir yerde takıldınız ve devamı gelmiyor. Bu noktada devamını getirmekte üç arkadaşımızın da etkisi oluyor ve böylece hızlı bir şekilde geçebiliyoruz en doğru şekilde.]

However, eight students stated that they saw themselves as *Learning Better Individually*. All of those students highlighted that even though the process would be more difficult when working individually compared to collaboratively, they thought that they would learn better when doing all of the tasks individually during the DS creation process. They also emphasized that the distribution of roles in a group might affect their learning process, as they had no chance to learn details about what other subgroup members did during the process when there is not enough time anyway. Therefore, they wanted to do everything – story writing, storyboarding, and digital story creating – by themselves. Two students shared their ideas on this as,

> It might be more difficult, but individual work is better for me. If you ask me why; for example, I was never able to understand what Zeynep (group member) or İlayda (group member) did. But, if we worked individually, we would learn better because we would do everything by ourselves.
>
> [Zor olabilir ama bence de bireysel daha iyi. Neden diye sorarsanız mesela ben Zeynep'in yaptığı şeyi belki de anlamadım ya da İlayda'nın yaptığı şeyi anlamadım. Ama bireysel olunca hepsini kendimiz yaptığımız için daha iyi anlamış oluyoruz.]
>
> I would go for 'individual' as well, because we each had different roles in our groups. For instance, İrem (group member) was writing the story, and since I did not write the story, I did not understand what happened in that process. Hence, I would understand it better if I had worked individually. It might be more difficult, but it would be better for me.
>
> [Ben de bireysel diyorum. Çünkü grupta dağılımda hepimize bir görev düşüyordu. Mesela hikaye yazma İrem'deydi ama ben hikaye yazmakla ilgilenmediğimden anlamadım orda olayı. Bence tek yapsaydım daha iyi anlayabilirdim. Zor olurdu ama daha iyi anlardım.]

4.4.2.4. Skills in collaborative groups

The last subtheme under this part includes some skills that might arise or improve in a group work as stated by some students. The first skill was coded as *Communication Skill*. Four students emphasized that they had the chance to improve their relationships with their friends thanks to the group work. They were able to spend more time with their friends and keep in touch with each other; so therefore they believed that they improved their communication skills during this process. One of them said that,

> I realized that I could get along better with my friends. My communication skill improved, and I got to know my friends better.
>
> [Arkadaşlarla iyi anlaşabildiğimi fark ettim, iletişim becerim gelişti, arkadaşlarımı daha iyi tanıdım.]

Collaboration Skill was the next skill mentioned by two of the students. Helping each other in group work allowed the students to collaborate more. Thus, those students believed that their collaboration skill improved during the DS creation process. It was also observed that those students were eager to help each other more in their future school tasks. According to one of those students,

> For example, Ilgın (group member) was writing the story, and we were helping her so that better ideas came up. I mean our collaboration skill improved.
>
> [Mesela hikayeyi Ilgın yazıyordu biz de ona yardım ettik yani öyle daha güzel fikirler ortaya çıktı. Yardımlaşma becerimiz gelişti yani.]

Apart from those skills, when one student declared that her *Criticizing Skill* improved during the DST process, because they learned to criticize each other regarding their opinions about any phase of the DS creation process; another student stated that she realized her *Ability to Work in a Group*. Even though she had not been used to working in a group and preferred studying by herself at the beginning of the implementation, she changed her mind after her experience gained during the process. Those two students shared their ideas about those skills as follows, respectively.

> For instance, we somehow criticized each other like 'it will be better if we do this like that or vice versa.' We learned to criticize both ourselves and each other.
>
> [Mesela kendimizi iyi kötü eleştirdik, bunu böyle yapsak daha iyi olur, şunu şöyle yapsak daha iyi olur gibi. Hem kendimizi hem de arkadaşımızı eleştirmeyi öğrendik.]
>
> I did not use to like working in a group. In general, I was always studying by myself, but I have liked working in a group thanks to this process. I now think that I can work in a group.
>
> [Ben grup olarak çalışmayı pek sevmezdim, genelde bireysel olarak çalışırdım ama bu sayede grupla çalışmayı da sevmeye başladım. Grup içerisinde çalışabildiğimi düşünüyorum.]

4.5. Examination of digital stories created by students

Each experimental group created two digital stories during the study. In Experimental Group 1, one student had health problems and therefore could not participate in the experiments. Out of the 30 students in this group, 27 of them wrote their first ever stories, and 23 created their first ever digital stories. In other words, even though four students had written their first stories, they could not achieve the second goal of creating a DS for their stories. On the other side, the number of students who wrote their second stories was also 27, but this number decreased to 19 for second digital stories.

In Experimental Group 2, there were seven different subgroups. All of the subgroups wrote their first and second stories, yet only one subgroup were unable to create their DSs. The distribution of the stories and digital stories created by the students is shown in Table 4.40.

Table 4.39 Distribution of Stories and DSs Created by Experimental Groups

Group	Stories & Digital Stories			
	First Story	**First Digital Story**	**Second Story**	**Second Digital Story**
Individual	27	23	27	19
Collaborative	7	6	7	6
Total	34	29	34	25

Since the number of the DSs varied between the experimental groups, the examination of the DSs was performed separately by using a digital storytelling evaluation rubric. Some of the categories were used together in order to accurately report the results.

4.5.1. Digital stories created in Experimental Group 1

Even though all of the students in Experimental Group 1 found a *Title* for both their stories, some of them did not add the *Title* to their digital stories. While nine students forgot to add their *Titles* to their first DS, this number decreased to five for the second DS. On the other hand, only one student created a *Title Page* introducing the cast of the story (first DS), and just two students did the same for their second DS. In other words, most of the students ignored this item during the process. Other details for these categories are presented in Table 4.41.

Table 4.40 Title and Title Page for Both DSs – Experimental Group 1

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Title	9	4	10	5	2	12
Title page	22	0	1	17	0	2

A significant number of the students created their DSs just starting with the story lines, rather than beginning with an effective or intriguing *Introduction*. Four DSs for each experimental study group were evaluated as good in terms of their *Introduction*, whilst six in total were rated as average. On the other hand, while eight students poorly introduced their *Characters* in their first DSs, this number decreased to two for their second DSs. Students better recognized the importance of their *Characters* in their second DSs and introduced their *Characters* during the stories. Table 4.42 shows the examination of these categories for both DSs.

Table 4.41 Introduction and Characters for Both DSs – Experimental Group 1

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Introduction	15	4	4	13	2	4
Characters	8	3	12	2	3	14

The next categories examined were *Dramatic Question* and *Creativity*. Almost half of the students in both DSs could not apply these items properly. Their stories were mostly narrated in a routine mode, and either without or with poor *Dramatic Questions*. However, seven students in the first DS, and six students in the second DS did a good job in terms of these categories. They asked some *Dramatic Questions* to grab the audience’s attention and used *Creativity* in their narration. Besides, in total, eight of the DSs were rated at an average level with regard to these categories.

Table 4.42 Dramatic Question and Creativity for Both DSs – Experimental Group 1

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Dramatic question	10	6	7	11	2	6
Creativity	10	8	5	10	1	8

In examining the *Pacing* and *Clarity* of speech for both DSs for this experimental group, it can be interpreted that an improvement was seen from the first to the second DS. The number of poor DSs in terms of this category markedly decreased. It can therefore be stated that the more experience in creating DSs the students had, the better products they created at the end of the process. Furthermore, having observed all of the DSs (n = 42) created in this experimental group; 12 of them were found to be poor in terms of their *Clarity*; as well as 17 DSs for *Rhythm and Voice Punctuation*; and 19 DSs for *Pacing*. Details about these items are shown in Table 4.44.

Table 4.43 Pacing/Clarity of Speech for Both DSs – Experimental Group 1

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Clarity	7	8	8	5	6	8
Rhythm & voice punctuation	11	5	7	6	4	9
Pacing	11	5	7	8	5	6

For the quality of *Visuals and Recordings/Sounds* category, while six DSs were found poor in terms of their *Recordings/Sounds* quality in the first DSs, four of them were also labelled as such in the second DSs. Those students were unable to adjust the level of their voices in their recordings, or that of the background music when needed. In terms of the *Visuals* they presented, the results concluded that the students learned how to find and use relevant pictures with an adequately high resolution. When nine of the DSs were rated poor in the first part, this number decreased to four in the second part. Of the 42 DSs in total, 19 of them were found to be good enough in terms of *Recordings/Sounds* quality; and 14 in terms of the *Visuals* quality. Table 4.45 details the examination results for these categories.

Table 4.44 Quality of Visuals and Recordings/Sounds for Both DSs – Experimental Group 1

Item	DS1			DS2		
	Poor	Average	Good	Poor	Average	Good
Recordings/sounds	6	9	8	4	4	11
Visuals	9	7	7	4	8	7

The *Environment* and *General Structure* of the story were also examined for both DSs. Most of the students specified their story *Environments* in both of their DSs; providing information about when and where the story lines would happen. Only three students in the first DS, and two students in the second DS ignored this information. This category was rated at levels of average or good for the other DSs. As to the *General Structure* of the story, almost all of the students used different words/verbs, and avoided using unended statements in their DSs; there were some problematic DSs in terms of the length and overall organization of the story. Some DSs were prepared too long in the first part, and the researcher provided feedback to those students in order to warn them about the length of their DSs, and to make sure that they did not ignore this in their second DSs. The feedback appeared to have been taken on board by some of the students; that is, the length of the DSs decreased considerably. Even so, there were still some long second DSs. The length of the course subjects to be integrated to the stories might have also affected this. On the other side, the fluency of story lines and clear endings were also ignored for a remarkable amount of DSs. In those DSs, the students just narrated their stories in a routine monotone fashion with just question/answer dialogue, or as if giving a classroom lecture. The scripts/story lines were not adequately and efficiently used in those DSs. This was a major problem especially in the first DSs, but the problem still existed in the second DSs for some students. The observations showed that more guidance was needed, particularly for these issues (overall organization, and length of story).

The next examined issues were *Grammar* and *Use of Language*, *Focusing on the Subject*, and *Content*. It can be interpreted from the results in Table 4.46 that *Grammar* structure and *Use of Language* improved from the first DS to the second. While six students had poor first DSs in terms of these issues, this number decreased to three in the second. Even though, some grammatical mistakes appeared in the stories; and after feedback was provided, those mistakes were corrected by some of the students during the DS creation process. It can generally be said that the DSs were not too problematic in terms of *Grammar* and *Use of Language* issues. The same evaluations can be stated for the issue of *Focusing on the Subject*. A few students divagated while they were writing their stories; with the number of students being four for both DSs. It can be interpreted that the majority of the students were able to maintain focus on the course subjects and story lines while both writing their stories and creating their DSs. Apart from those issues; as can be seen in Table 4.46, only three of the students created DSs that were rated as poor in terms of their *Content*. In other words, the majority of the students were able to satisfactorily integrate the course subjects to their stories. Other details about related categories are shown in Table 4.46.

Table 4.45 Grammar and Language Use, Focusing on the Subject, and Content for Both DSs – Experimental Group 1

Items	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Grammar and use of language	6	5	12	3	4	12
Focusing on the subject	4	8	11	4	7	8
Content	1	4	18	2	4	13

4.5.2. Digital stories created in Experimental Group 2

Similar to Experimental Group 1, all of the subgroups in collaborative working Experimental Group 2 found a *Title* for their stories, but three subgroups in the first DSs, and four subgroups in the second DSs forgot to add a *Title* to their DSs. Besides, out of the 12 DSs created, five of them were found to have used a *Title* that was intriguing. As seen in Table 4.47, none of the subgroups added a *Title Page* to their DSs for giving brief information about the cast of the DS.

Table 4.46 Title and Title Page for Both DSs – Experimental Group 2

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Title	3	0	3	4	0	2
Title page	6	0	0	6	0	0

The results showed that four DSs from each part had a poor *Introduction*. Those subgroups were unable to begin their stories with a remarkable *Introduction* by which to grab the audiences' attention. They just started narrating their stories by dubbing them. Besides, while half of the subgroups (n = 3) introduced their characters in their first DSs, two subgroups ignored introducing them in their second DSs, as indicated in Table 4.48.

Table 4.47 Introduction and Characters for Both DSs – Experimental Group 2

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Introduction	4	1	1	4	1	1
Characters	3	0	3	2	2	2

Even though four subgroups did not begin their stories with an effective *Introduction*, it can be said that most of the subgroups were successful in terms of using *Dramatic Questions* in their DSs. Of the 12 DSs in total for this collaborative experimental group, three of them were found poor in terms of *Dramatic Question* use, as indicated in Table 4.49. Other subgroups mostly used *Dramatic Questions* both at the beginning and in the middle of their stories; insomuch as that some groups asked several questions to grab their audiences' attention. Considering the *Creativity* issue, the created DSs were at an average level, and four of them were found to be good. Those students achieved finding different story lines while narrating their stories.

Table 4.48 Dramatic Question and Creativity for Both DSs – Experimental Group 2

Item	DS1			DS2		
	Poor	Average	Good	Poor	Average	Good
Dramatic question	1	1	4	2	0	4
Creativity	3	1	2	1	3	2

Of the 12 DSs created in this experimental group, three of them were labelled as poor in terms of the *Clarity* of the speech used; as well as five for *Rhythm and Voice Punctuation*; and four for *Pacing*. Some of those groups could not use the microphones or headphones accurately while recording their voices, therefore it was difficult to hear and understand their DSs. Other than that, while some of them narrated their stories too fast, some groups applied a slow and monotonous mood during their DSs. Table 4.50 presents the results under these categories.

Table 4.49 Pacing/Clarity of Speech for Both DSs – Experimental Group 2

Item	DS1			DS2		
	Poor	Average	Good	Poor	Average	Good
Clarity	1	4	1	2	1	3
Rhythm & voice punctuation	3	2	1	2	2	2
Pacing	1	3	2	3	1	1

In examining the quality of the *Recordings and Sounds*, half of the DSs in total (n = 6) were rated as moderate. There were some interruptions in two of the DSs so they were labelled as poor, and four of them were found to be good in terms of the quality of the recordings and background music where applied. On the other side, half of the subgroups (n = 3) in the first DSs could not use appropriate *Visuals* or pictures with significantly high enough resolution. Yet, as seen in Table 4.51, those subgroups improved themselves in terms of this issue, and found more appropriate and high quality pictures for their second DSs.

Table 4.50 Quality of Visuals and Recordings/Sounds for Both DSs – Experimental Group 2

Item	DS1			DS2		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Recordings/sounds	1	4	1	1	2	3
Visuals	3	2	1	0	3	3

Other than those categories, the 12 DSs created by this experimental group were also examined through the *Environment* and *General Structure* of the story categories. Of the first part's six DSs, five groups overlooked the environment issue altogether. Those groups did not clearly give adequate information about where and when their story lines would happen. But, in their second DSs, they considered this information as well, and let their audiences clearly know about the environment of their stories. Moreover, as to the *General Structure* of the story, as in Experimental Group 1; student subgroups in this study group also used different words/verbs and completed their statements with right amount of details. On the other hand, problems about the length and overall organization of the stories also appeared for these subgroups. According to the results, these subgroups were hardly able to manage the length of their stories, with most of the DSs longer than expected. They stated that their stories became long due to the amount of course subjects. Interestingly, this problem was common for both DSs. Unlike Experimental Group 1, this study group were unable to adjust the length of their stories, even after receiving feedback about this issue for their first DSs. Even though five of the DSs (out of 12) had different and creative narrations, question/answer styled dialogue and lecture-type narration still notably existed. As emphasized for Experimental Group 1, student subgroups in this study group also required more guidance in organizing their stories appropriately.

Lastly, taking the *Grammar* and *Use of Language*, *Focusing on the Subject*, and *Content* categories into consideration, there was a remarkable improvement between the first and second DSs in terms of these issues. The results supported that the students learned to use their language more accurately, and considered their grammatical mistakes, focused of the course subjects among the story lines, and gave the entire content with the right amount of details in their DSs. Table 4.52 displays the results in detail about those categories.

Table 4.51 Grammar and Language Use, Focusing on the Subject, and Content for Both DSs – Experimental Group 2

Item	**DS1**			**DS2**		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Grammar and use of language	3	2	1	1	2	3
Focusing on the subject	2	3	1	0	3	3
Content	1	1	4	0	0	6

To summarize, even though there were some problematic points related to the DSs in terms of certain categories, students in both of the experimental study groups did a good job on the whole when considering the entire process.

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter presents the discussion and conclusion of the study based on the findings. The chapter is organized based on the five research questions of the study, and is elaborated in five parts that are Academic Achievement, Learning Strategies, Students' Attitudes Toward Creating DS on a Science Course, Students' Opinions About DST Use, and the Quality of DSs Created by Students. Each part includes the related primary findings and discussion supported by quantitative and qualitative data. Comparisons between the current study's results and previous studies are also provided throughout this chapter. Lastly, the implications for practice and practitioners regarding the effective and efficient use of DST in science education are reported, together with suggestions for further research.

5.1. Primary Findings and Discussion

This study essentially aimed to determine the effects of digital storytelling in middle school science education. Firstly, academic achievement and learning strategies of middle school students were examined before and after the digital story development process. Secondly, their attitudes toward creating digital stories in a science course, and their opinions' based on their experiences during the process were investigated. Lastly, the digital stories created by 6th grade students were evaluated.

In line with these purposes, primary findings and discussion of the current study are elaborated through the five research questions. By representing the findings and discussion of each question separately, it is expected to contribute to seeing the whole picture of the study in detail.

5.1.1. Academic Achievement

The first research question of the study was to determine whether or not the academic achievement of middle school students on a science course are influenced by digital storytelling. Three study groups, consisting of one Control Group and two experimental groups (individual and collaborative digital story development) were assigned for the current study.

Academic achievement of the students were examined for both within and between the study groups. According to the within study groups' results, the achievement scores for all study groups statistically significantly increased after the implementations of the study were conducted. While the smallest mean score difference (11.57) was observed in the Control Group, the largest mean score difference (16.65) belonged to Experimental Group 1 (individual digital story development). As seen, experimental groups had larger mean score differences than the Control Group at the end of the study. An increase in posttest scores was expected since there were various kinds of intervention applied to help students learn the course topics. Therefore, these results supported the expected outcomes, and all of the study groups increased their achievement scores from pretest to posttest. Another reason might be the novelty effect factor of a new learning environment (Carr-Chellman & Duchastel, 2000), which was enhanced by the digital story development process, and because the students in the experimental groups had their first experiences in creating digital stories in a science course. Relying on this result, it might be interpreted that the individual and collaborative digital story development process contributed more to students' achievement than did a traditional teaching method of a science course.

This study was conducted through a specific unit called "Gamogenesis, Growth, and Development in Plants and Animals" of a 6th grade science course curriculum. Before starting the implementations of the study, the pretest scores of the study groups for this specific unit of the curriculum were examined, and a statistically significant difference was found between the study groups. When pair-comparison tests were checked, the significant difference was only seen between the Control Group and Experimental Group 1 (individual digital story development), and this difference was in favor of the Control Group. Even though there was no statistically significant difference found between the study groups in terms of their previous year's science course achievement scores, such a difference was found in the pretest scores of the current study. This result indicated that these study groups statistically significantly differed from each other in terms of this science course's specific unit scores. While Experimental Group 1 had the smallest mean pretest score (M = 13.76), the largest pretest score

(M = 17.54) was seen in the Control Group, and Experimental Group 2 (collaborative digital story development) was placed between those two groups in terms of their pretest scores.

After comparing the pretest scores of the study groups, the required tests (ANCOVA) were implemented in order to compare the posttest scores of the study groups. Since the pretest scores were found as significant covariate on students' posttest scores, this covariate was controlled and then the required tests were run. The results indicated that there was no statistically significant difference between the study groups in terms of their posttest scores. Even though no statistically significant difference was found between the posttest scores of the study groups, the achievement scores for all the study groups increased from pretest to posttest. Experimental Group 1 had the largest mean score (M = 31.08), whereas Experimental Group 2 had the smallest mean score (M = 29.88), and the Control Group had a mean score of 30.46. These results showed that Experimental Group 1 was more successful than both the Control Group and Experimental Group 2. It can be inferred from this result that creating digital stories individually in a science course might have enabled the students to learn better (Di Blas et al., 2009; Dupain & Maguire, 2005) when comparing their results to that of creating digital stories in groups or taking instruction with a traditional teaching method.

Taking academic achievement into consideration, while some researchers (Banaszewski, 2005; Büyükcengiz, 2017; Dogan, 2007; Figg et al., 2010; Foley, 2013; Göçen, 2014; Hung et al., 2012; Papadopoulou & Ioannis, 2010; Smeda et al., 2010) reported that digital storytelling increases the level of academic achievement, some studies (Demirer, 2013; Kahraman, 2013; Torun, 2016; Yang & Wu, 2012) found statistically significant results in favor of participants who were already experienced with DST in various contexts.

During the current study, each student in Experimental Group 1 and each subgroup in Experimental Group 2 created two digital stories; whereas the Control Group received traditional instruction (with homework assignments). The only role of the researcher throughout the study was in providing guidance. In other words, the students were at the core of the learning process and were actively (Bromberg et al., 2013; Liu, 2003; Wang, 2009) constructing the knowledge they needed for themselves. This learning environment provided them with some “active learning activities include planning, creating, sharing, and communicating with content that requires higher order thinking skills (Bloom, 1981). These are different skills from passive learning activities that include listening to lectures and memorizing information for exams” (as cited in Midland, 2008, p. 5). Similarly, Shepard (2000) describes the constructivist-learning approach as a social activity-based pedagogy, and in the current study, continuous interaction and communication between the researcher and learners facilitated the learning process. In this manner, the students created digital stories by constructing their own knowledge and in using their own words while narrating them. During this period, since they were able to regulate their own ideas, asked their peers about their narrations, shared their thoughts with them, and developed their digital stories, they had the opportunity to improve upon their existing communication skills (Robin, 2006). In doing so, the students were more engaged to the process, and experienced more meaningful learning thanks to the DS creation process (Burmark, 2004; Figg et al., 2010; Jenkins & Lonsdale, 2007; Ohler, 2008; Robin, 2006, 2008b; Wang & Zhan, 2010). Therefore, this active process might have enabled them to increase their achievement levels.

Similar to other study results (Bangert-Drowns & Pyke, 2002; Figg et al., 2010; Fredricks et al., 2004; Hung et al., 2012; Kahraman, 2013), during the DS creation process, the level of the students’ motivation and engagement was also seen to increase in the current study (results also supported by the interviews). Thus, the students were more eager to learn the course subjects through their narrating and digitalizing. Since their interests to the course were seen to increase with DST, their sense of achievement also improved, and they learned how to regulate their knowledge (Reyes-Torres et al., 2012). One of the major reasons for the increases seen in the students’ motivation and engagement levels was that the students found the educational environment more appealing and entertaining with DST (Hung et al., 2012; Tsou et al., 2006), and they had the opportunity to make real life relationships (Andrée, 2005; Gils, 2005; Hawthorne, 2002; Kahraman, 2013; Liu, 2003) so that they experienced permanent learning (Di Blas et al., 2009; Dupain & Maguire, 2005). This situation also enabled them to achieve the learning goals for the related topics, because it became easier for them to remember (Bromberg et al., 2013; Di Blas et al., 2009; Dupain & Maguire, 2005; Wang & Zhan, 2010) the course subjects thanks to their own narrations.

Furthermore, the interview results for the current study also supported this fact. Most of the students declared that due to their experiences with stories and digital stories, they could more easily remember the topics, particularly when it came to sitting their exams, and found they could answer more questions correctly. Thus, their level of academic achievement increased. In this regard, Schank's (1995) statement that reads, "Not every experience makes a good story, but, if it does, the experience will be easier to remember" (p. 12) backs up the importance of stories.

Additionally, as a well-known fact, when we remember what we already knew, it becomes easier to achieve the goals that we are supposed to. In this manner, remembering takes a serious place in the teaching process. Observations and interviews held during the current study illustrated that *writing*, *visualizing, recording*, and *rehearsing* are four important keys to unlock student potential for remembering what they had already heard or learned. Most of the students who participated in the current study emphasized that they used their own words and wrote their own stories, that they made real life relationships while writing their stories, storyboarded what they wrote, and finally were able to visualize and record what they narrated during this study. All those steps helped them to remember the course topics more easily during their exams, and were more able to correctly answer the questions. Moreover, thanks to those tasks, they learned the course topics better, and some of them declared that they had in-depth and more meaningful learning within the help of the stories and digital stories they created, and thereby their achievement levels increased. Almost all of them stated that the DST process contributed to their learning. Also, the number of students who chose story writing and digital story creating phases as the most contributing phase for their learning were almost the same with nearly half of all the students choosing one of those phases. On the other hand, several students preferred the storyboarding phase as the most contributing part to their learning. As seen, the phases of the DST process might have enabled students to learn the course subjects to various different extents. Because those phases enable students to remember what they already experienced, and the more they remembered, the easier they achieved on the science course.

Digital storytelling (a) includes various multimedia components such as texts, visuals, and audio (Gyabak & Godina, 2011; Simkins et al., 2002), (b) links the narrations to visual information (Burmark, 2004; Ohler, 2008; Simkins et al., 2002), (c) enables learners to gather, evaluate, and transfer the knowledge (Burmark, 2004), (d) increases the learners interests and encourage them to make research for new information (Robin, 2008a), (e) allows learners to take roles in reading and writing tasks (Kajder, 2004), (f) helps them make real life relationships (Gils, 2005), and (g) enhances the learning environment with new technologies (Wang & Zhan, 2010; Woo & Reeves, 2007). Throughout all these aspects, learners can more easily remember and recall knowledge when they need it, and all these enablers of DST were seen during the current study. Therefore, the achievement levels of students might well have increased.

Similar findings to the current study were reported in the literature. While Karakoyun and Yapıcı (2016) described how DST helped students visualize biology subjects, and enabled them to learn the subjects better, the same opportunity was provided for a social science course in Demirer's (2013) study, and with a physics course by Kahraman (2013). In this regard, it can be inferred that visualizing enables students to remember content (Midland, 2008; Wang & Zhan, 2010), and provides them with permanent learning (Bromberg et al., 2013; Demirer, 2013; Karakoyun & Yapıcı, 2016; Şimşek, 2006), which is also supported by the findings of the current study.

Lastly, students who participated in the current study emphasized that the DS creation process enabled them to rehearse the course subjects over and over, particularly whilst story writing and recording their narrations; repeating the subjects many times over through writing and recording, that they learned the course subjects better as a result. This outcome was also seen in the case of Burmark (2004), and Demirer's (2013) studies. In this sense, Yore et al. (2003) expressed that writing sessions in science course are moments in which students can repeat the knowledge. During this period, students might reflect what they understand from the knowledge they have constructed. On the flip side, Fellows (1994) stated that when students communicate with the content they have written and understand the knowledge they have created, the next step is to apply audio recordings in order to gain a conceptual understanding of their scientific knowledge. Thus, it can be said that writing and recording are two considerable enablers of rehearsing the content that students communicate with during the DST process.

In conclusion, based on the findings of the current study, it can be said that the characteristics of the constructivist-learning approach, the motivation and engagement level of the students, the level of real life relationships, and the advantages of writing, visualizing, recording, rehearsing, and especially remembering all might affect the academic achievement of students on a science course enhanced by digital storytelling. By taking all of those DST enablers into consideration, students have the opportunity to personalize their experiences (Gils, 2005; Midland, 2008; Sadik, 2008) and to communicate with the content they have created. Thus, in the current study, a more meaningful and in-depth understanding of the content (Barrett, 2005; Yoon, 2013) was provided to the students during the DS creation process.

5.1.2. Learning Strategies

The second research question of this study addressed the determination of whether or not the learning strategies of middle school students differed from each other before and after the digital story development process was applied to their science course. To be able to measure the learning strategies differences of the three study groups, the Motivated Strategies for Learning Questionnaire (MSLQ), as designed by Pintrich et al. (1991), was adapted and applied. While the original version of the questionnaire includes nine subscales, three of them (Effort Regulation, Peer Learning, and Help Seeking) were eliminated due to their having low reliability coefficients. Thus, the remaining six subscales of Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-regulation, and Time/study Environmental Management were applied to the current study. Both within and between groups' learning strategies differences were compared by using relevant types of analysis.

First, the within groups' pre- and post-learning strategies scores for three study groups were checked to see whether or not any statistically significant differences occurred. According to the results, there was no statistically significant mean differences between the pre- and post-learning strategies scores of the Control Group and Experimental Group 1. Yet, only the Metacognitive Self-Regulation strategies scores of Experimental Group 2 statistically significantly differed from pre- to post-scores. In the Control Group, only the mean scores of Metacognitive Self-Regulation, and Time/Study Environmental Management strategies increased by a very small amount, and there was a decrease from pre- to post-scores in the other subscales. In Experimental Group 1, there was a small decrease only in the mean scores of the Critical Thinking and Time/Study Environmental Management strategies. The mean scores of the other strategies in this experimental group increased by different amounts. Lastly, unlike these two study groups, all mean scores of the strategies increased by a considerable amount for Experimental Group 2.

Second, on comparing the pre- and post-learning strategies scores between the study groups, neither their pre-scores nor post-scores statistically significantly differed from each other. The differences for each learning strategy and the related discussion are reported separately as follows.

For the *Rehearsal Strategy*, while the Control Group's mean scores decreased after the implementation of the study, this strategy's scores increased in both of the experimental groups. According to Yore et al. (2003), writing sessions in a science course allows students to repeat their learned knowledge, and after they communicate with the content during these sessions, the next step is to start making their recordings in order to gain a conceptual understanding of the knowledge (Fellows, 1994), and thereby have a chance to repeat the content while recording as many times as they wish (Miller, 2009). As seen during the current study's DS creation process, students can repeat content while both writing and recording what they narrate. Additionally, Burmark (2004) highlights that students conduct their own research in order to find the relevant information during the DST process, then they link the information to their prior knowledge; and lastly, they repeatedly review the knowledge they constructed until they have created a good story. In line with these statements, particularly during the narrating and recording sessions of the DST process, students frequently were able to apply rehearsal strategies. Consequently, their rehearsal strategies scores increased more than those who did not experience the DST process. Additionally, the interviews held at the end of this study also supported these findings. Many students declared that they could repeat the content many times over, particularly while writing their stories and recording their narration.

For the *Elaboration Strategy*, similar to Rehearsal Strategy, the mean scores of the Control Group were seen to decrease, while there was an increase in the experimental groups' mean scores. These differences were quite considerable. Also, the pre- and post-elaboration strategy mean scores for Experimental Group 1 were higher than that of Experimental Group 2. During the DS creation process, students applied their prior experiences in order to make real life relationships (Andrée, 2005; Gils, 2005;

Hawthorne, 2002; Kahraman, 2013; Liu, 2003) while narrating. In other words, they had the opportunity to personalize their experience (Gils, 2005; Midland, 2008; Sadik, 2008), communicate with the content (Miller, 2009); they were also able to construct them using different higher order skills (Hung et al., 2012; Robin, 2008a) and thereby gain more meaningful and in-depth understanding of the content (Barrett, 2005; Yoon, 2013). Along these same lines, as Robin (2006, 2008a) stressed, students experienced in the DS creation process can represent the knowledge by applying different techniques such as asking questions, organizing and expressing their thoughts, analyzing, evaluating, and synthesizing. Consequently, all those techniques might have enabled the students to elaborate upon the knowledge they had constructed, and therefore to have a better understanding (Burmark, 2004). On another side, when students work in a collaborative learning environment, they communicate with each other in order to solve problems (Bean, 1996, as cited in Laal & Ghodsi, 2012), and are expected to evaluate themselves, their peers, and the classroom activities (Meier & Panitz, 1996) in order to be successful regarding specific tasks. Thus, high levels of interdependence and interaction can occur between group members, enabling them to gain deep learning (Entwistle & Tai, 1993). Those two variables were also declared by most students working in the study groups during the current study. Therefore, those variables might also have contributed to increasing the *Elaboration Strategy* scores of the collaborative subgroups of Experimental Group 2.

Observing the *Organization Strategy*, the experimental groups' scores increased whereas there was again a decrease seen in the Control Group's scores. Even though the pre- and post-scores were higher in Experimental Group 1, the results indicated that the improvement was larger in Experimental Group 2. Paull (2002) and Salpeter (2005) reported that thanks to DST usage, students who actively engage in the process increase their levels of research and organization skills. Within the help of the DST process, students apply different resources such as their self-notes, course books, and the Internet in order to *cluster* the relevant information they need; then they *outline* what they want to narrate, and finally they *select main ideas* to be able to maintain their stories. By applying those different techniques (Pintrich et al., 1991) they are able to improve their organization skills. Apart from that, DST allows students to come together, collaborate with each other, and encourages them to achieve the goals (Robin, 2006; Smeda et al., 2014a) related to specific tasks. In such collaborative learning environments, students distribute the roles among themselves, share ideas, criticize each other, and finally make decisions in order to create a better DS. By doing so, they might learn how to organize themselves. However, the interviews and observations also revealed that some students had difficulties in organizing their learning processes enhanced by DST because some students did not experience equally distributed roles. Additionally, since some of the collaborative subgroup members did not do their tasks on time, the workload for the other group members increased as a result. Another problem was that some group members did not always attend the group work; therefore, they had difficulties in preparing their materials right up until the due date of the process. These problems might also have affected the organization strategy scores of the collaborative groups.

The results of the *Critical Thinking Strategy* showed a slight decrease in the mean scores of both the Control Group and Experimental Group 1. On the other hand, Experimental Group 2 improved this strategy's scores as in the previous strategies. Yet, interestingly, the pre- and post-mean scores of Experimental Group 1 were again higher than the scores of Experimental Group 2. According to Schank (1995), stories make people more persuasive. In this manner, Sims (2004) expressed that if narrators want to convince their audience, they need to utilize critical thinking strategies such as inferences, evaluations, and explications (as cited in Yang & Wu, 2012). On the other hand, during the DST process, students are expected to make decisions in order to resolve problems and maintain their stories; and in that way they apply their critical and reflection skills (Benmayor, 2008; Maier & Fisher, 2006; Malita & Martin, 2010). They are not only presenting the concepts related to the specific subject, but also reflecting their ideas visually and audibly (Sadik, 2008). Therefore, the DST process enables students to enhance their critical thinking skills (Mullen & Wedwick, 2008; Yang & Wu, 2012). Additionally though, Webb (1982) highlighted that a collaborative learning environment enhances students' higher order thinking skills; because students working in groups express their ideas, discuss them, self-criticize, give immediate feedback to each other, and evaluate their tasks (Johnson, 1971; Peterson & Swing, 1985), reflect on each other's ideas, and their levels of critical thinking strategies improve as a result. In this sense, the enablers of collaborative learning might also have affected these study findings. In other words, thanks to collaborative learning, Experimental Group 2 improved their critical thinking strategy scores at the end of this study. Consistent results were also concluded in the study of Gokhale (1995), who reported that students in collaborative groups performed better when compared to those who worked individually in terms of their critical thinking scores. For students in the Control Group, they studied by themselves, did not reflect their ideas with their peers, and were just expected to undertake related homework in their course books. If they had any questions about the homework, their course teacher answered them. In addition, they were not expected to prepare any visual or audible materials during the process. Therefore, it can be said that their levels of critical thinking strategies use might not have been influenced as much as appeared in the experimental groups.

For the *Metacognitive Self-Regulation Strategy*, this was the only learning strategy that increased for all study groups. While the improvement was very small for the Control Group and Experimental Group 1, the mean scores of Experimental Group 2 increased by a notable amount. A significant difference was found only within scores of this strategy in the Experimental Group 2. Moreover, before conducting the implementations, the pre-metacognitive mean scores of Experimental Group 1 were higher than that of Experimental Group 2. However, the post-scores concluded with the reverse situation. According to Sungur (2007), one of the factors affecting the metacognitive strategy use is task value. Some studies (Dembo & Eaton, 2000; Neber & Schommer-Aikins, 2002; Pintrich & De Groot, 1990; Shu-Shen, 2002; Tung-Hsien, 2004; Valle et al., 2003) concluded that metacognitive strategies applied by the students are significantly influenced by various motivational beliefs, and task value is one of those beliefs. Similarly, many researchers (Ablard & Lipschultz, 1998; Ee, Moore, & Atputhasamy, 2003; Elliot & Church, 1997; Meece et al., 1988; Wolters et al., 1996) stress that the level of metacognitive strategy use increases in direct proportion to higher levels of intrinsic goal orientation and task value. For the current study, a student could achieve a maximum task value score of 42. When investigating the task value mean scores of the experimental groups (Experimental Group 1 = 38.13; Experimental Group 2 = 38.60), they were found to be very close to each other and appeared significantly high considering the maximum score available. These findings revealed that the experimental groups who participated in the study were highly motivated to the process; yet, especially the students in Experimental Group 2 were more motivated and showed higher levels of task value. Thus, it might be said that their high levels of motivation and task value enabled them to increase their level of metacognitive strategy use during the DS creation process.

Lastly, for the *Time/Study Environmental Management* strategy, while a very small decrease was seen in the scores of Experimental Group 1, the Control Group improved their scores with a very small increase. However, there was also a considerable rise in the scores of Experimental Group 2 compared to the other study groups. As a well-known fact, time is a major restriction when it comes to meaningful technology integration (Hew & Brush, 2007; Keengwe et al., 2008; Snoeyink & Ertmer, 2001). This situation is also the case for DST usage in an educational setting. Robin (2006) emphasized that since various multimedia components are used altogether having written a story in the DST process, it takes up too much time. Similarly, Dogan (2007) reported that some of the teachers who participated in his study stated that they could not find enough time to efficiently conduct the DST process within their classrooms, as it was a time-consuming process for them. In this regard, Behmer et al. (2006) and Ohler (2008) highlighted that sufficient orientation should be provided for students in order to allow them to gain the required skills for DST, and sufficient time should be given throughout the entire process. For the current study, a DS creation process evaluation scale was applied in order to elaborate on the participants' achievements in detail during the DST process. The results revealed that all of the students were satisfied with the introductory sessions given by the researcher before commencing the implementations, and almost all of the students believed that the time given for each phase of the DST process was sufficient enough for them. Moreover, the observations revealed that even though some students had difficulties in managing their time and the process due to other exams and their homework, the implementations lasted as expected. The researcher observed that the number of students who experienced time management difficulties during the first DST session decreased in the second DST session, particularly in Experimental Group 2. Hence, this improvement might have contributed to their Time/Study Environmental Management Strategy scores. Lastly, for the entire process, the researcher used half of the IT course hours in order not to cause any delay in the related curriculum of the course. Therefore, he requested extra hours from other course teachers in order to maintain the study. This case might also have contributed to students' time/study environmental management strategy use in the experimental groups.

When looking at the learning strategies in perspective, Pintrich et al. (1991) classified the learning strategies under three main categories of (1) Cognitive, (2) Metacognitive, and (3) Resource Management strategies. Since the metacognitive and time/study environmental management strategy scores have already been investigated, the mean score differences of the study groups' cognitive learning strategies (Rehearsal, Elaboration, Organization, and Critical Thinking) were also calculated altogether in order to be able better understand the findings. When comparing the cognitive strategies scores of the study groups, there were no statistically significant differences found between the study groups in terms of their cognitive strategies scores. However, while there was a decrease in the mean scores of the Control Group, Experimental Group 1 improved their cognitive strategy mean scores with a small difference. On the other hand, there was a considerable increase in the cognitive strategies' mean scores of Experimental Group 2. As emphasized by some researchers (Nichols & Miller, 1994; Stevens & Slavin, 1995), the level of intrinsic motivation, academic achievement and learning strategy use of students improves with the help of collaborative learning environment in a math class. This improvement also appeared in the current study, which was conducted through a science course. In other words, the students who collaborated while creating their DSs increased their cognitive strategy scores compared to the other two study groups. Regarding this, Reyes-Torres et al. (2012) highlighted that DST arouses students' interest with various learning types, enables them to maintain their group work, and also provides them with a meaningful way of collaborating on how to organize the knowledge. Additionally, the level of deep learning strategies use of students positively correlates with their level of task values (Ames &Archer, 1988; Meece et al. 1988; Pintrich & De Groot, 1990). When observing the task value mean scores of the experimental groups in the current study, it can be interpreted that their high mean scores might also have contributed to them improving their use of learning strategies during the DS creation process.

From a different aspect, Midland (2008) asserted that students might improve their learning strategies for self-regulated learning when listening to their own voices. They might pay more attention to the details, become more eager to overcome problems, and might improve their level of creativity (Benware & Deci, 1984). Considering those assertions, since the students recorded and listened to their own voices repeatedly during the DS creation process, they might also have improved their learning strategies. Göçen (2014) also reported similar findings in her study that was conducted with university students. She concluded that DST contributed to students' learning and study strategies scores. Consequently, the results of the current study supports the point of view that the enablers of DST in a collaborative learning environment and the students' task value levels might have enhanced their levels of learning strategies usage more than those who worked individually or who studied in a traditional learning environment.

In conclusion, while almost all of the learning strategies scores decreased in the Control Group after the experiment; only critical thinking and time/study environmental management strategies scores decreased, and by a very small amount, in Experimental Group 1. On the other hand, all of the strategy scores increased by a considerable amount in Experimental Group 2. Therefore, it can be concluded, based on the findings, that collaborative creation of DSs in a science course might contribute more to the learning strategies scores of the students than those who created DSs individually, or those who were not experienced in the DST process.

5.1.3. Students' Attitudes toward Creating DS on a Science Course

The third research question of the current study was addressed in order to determine whether or not the participants' attitudes toward creating digital stories in a science course are influenced by the DST process. First, within groups' attitude scores were examined; then, the differences between the experimental groups were checked; and lastly the attitude score differences between males and females were compared.

The results concluded that there was no statistically significant mean difference between the pre- and post-attitude scores within the study groups. In other words, creating digital stories individually or collaboratively did not significantly affect the students' attitudes toward creating digital stories in a science course. Even though, there was no statistically significant mean difference within the groups, the attitude scores for both experimental groups was seen to have increased after the DS creation process. The increase in Experimental Group 2 (from 22.88 to 25.13) was larger than the increase recorded for Experimental Group 1 (from 22.57 to 23.23). When considering the minimum and maximum attitude scores for a student (from 4 up to 28), the mean of the pre- and post-scores for both experimental groups can be accepted at a noteworthy level.

On another side, a non-significant difference was found between the experimental groups in terms of their pre- and post-attitude scores. Experimental Group 2 had larger pre- and post-attitude mean scores when compared to Experimental Group 1. Relying on these results, it might be supposed that creating digital stories collaboratively contributed more to the attitudes of students than those who created their digital stories individually.

Apart from those results, the interviews revealed that all of the students found the science course to be the best choice of course for creating a digital story; and even though they experienced some difficulties during the process, all of them had positive attitudes toward creating a digital story in a science course. This result showed dissimilarity with DISTCO 2009, as Dogan (2010) concluded that students rated Math and Science courses with low ranks as their most popular courses for creating a DS. Hence, the current study indicated the reverse of Dogan's (2010) findings. While science appeared as the most popular course for all of the students to create a DS, a math course was ranked second.

During the current study, both quantitative and qualitative data related to the attitudes toward using DST in a science course were gathered in order to examine the students' perceptions about DST integration into their learning process. In this manner, while Dexter et al. (1999) emphasized that the level of student engagement to a learning environment is mostly influenced by effective technology integration; Gils (2005) expressed that DST might greatly improve the cognitive development of learners, and provide effective technology integration into education for long-term purposes. Furthermore, Barrett (2006) stressed that DST contributes to apply effective technology integration into the learning process. In this regard, meaningful technology integration comes into prominence. When learners are allowed to choose useful technological instruments to be able to gather their required information, evaluate and harmonize that knowledge and represent it in a professional manner, then meaningful technology should be provided (Harris, 2005). Additionally, some researchers (Griest, 1996; Hoffman, 1997; Richards, 1998) highlight that instruction must be given based on constructivist-learning approach – that enables learners to socialize while learning, and to apply various strategies such as problem-solving and critical thinking when constructing their own knowledge – to be able to actualize meaningful technology integration.

On another side, Midland (2008) states that if learners are not adequately motivated to improve their writing and editing skills, they mostly develop negative attitudes toward their learning. Since writing and editing skills are also important for the DST process, students' motivation levels to use those skills also influence their attitudes toward using DST in a science course. Similarly, Hawthorne (2002) highlighted that students who lack prior knowledge and cannot connect with the language might build negative attitudes associated with their competences to write, and therefore do not pay enough attention to their learning process. Lastly, as Kim, Chun, and Song (2009) stressed, "prior hands-on experience with a technology may influence the strength of the user's attitude toward using the technology" (p. 11).

Relying on these considerations, it can be concluded that students' attitudes toward using DST in a science course might be dependent upon meaningful technology integration (the effective use of DST), the level of expectations met by the technology-enhanced constructivist learning environment, the students' motivation levels to use various skills such as writing, editing, their competences and prior knowledge to the learning activities, and their prior hands-on activities based on technology.

Primarily, all of the students were satisfied with the information provided to them about the DST process at the beginning of the study. Besides, almost all of the students thought that the documents provided, the allocation of time for each phase of the DST, and the feedback given by the researcher were sufficient for them. In other words, the requirements before and during the process were provided by the researcher in order to maintain efficiency of the process. While the students were creating their content, constructing their knowledge, narrating their stories in their own words, storyboarding what they narrated, and finally creating their own digital stories in a constructivist-based learning environment; the researcher was only guiding, encouraging, and motivating the students throughout the process. The observations and interviews revealed that even though several students experienced some technological problems, and the process took up a lot of time for most of the students, they enjoyed the process, and found it entertaining and interesting, as also concluded by Demirer (2013), Dogan (2010, 2011), Mullen and Wedwick (2008), and Yoon (2013). Additionally, the students who participated in this study had not previously created a DS before. Nevertheless, the pre-attitude (M = 22.71) and post-attitude (M = 24.09) mean scores of the students toward creating DSs in a science course can be evaluated as remarkably high considering the maximum mean score of 28. In this manner, the novelty effect (Carr-Chellman & Duchastel, 2000) of this constructivist-learning environment might have also contributed to their attitude scores.

On another side, based on the observations and the interviews, six students from Experimental Group 1, and four students from Experimental Group 2 either did not write their stories or did not create their DSs. The interviews revealed that three of them were not sufficiently motivated to write a story and create a DS, and three of them thought that they had no ability to write a story. Apart from them, because four of them faced technological problems, they abandoned the process. In other words, they could not efficiently integrate the DST into their learning process. Therefore, the attitude scores of those students were as low as expected when considering the concerns of Hawthorne (2002) and Midland (2008), and those students were found to be outliers of the study. Otherwise, the total attitude mean scores would have been higher than the current scores.

In addition, nearly all of the students were eager to use DST in their science course. While more than half of them wanted to both create and watch a DS, some of them either wanted to watch a DS or to create a DS in a science course. These results were also congruent with the results of the DISTCO 2009 and DISTCO 2012 Digital Storytelling Contests. Dogan (2010, 2012) reported that students were willing to use DST in various courses such as English, Music, Art, Science, Math, and Computing. Additionally, most of the teachers who participated in these contests tended to use DST in their classes in order to encourage and motivate their students.

Lastly, only three of the students in the current study were unwilling to create or watch a DS as part of their science course. The vast majority (95%) of the students had positive attitudes toward using DST and creating a DS in their science classes. While some of them wanted to create a DS during the semester, some students were eager to create their DSs as a performance homework to be assigned at the end of the semester.

As seen, almost all of the students who participated in the current study had positive attitudes toward creating a DS in a science course. In the related literature, some studies concluded that the educational environments enhanced with DST improved students' attitudes toward the related context (Ballast et al., 2008; Demirer, 2013; Figg et al., 2010; Hung et al., 2012; Kahraman, 2013; Paull, 2002; Robin, 2006; Salpeter, 2005; Yang & Wu, 2012; Yoon, 2013). On another hand, there are some studies (Büyükcengiz, 2017; Crăciun et al., 2016; Dogan, 2010, 2011; Gakhar, 2007; Karakoyun & Yapıcı, 2016; Sadik, 2008, Smeda et al., 2014b; Torun, 2016) that reported congruent findings with the current study. All those research studies supported that students had positive attitudes toward using DST and creating DSs in their courses.

Another interesting and notable finding of this study was that even though the females' pre-attitude mean scores were lower than that of the males, a larger increase appeared in the females' post-attitude mean scores when compared to their male counterparts. While females increased their attitude scores from 21.23 to 25.96 after the DS creation process was conducted; the attitude mean scores of the males decreased from 24.03 to 22.41. Furthermore, while there was no statistically significant difference between males and females in terms of their pre-attitude scores; a statistically significant difference was found in terms of their post-attitude mean scores and this significant difference was inherently seen in favor of the females.

Since there is not enough evidence about the effect of gender differences in the scope of DST usage, this difference for the current study can be explained by the *task value* scores of the students. As a matter of fact, a statistically significant correlation was found between the post-attitude and task value scores of the students. Moreover, a statistically significant difference was found between males and females in terms of their task value scores, and that this significant difference was in favor of the females. Therefore, one can assume that task value scores had an effect on the post-attitude scores of the students in terms of gender difference.

Task value refers to a reason, an incentive, or a catalyst that drives a learner to attempt and complete a specific task (Velez & Cano, 2012; Wentzel & Wigfield, 1998). Moreover, while Eccles, Adler, Futterman, Goff, Kaczala, Meece, and Midgley (1983) identified task value as the combination of intention and practical judgements in order to maintain a particular task in a learning environment (as cited in Velez & Cano, 2012); Pintrich (1994) defined it as an incentive factor which is very critical to a specific task. Based on expectancy-value theory, Wigfield and Eccles (2002) emphasized four types of value when considering *task value*. Those types are (1) importance, (2) interest, (3) utility, and (4) cost value. Notably, the six items of task value on the MSLQ that was also used during the current study includes the first three types of value (Velez & Cano, 2012).

In addition, Putrevu (2001) emphasized that behavioral and informational processing of males and females can be clarified by biological and social agents (as cited in González-Gómez, Guardiola, Rodríguez, & Alonso, 2012). Alternatively, Pintrich (1994) asserted that, when considering task value, contextual and personological variables are important for performing a task. In regard to those variables, some students might have higher levels of task value, whereas some of them indicate decreased task value during a classroom activity. Along the same lines, Velez and Cano (2012) stated that some students might have high potential for doing a task, yet, if they do not communicate with their task values, their potential would not be distinguishable.

By considering the importance of task value as emphasized by many researchers, different task value levels of the students were also apparent during the current study too. The observations also clarified the difference between males and females in terms of their levels of task value. For instance, females were found to be writing their stories more meticulously than males. They were taking their tasks seriously, and following the process more carefully than the males. They were also keeping their documents/storyboards/stories clearer. Furthermore, most of the questions received from the students were from females, and in particular, some were asking the researcher for feedback. Another important difference between males and females was about their storyboards. Even though the number of students who storyboarded their stories was not that high, it was seen that the females were more conscientious than males when drawing their storyboards. Lastly, the female-only subgroups in Experimental Group 2 were more careful about organizing their in-group tasks, and distributing their roles when compared to the male-only groups.

All these differences of task value levels brought out a significant difference between males and females in terms of their attitudes toward creating DSs in a science course. Lastly, even though the researcher spent considerable effort to involve all of the students in the process by providing feedback and corresponding to their needs, some students were still left demotivated by the process and their task value levels were therefore naturally low. However, the total mean scores of attitude toward creating DSs in a science course was found to be considerably high.

5.1.4. Students' Opinions about DST Use

Students' opinions about DST usage in a science course are elaborated in this section under two subsections. First, the quantitative findings are concluded from the students' opinions along with related discussion, and then the qualitative findings are presented and discussed in the second subsection.

5.1.4.1. Quantitative findings of students' opinions about DST use

The findings under this subsection were taken from 55 students' responses in total. Six different major themes namely (1) *Sufficiency of Provided Information, Documents, Time, and Feedback*, (2) *Preferences of Students While Writing Their Stories*, (3) *Difficulty Level of Each Phase in DST Process*, (4) *Contribution Levels of DST Phases to Students' Learning*, (5) *Most Challenging Tasks in DS Creation Process*, and (6) *Students' Willingness and Preferences About DST Process* emerged in order to report the findings in detail to help elaborate on the whole picture.

5.1.4.1.1. Sufficiency of provided information, documents, time, and feedback

Before starting the implementation of the current study, all of the study groups were informed about the process, provided certain materials in a USB flash drive, and in addition, the researcher provided feedback when needed by the students. All of the students thought that the information provided by the researcher about digital storytelling was sufficient for them to understand what they would be doing. Only two students stated that the information given by the researcher about how to use the Photo Story software (DS creation program) was inadequate, and a few students experienced occasional difficulties in using the program. Besides, while almost all of the students agreed with the idea that the documents included in the USB flash drives were sufficient, one student thought the opposite. Most of the students (n = 49) were likeminded; in that the time given for writing their stories and storyboarding was considered to be enough. Yet, only four of the students thought that the time given for creating the DSs was not enough for them. Additionally, 52 out of the 55 students thought that the feedback provided by the researcher for maintaining the process was adequate. These issues were important for the researcher in order to efficiently maintain the DS creation process. As seen, almost all of the students were fine with the sufficiency of the provided information, documents, time, and feedback during the process. These findings were also important to be able to have healthy results at the end of the study. To put it another way, with the help of such support, the students felt more comfortable about the DST process, because they were informed about all phases of the process, and adequate time and feedback was provided for them in order to facilitate their DS creation process.

5.1.4.1.2. Preferences of students while writing their stories

When the students were writing their stories, they used different strategies to maintain the process. Since each student and/or each group wrote two stories, some of them changed strategies between the two stories. Therefore the total frequencies of the strategies used may exceed the number of students (n = 55). For instance, when the strategy of *First I Identified my Characters in the Story* (before writing the story) was rated 47 times; the strategy of *First I Identified my Scenario* (before writing the story) was selected 41 times. On the other hand, while 41 students stated *I started writing my story according to the table of content* (of related science course topics); 18 students said that *First, I wrote my story, then I added related science course subjects to my scenario*. Lastly, when the strategy of *I started Writing my Story by Using Storyboard* was rated 15 times; 14 students preferred a strategy of *I Started Writing my Story by Using the Course Subjects Randomly*. On the other hand, almost all of the students (n = 47) stated that *I Used my Imagination While Writing my Story*; and 24 students said that *I was Inspired from a Movie/Cartoon/Video game/Book While Writing my Story*. Finally, four students said *I Wrote my Story in Regard to my Future Plans*.

Additionally, considering the resources used by the students, referring to *Self-Notes* (or a) *Notebook* while writing the story was rated 50 times; *Course Books* 42 times; the *Internet* 41 times; *Reference Books* 18 times; and use of an *Encyclopedia* was mentioned once. Based on these results, it is clear to see that students applied different strategies while narrating, used different resources, and also that they sometimes changed their strategies or ways during the process. Using different strategies and resources or following different ways during the story writing process is a way of personalizing the learning experiences, as Gils (2005), Midland (2008), and Sadik (2008) and emphasized. By personalizing their learning experiences, the students also learned how to use their story writing strategies more efficiently. This improvement was seen during the observations, and particularly in the second stories of the students, where they displayed far less difficulties in writing their second stories. Another important finding was the inspiration of students from a *Movie, Cartoon, Video Game or Book*. The inspiration enabled them to write their stories more easily. Especially, some of them were quite excited and motivated to write their stories by using a video game scenario they had played, a movie they had watched or a book they had read before. The same results were also reported in Dogan's (2007) study, where an interviewee (teacher) in his study emphasized that digital storytelling was an inspiration for the students. He said, "They were so inspired to create…that they got to tell a story about themselves" (p. 93). Therefore, the students were motivated and engaged in the process, much the same as was also observed in the current study too.

5.1.4.1.3. Difficulty level of each phase in DST process

Another noteworthy finding emerged from students' opinions was about the perceived difficulty levels (difficult, medium, easy) of each of the DST phases. In this manner, when *Story Writing* (SW) and *Storyboarding* (SB) phases were found difficult for 11 students, 24 students stated that the *Digital Story Creation* (DSC) phase was difficult for them. Besides, students were also asked to order these three phases according to their perceived level of difficulty, from difficult to easy. The results indicated that the order of *DSC–SB–SW* was the most rated (n = 15) in Experimental Group 1, whereas *SW–DSC–SB* was rated eight times by Experimental Group 2. In addition, the least frequently rated order was the same for both experimental groups, which was *SB–DSC–SW*. These findings suggest that the DSC phase was the most rated phase (n = 24) in terms of its perceived difficult among all of the students. Since Experimental Group 1 worked individually, they naturally faced more difficulties during this phase than students in the collaborative working experimental study group (Experimental Group 2); because, they had to undertake all of the tasks by themselves. In other words, their workload was higher than those who worked in collaborative groups; therefore, the DSC phase was seen to have the highest difficulty level for this experimental group. In this regard, various factors might affect students' workload. For example, when González and Wagenaar (2003) considered the effect of instructional resources and student competences on student workload (as cited in Ruiz-Gallardo, Castaño, Gómez-Alday, & Valdés, 2011), it was seen that skills for reading and studying (Lawless, 2000), learning background and motivation level (Chambers, 1994), perceived workload and learning tasks (Bachman & Bachman, 2006; Kember, 2004; Kember & Leung, 2006), and difficulty levels of content (Kember, 2004) might also affect students' workload. Hence, in their preferences for selecting a DST phase as the most difficult, the students in the current study might have changed due to such factor variances.

Observations and interviews also revealed that students in Experimental Group 2 experienced some conflicts, especially while writing their stories. Sometimes, disagreements occurred among students in the collaborative subgroups, which made the process more challenging for them. Hence, the *Story Writing* (SW) phase was placed first in the order of difficulty level of DST phases for Experimental Group 2. According to York-Barr, Ghere, and Sommerness (2007), while collaborative learning environments provide many benefits for learners, there are also some challenges that instructors meet. Some of those challenges were reported as "loss of instructional and decision-making autonomy; role shifts and confusion about how to share instructional time (e.g., who leads, who follows, how to co-teach) and how to share responsibilities (e.g., assessment, reporting)" (York-Barr et al., 2007, p. 318). Those challenges also occurred during the current study, and might have influenced the students' decisions about which phase of the DS creation process was more difficult for them.

Lastly, the distribution of roles in Experimental Group 2 made the DSC phase especially easier for its students when compared to those working individually in Experimental Group 1, because the students working in subgroups divided the workload between themselves, and so the process was easier for them. The interviews and observations also supported these findings. According to some researchers (Johnson & Johnson, 1999; Johnson, Johnson & Smith, 1998), each member in a group is complementary and distributed various roles and responsibilities in order to accomplish a specific task; and positive role interdependence occurs as all roles are assigned and fulfilled by group members (as cited in Laal, 2013). In this manner, it can be said that positive role interdependence was observed in the collaborative subgroups who accomplished their tasks successfully during the study. Therefore, the DSC phase might have appeared easier especially for them.

5.1.4.1.4. Contribution levels of DST phases to students' learning

Each student in the current study shared their ideas about which phase of the DS creation process contributed more to their learning, and the reasons behind those selections were also mentioned by the students. Of the 55 students in total, 50 of them expressed that the DST process contributed to their learning, repeating, and reinforcement of the science course topics. Apart from that, each phase was rated in itself according to its contribution level (most, medium, least contribution). The *Most Contribution* level was rated 33 times for the SW phase; 11 times for the SB phase; and 25 times for the DSC phase. Besides, the *Least Contribution* level was rated six times for the SW phase; 24 times for the SB phase; and 16 times for the DSC phase. As seen, the *Story Writing* phase was rated by the students as providing the *Most Contribution*. When students were asked to order those phases according to perceived contribution level to their learning on a science course, the frequencies differed for both the experimental groups. Considered an important finding, the order as *SW–DSC–SB* was the most rated for both experimental groups. While *SW–SB–DSC* was rated five times in Experimental Group 1; eight times in Experimental Group 2, and *DSC–SW–SB* was rated nine times in Experimental Group 1 and three times in Experimental Group 2. Another notable result was that the orders of *SB–SW–DSC*, *SB–DSC–SW*, and *DSC–SB–SW* were only rated once in Experimental Group 1, but not at all in Experimental Group 2. These results suggest that the contribution of the storyboarding phase to the students' learning was poor when compared to the other phases.

The interview results clarified several reasons behind the contribution of the DST phases to students' learning on a science course. According to the findings, the *Storyboarding* phase did not contribute enough to the students' learning. Only two students believed that they learned better as they were storyboarding their stories. On the other hand, almost half of the remaining students believed that the *Story Writing* phase enabled them to learn the course subjects better. One of the most rated reasons for choosing this phase was that students believed that they learn better while writing. As Rivard (1994) highlighted, the writing process is useful for making ideas clear, constructing knowledge, and creating a personal response to what is learned. He considered that although students write a lot, they barely improve their learning. Students who know how to write to learn as a strategy can have better understanding, think critically, and can easily recall what they learn. Based on the findings of the current study, it can be said that story writing might have enabled students to form their knowledge bases and help them gain better understanding, therefore, they might have preferred the *Story Writing* phase as the most contributing phase to their learning process. In addition, some students stated that since they searched on the Internet while writing their stories, they learned additional information about the course subjects and learned specific topics of the course better. In this regard, Burmark (2004) and Robin (2008) also emphasized the contribution of researching whilst learning during the DST process. Lastly, using *Books*, *Self-Notes* and other resources while writing the story led the students in the current study to learn the course subjects better. Relying on these findings, it might be possible to say that the *Story Writing* phase in the DS creation process enhances students' learning by leading them to use different resources such as the Internet. Even though the number of students who chose those reasons for the *Story Writing* phase differed between the experimental groups, the reasons given were common across both groups.

The other half of the students chose the DSC phase as the *Most Contributing* phase to their learning. While most of those students chose this phase because digital stories have both visuals and sounds/recordings, some students believed that they learned better in this phase because they recorded their own voices while creating their DSs. In observing the results of the current study, one of the cognitive strategies mentioned by most of the students was the Rehearsal Strategy. Hence, the findings might lead one to think that the DS creation process provides learners with the opportunity to rehearse the knowledge through writing and especially through recording. According to Fellows (1994) and Miller (2009), repeatedly recording sessions in the DS creation phase allow students to improve their use of rehearsal strategies. Thus, the more the students rehearse by recording what they wrote, the better they might have learned the course subjects. Additionally, some students stated that they had the opportunity to visualize while writing and reading their stories in this phase; and once they had visualized, they could easily remember what they had previously narrated. Thus, this phase contributed more to their learning process. According to McLeod (2007), the information that our memory takes is encoded into a new form, and stored in our memory to be recalled at a later point. This information can be encoded by visual, acoustic, and semantic means. In this sense, it can be interpreted that the DS creation process might foster students to encode data to their memory. In particularly, visual coding that enhances students' learning is provided within this process. The frequencies of those reasons for the DS creation phase also varied in the experimental groups of the current study.

5.1.4.1.5. Most challenging tasks in DS creation process

During the DS creation process, the students faced some challenging tasks. In this regard, seven tasks emerged from the students' responses. Almost half of the students found *Recording for the DS* (*n* = 27), *Finding Visuals Related to the Story* (*n* = 24), *Adjusting the Time for Each Scene in the DS* (*n* = 24), *Adjusting the Duration of the Entire DS* (*n* = 24), and *Ordering the Visuals According to DS Flow* (*n* = 22) as challenging tasks within the DS creation process. On the other hand, *Adding Sounds/Music to the DS* was rated 13 times; and *Adding Texts to the DS*, was rated four times as a challenging task. Even though most of those challenging tasks could have been overcome through an increased level of the students' ICT skill, as the finding of related and high quality pictures for their stories was especially challenging for the students. Also, as their stories were individual to each student, sometimes they could not find the relevant pictures they needed, and therefore, some of them struggled to resolve the problem, and ending up drawing their own pictures for use in their DSs.

5.1.4.1.6. Students' willingness and preferences about DST process

Finally, the students' willingness and preferences about the DST process were investigated under the quantitative part of the students' opinions. For the willingness of the students, the results indicated that more than half of the students (*n* = 32) *Wanted to Both Create and Watch a DS About Any Subject on Science Course* in the future, and only three of them were willing to *Neither Create Nor Watch a DS About Any Subject on a Science Course*. For the preferences of the students, the findings illustrated that more than half of the students (*n* = 33) *Wanted to Create a DS About a Unit That I Like on a Science Course*. Lastly, 22 of them preferred to *Create a DS About a Unit That I Like as a Performance Homework at the End of the Semester*.

Some related research studies (Haigh & Hardy, 2011; Hung et al., 2012; Lowenthal, 2009; Lowenthal & Dunlap, 2010; Reitmaier, Bidwell, & Marsden, 2010; Stacey & Hardy, 2011) reported that students engage more to technology-based educational environments such as those enhanced with DST, as the use of technology increases students' levels of interest (Shih, Chuang, & Hwang, 2010; Hung et al., 2012; Hwang

& Chang, 2011). The observations and interview results of the current study also revealed that integrating technology into a science course through using DST, allowing students to use computers and different programs (such as Photo Story), and leading them to search the Internet during the DS creation process increased their motivation and ensured they were involved more in the course. Therefore, the students were eager to watch or create more DSs in their future science courses. Lastly, as Robin (2008a) and Hung et al. (2012) emphasized, since the students used a DS creation program (Photo Story 3), they had the opportunity to generate the knowledge they gathered and to integrate it into their learning process in a more appealing and meaningful way. As a result, they liked the way they managed their own learning process by taking on board the advantage of DST, and becoming more willing to use it in their other courses as well.

5.1.4.2. Qualitative findings of students' opinions about DST use

In this section, the students' opinions are reported twofold. First, the common themes that emerged from both of the experimental groups are presented. Then, the themes created from the collaborative group's responses are elaborated upon. The common themes were mainly classified under four categories that are *Effects of DST in Science Education, Difficulties Faced in DST Process, Preferences of Students,* and *Suggestions from Students*. These themes and related discussion are reported respectively as follows.

5.1.4.2.1. Effects of DST in science education

The effects of DST in science education were labelled as positive and negative, based on the interview results. As starting with the positive effects, several contributions of DST use in science course were declared by the students and gathered under five subthemes. One of those subthemes was related to *Cognitive Strategies*. Two strategies which were *Rehearsal* and *Reinforcement* were mentioned by more than half of the students. They stated that thanks to the DS creation process, they improved their *Rehearsal* and *Reinforcement* strategies. In particular, writing sessions (Yore et al., 2003) during the story writing phase, and repeatedly recording sessions (Fellows, 1994; Miller, 2009) in the DS creation phase can help students to improve their use of such strategies.

By writing and recording what they had written, it enabled them to communicate more with the content and to gain a conceptual understanding of the knowledge.

The second subtheme that emerged from the students' responses was *Enablers for Learning*. For instance, creating a DS supported students in their exam preparations. They expressed that during their exams, they could easily remember their own stories related to the specific course subjects, so that they answered the questions correctly, and their course scores increased. As Schank (1995) emphasized, good stories help us to easily remember our experiences; and, some researchers (Bromberg et al., 2013; Dupain & Maguire, 2005; Wang & Zhan, 2010) also expressed the importance of DST with regard to its contribution to memory, stating that DST allows learners to remember the related subjects more easily. This positive effect of DST, as mentioned by those researchers, was also the case seen in the current study's results. The next enabler for learning was that DST usage led students to use their imagination, as also reported by Karakoyun and Yapıcı (2016). Pelayo (2013) highlighted that storytelling is an effective way of constructing knowledge, and that using the imagination helps students to complete areas lacking in their learning process. Additionally, using the imagination enables learners to articulate their knowledge in a well-structured and meaningful way (Pelayo, 2013). Likewise, Menezes (2012), Reed (1987), and Sylla et al. (2014) stated that DST plays a significant role in developing the students' skills in the use of their imagination. In this sense, students declared that because they used their imagination and organized their knowledge by themselves, a more permanent learning (Di Blas et al., 2009; Dupain & Maguire, 2005; Karakoyun & Yapıcı, 2016) occurred in their science courses. Some students also stressed that, thanks to DST usage in their science course, they were afforded the opportunity to use different techniques such as visualizing, recording, searching the Internet while learning the course subjects, and that applying those techniques encouraged and motivated them more towards the course and a more entertaining learning environment happened as result. Applying imagination and using different techniques might have contributed to the students' learning process in science.

The third subtheme was related to *Enhancing the Knowledge Gain*. Almost all of the students emphasized that DST usage increased their level of knowledge about the course subjects and that they learned better as a result. The results also conformed to the findings of many other studies (e.g., Bangert-Drowns & Pyke, 2002; Figg et al., 2010; Fredricks et al., 2004; Hung et al., 2012; Kahraman, 2013; Karakoyun & Yapıcı, 2016; Tsou et al., 2006) to be found in the related literature. It can be inferred from those results that DST can be used as a beneficial pedagogical tool in science education, which facilitates students' learning process.

The next subtheme categorized under the positive effects of DST use was students' *Making Real-Life Relationships* during the DST process, which was also reported by Andrée (2005), Gils (2005), Hawthorne (2002), and Liu (2003). They were inspired from different incentives such as video games, books, cartoons, and movies when making those relationships. Besides, they used real life names and real/daily life events in their DSs. Thus, remembering the course subjects became easier for them.

The last positive effect of DST was about the varied *Contribution to Individual Skills* of the students. The most mentioned skills improved during this process were ICT skills. Almost all of the students stated that since they often used their PCs, installed a new program to their PCs and then used it, performed searches on the Internet, found different pictures and then edited them, recorded their own sounds, edited the background music, switched between different files on their PCs, and transferred various documents using USB flash drives etc., they can say that their ICT skills improved during this DS creation process. Some of them also improved their drawing skills thanks to the storyboarding phase. Effective technology integration (Barrett, 2006; Dexter et al., 1999; Gils, 2005) not only allows learners to be active in the learning environment, it also helps them to improve various skills (Brown, 2004; Kulik, 2003; Smeda et al., 2014b; Ware, 2006). During the DS creation process, since the students are more involved in using the technology, their ICT skills (Sadik, 2008) or technology usage skills (Dogan, 2012) become more developed. Some related studies (Czarnecki, 2009; Robin, 2008a; Smeda et al., 2014a, and Yüksel et al., 2011) also corroborated the findings of this study in terms of those skills.

Apart from that, even though the number of students who declared that they improved their cognitive skills were not so high, some students shared that they improved their story writing, memorization, organization, critical thinking, researching, and concentration skills. In addition, one of the most important findings of the current study was that nearly half of the students realized some skills that they did not know they already had. Imagination, writing, self-dubbing, and DS creating skills were among those self-realized skills. Many studies also claimed that usage of DST enables learners' to improve different individual or collaborative skills. For instance, Yüksel et al. (2011) reported that respondents' writing, technology use, language (listening, speaking, narrating etc.), social, reflection, higher order thinking and artistic skills improved during their studies. Additionally, various research studies concluded that DST usage helps learners improve their higher order thinking skills (Dakich, 2008; Hung et al., 2012; Robin, 2008a), critical and reflection skills (Benmayor, 2008; Maier & Fisher, 2006; Malita & Martin, 2010; Yang & Wu, 2012), technical skills (Dogan, 2012), research and organization skills (Dogan, 2012; Karakoyun & Yapıcı, 2016; Paull, 2002; Salpeter, 2005), and writing and organization skills (Dogan, 2012; Yamaç & Ulusoy, 2016), which are also considered major findings of the current study.

Finally, the interview results clarified that the only negative effect of DST use in science education was about *Time Constraint*. More than half of the students complained that this process was very time-consuming. While some of them stated that their other homework and courses were negatively affected due to the workload of the DST process; some students complained that they could not study enough for their other exams. As emphasized by other researchers (Dexter, Anderson, & Ronnkvist, 2002; Hew & Brush, 2007; Keengwe et al., 2008; Ringstaff & Kelley, 2002; Snoeyink & Ertmer, 2001; White, Ringstaff, & Kelley, 2002), meaningful technology integration requires time to be invested in order to enhance students' learning. In addition, Robin (2006) highlighted that due to using various multimedia components, writing a story in a DST process takes too much time. Banaszewski (2002), Lowenthal (2009), Nguyen (2011), and Robin (2006) also stated that it was a time-consuming process This was also the case experienced by the students of the current study. When comparing the phases of the DST process; in particular, the *Digital Story Creation* phase took considerably more time than the *Story Writing* or *Storyboarding* phases; whereas students were easily able to handle the *Story Writing* and *Storyboarding* phases. However, as previously stated, when technology is integrated into the process, students faced additional struggles; therefore, they had difficulties in managing their time, and some students could not complete their tasks on time. The findings of the current study regarding time as a barrier were congruent with the results of several other published studies (Dogan, 2007; Dogan & Robin, 2008, 2009; Yuksel et al., 2011). Participants of these other research studies also pointed out that DST usage took up too much time and that they were unsure whether or not its contribution was worth spending so much time during their learning process.

5.1.4.2.2. Difficulties faced in DST process

The next main theme emerged from the interview results was *Difficulties Faced in DST Process*. The difficulties mentioned by the students varied according to the phases of the process. In the *Story Writing* phase, while some students had difficulties in finding or naming their characters, others stated that *Creating the Scenario* was difficult for them. Additionally, *Ordering/Integrating the Course Subjects to the Stories*, and *Arranging the Length of the Stories* were some other difficulties faced in this phase. Similar findings were also found in the studies conducted by Kulla-Abott and Polman (2008) and Nguyen (2011), who reported that effective scriptwriting is dependent upon the familiarity of the topics and the level of emotional stances. When students are not emotionally involved in the topics and find them irrelevant, then they face difficulties in writing their narrations and likewise, persuading their audiences (Kulla-Abott & Polman, 2008). In this manner, students in the current study who experienced difficulties in writing their stories might not have been emotionally involved in the process, and therefore they could not efficiently write their story's scripts.

Additionally, while only several students underwent difficulties in the storyboarding phase; the most rated difficulties were found in the DS creation phase. For example, recording and finding/choosing pictures for DSs was considered difficult by almost half of all the students. They pointed out that they had to repeatedly record their voices because of environmental noises or mispronunciation mistakes while recording. Additionally, finding relevant and high quality pictures for their DSs was very challenging. On the other hand, only a few students reported having had difficulties in adding music and ordering the pictures in their DSs. Banaszewski (2005) and Nguyen (2011) also faced such problems in their studies.

One of the reasons behind those difficulties might be that none of the students had previously created a DS. In other words, they had no prior experience to draw upon in creating their DSs; and therefore, such difficulties were quite natural. Another reason might be their levels of technological skills (Lambert, 2010, as cited in Nguyen, 2011; Ohler, 2008). Those students pointed out that even though they were not good at using

PCs/technology, and were anxious before even starting this process; and spent considerable effort in trying to deal with those difficulties. When considering the difficulties faced in the DS creation process, additional writing and digital story creation practices might solve such problems to some extent, and help students improve their writing and technological skills.

Lastly, some difficulties were faced in the collaborative subgroups. While some of them could not manage their time, and could not meet up sometimes for their group works; some of them had dichotomy problems when sharing their ideas and making decisions about their narrations and their DS designs. Yet, the researcher's observations revealed that the most important difficulty faced was the distribution of roles among the subgroup members. Because some of the subgroup members did not actively participate in the process, the other team members' workloads increased as a consequence. Hence, those subgroups could not perform their tasks on time, and therefore struggled as a result. Similar problems were also reported by Sadik (2008). He stressed that just one or sometimes two students in collaborative groups performed their tasks actively, and that those students did not care about the others' opinions during the DS creation process; which is as also observed in the current study. Such problems can be overcome when the practitioners distribute the group roles for each member, and frequently control their tasks as to whether or not they complete them on time.

5.1.4.2.3. Preferences of students

The third theme, which is considered to be one of the important findings of the current study, was about the *Preferences of the Students*. First of all, Science was found as the most appropriate course for creating a DS by all of the students. The students were then asked to select another course within which they would like to create a DS, apart from science, and also to share their reasons behind their selection.

Math was the most rated non-science course. Most of the students who chose this course stated that they preferred the Math course because they often had difficulties in understanding the subjects of math. Therefore, they would like to apply the advantages of the DST process in order to overcome those math course difficulties. Some students thought that the subjects of math are appropriate to creating a digital story. They believed that narrating about the subjects of math would be easy for them when they employed the use of numbers, formulas etc. For instance, they pointed out that they could choose the numbers as their story characters, and some daily life events for the basic calculations. Additionally, when one student wanted to make math more entertaining, another student stated that the course was his favorite; hence, they wanted to create a DS for math.

The second most rated course was *Social Science*. The top-rated reason for this course was that since some students believed the subjects of the course to be appropriate to the creation of a digital story, and that they preferred social sciences. Whereas several students stated that they faced difficulties in understanding social sciences; for some students it was their favorite course, and therefore they chose social sciences. In addition, one student wanted to get a higher grade in social sciences; therefore, she selected this course.

The third most preferred course was *Turkish*. Two different reasons emerged from the students' responses for this course. While half of the students who preferred this course thought that the course subjects were appropriate to the creation of a digital story; the others said they had difficulties in understanding the subjects of the Turkish course, and that they would therefore like to create a DS for this course. Furthermore, an interesting finding of the current study was that only four students chose English as a course where they wanted to create a DS, and the reasons of those students differed. One of them thought that the subjects of the English course are appropriate to creating a digital story, whereas another student had difficulties in understanding the course. Additionally, English was the favorite course of one of the students, and another chose this course in order to improve his English. Lastly, when two students highlighted that they would choose any course in which they faced difficulties in understanding, only one student wanted to create a DS for the physical education course in order to make the course more entertaining.

The findings of the students' preferences about choosing a course in which they wanted to create a DS could be compared with the results of the Digital Storytelling Contests (DISTCO), which are a series of contests held annually since 2008. According to Dogan (2010),

> The DISTCO had two major goals: 1) to encourage students and teachers to challenge themselves in an exciting competition where 21st

century skills can be enhanced, and 2) to further current research on the effectiveness of digital storytelling in K-12 education. (p. 1062)

For the current study, the results of DISTCO 2008 (Dogan & Robin, 2009), DISTCO 2009 (Dogan, 2010), DISTCO 2010 (Dogan, 2011), and DISTCO 2012 (Dogan, 2012) were examined. The DISTCO contests concluded different results in terms of the popularity of subjects preferred by the students each year. In examining four of the contests' results (2008-2010, 2012), the science course was ranked fourth or sixth, whereas it was the most popular course of the current study for students' preferences to create a DS. One of the reasons behind the popularity of the science course for the current study might be that the students had the experience in creating DSs on science topics through this study. The other reason might be the applicability of the science course to creating a DS, as stated by most of the students. Another interesting result was that math was found to be a less popular course in the DISTCO contests, yet, it was the second most rated course in the current study. When some of the students selected this course stated that math subjects are appropriate for creating a DS; some also highlighted that since they had difficulties in understanding math subjects, DST might facilitate the learning of these subjects. For social sciences, the results of the contests showed similar trend with the science course. In other words, the science course was preferred at fourth or seventh rank during the contests, whereas it was ranked in third place in the current study. Even though similar reasons to math course were also stated for social sciences, the number of students who mentioned those reasons were lower than those who preferred math. Lastly, another interesting and important finding was found regarding the English Language course. Even though Banaszewski (2005), Salpeter (2005), and Weis, Benmayor, O'Leary, and Eynon (2002) asserted that English Language Arts can be assumed as a common field of DST in order to teach writing to the learners, the results of the current study and the DISTCO contests indicated the opposite. In other words, the English Language Arts course was found to be less popular for creating a DS.

Furthermore, when the DISTCO contests questioned the primary motivation factors for students to create a DS, the current study particularly examined the factors leading students to choose a specific course for which to create a DS. In this sense, the results indicated two major motivating factors for all of the courses preferred by the students. One of those factors was that because the students had difficulties in understanding those courses, they wanted to create a DS in order to make their learning process easier and to gain a better understanding. The other reason was that they believed the subjects of the course they selected were considered appropriate to the creation of a digital story. They thought that they could easily create scenarios about their stories thanks to the appropriateness of the course subjects. Relying on the findings of the current study, when the DS creation process might not be effective for courses whose subjects are considered inappropriate for the creation of a DS, it might be especially beneficial for enabling students to learn subjects that they have difficulties in understanding.

To summarize, when considering the students' preferences, the results of the current study indicated notable differences compared to previous DISTCO results.

5.1.4.2.4. Suggestions from students

The last main theme that emerged from the students' interviews was about their *Suggestions* in order to *Improve the DST Process* and to *Determine the Students' Expectations*. In this regard, the most mentioned suggestion was that some students emphasized that if they had different roles as a character of the story, and they could role-play the story on a stage as in a theatre, the DST process would be more effective and instructive for the students. Some stressed that, on a stage and whilst the story is being narrated, not only could actors portray characters of the story, but also use different pictures of the objects (each student could hold a picture of the story on the stage whilst another narrated), so it would appear like a live DS. Besides, the following suggestion came from some students in Experimental Group 1 who created their DSs individually. Those students thought that if they worked in a group, they would have the opportunity to take advantage of expressing their ideas, distributing roles in a group, and learning from other group members in order that the process would be easier and more effective for them. Johnson, Johnson, and Holubec (1998) stated that in a collaborative learning environment, each group member has some unique tasks and is expected to expend effort in order to accomplish those tasks. They also emphasized that when all group members achieved the goals needed for the group's success, positive interdependence occurs in this collaborative learning setting (as cited in Laal, 2013). One can interpret that those students might have been aware of the importance of positive interdependence of collaborative learning environment, and expected to have experiences in such learning setting during a DS creation process.

Another interesting and important suggestion stressed by several students was that those students recommended removing the storyboarding phase from the process. They thought that since they had found and used pictures in the DS creation phase, that they would not need to draw these pictures again in the storyboarding phase. In other words, they found this an unnecessary phase within the DST process. Karakoyun and Yapıcı (2016) also reported the same suggestion taken by participants in their studies as the phase being unnecessary and recommended to exclude it. Yet, Jakes (2005) highlighted that even though most students in their study did not like the storyboarding phase and teachers were mostly willing to remove this phase from the DST process, it is actually an important and required phase in order to facilitate the DST process. Although some students suggested removing the storyboarding phase from the DS creation process, the researcher considers it would be better to keep this phase in the process, but that more detailed guidance needs to be provided to the students, and more time for allocated to facilitating the process.

On another side, while several students wanted to create a DS for other subjects of a science course, some of them suggested to create a DS for a course that they were not good at. This suggestion might lead to an assumption that the DST process encouraged and motivated students in order to use DST in their future courses. Another noteworthy suggestion came from the students in Experimental Group 2. One subgroup of students suggested to form their own collaborative groups, to choose a group leader, and then the group leader would distribute their roles. However, some students complained about the distribution of their roles. They thought that they had not equally distributed the roles for each member of the group, and therefore, some tasks were not sufficiently carried out. In this manner, even though, they believed that distributing the roles by themselves would be better for them, they preferred that they be distributed roles by the researcher due to their perceived inability with this task. Since the researcher planned to create a constructivist-based learning environment, he did not want to intervene while the students were forming their study groups. However, this suggestion might be considered for further research of related fields. Lastly, when a few students suggested having more classmates in the group, particularly for recording sessions, two students suggested collaboration with the course teacher/researcher during the entire process due to their own perceived limitations and the difficulties they faced in the process.

Apart from those four main themes that emerged from the experimental groups; several themes were also generated from the students of Experimental Group 2, who worked collaboratively in small subgroups. Since those themes were specific to this one study group, the researcher decided to report them separately from the previous joint findings. In this regard, four different themes emerged from the students' responses, and are presented as follows.

5.1.4.2.5. Advantages of collaborative work

The most mentioned advantage of collaborative work was the distribution of roles within the groups. Some students agreed that distributing their roles in the group made the process easier, because as they shared their tasks in the group, the workload decreased for each group member. Otherwise, they thought that the process would be very difficult for them if they had to work individually. Another important advantage of group work was that the students in these groups could exchange ideas. When working in a group while creating their DSs, they had the chance to share their ideas with other group members. In doing so, they gathered various ideas about all phases of the process, and then they could select the best of them. Johnson (1971) and Peterson and Swing (1985) emphasized some advantages of collaborative works that were also concluded in the current study. They stressed that students working together in collaborative groups can express their ideas, discuss them, self-criticize, give immediate feedback to each other, and evaluate their tasks together. While Forsyth and McMillan (1991) claimed that intrinsic motivation is the core factor influencing the learning process, helps learners develop their attitude, increases their level of comprehension, and enhances their abilities; Hertz-Lazarowitz, Kirkus, and Miller's (1992) view was that collaborative learning is a major motivation factor for learners.

Moreover, Robin (2006) and Smeda et al. (2014a) highlighted that DST enables students to get together, collaborate with each other, and encourage them to achieve goals related to specific tasks. During this study, the observations also indicated that some groups in particular took advantage of working collaboratively. Those groups often discussed what and how they were narrating their stories, the finding and naming of their characters, examining story lines, storyboarding what they narrated, and they also pooled their ideas, criticized each other, and finally made decisions about what they would do. When they came up with a good idea, all of the group members became happier and maintained their work on the process with a higher level of motivation. Furthermore, since they had such collaborative experiences during their first story and DS, they improved their abilities to group work during the second story and DS. Thus, the process became easier for them to handle.

On the other hand, some of the students declared that they had learned how to take responsibility and to do tasks on time during the group works. This was because they were all aware of what would happen if they did not do their self-tasks. In other words, they knew that they were supposed to accomplish their tasks on time in order to achieve group and individual success. During this period, while some of them had their first experiences in taking on responsibilities in a group work, other students improved their responsibility taking awareness. ChanLin (2008) and Wang (2011) expressed that students can enhance their sense of responsibility through collaborative works, so that their ability to accomplish a group task might improve. In line with this, some research studies (Karakoyun, 2014; Karakoyun & Yapıcı, 2016; Sadik, 2008) supported similar findings. They reported that, during the DS creation process, the participants took on certain responsibilities in order to accomplish their tasks on time, and as a result their responsibility skills improved. As concluded in the current study, especially those groups whose members were aware of the positive interdependence of collaboration performed their tasks well, narrated better stories and created good DSs. Additionally, even though some group members did not perform their self-tasks in the group, other group members tried to make up for these insufficiencies caused by their group mates inaction. When the researcher determined such problems had occurred in certain groups during the first story and DS, he tried to resolve those problems in the second phase of the study, and encouraged group members who did not take on adequate responsibilities to become more involved in the process.

The next advantage of group work also related to the distribution of roles in groups was time-based issues. Since the collaborative groups divided the group’s tasks up among themselves, they could more easily handle the process, and finished their tasks in a shorter period of time compared to those students working individually in Experimental Group 1. The students in Experiment Group 2 felt lucky because they were working in small subgroups throughout the process. Apart from those advantages, while some students had their first experience in a group work situation and learned how to work along with their classmates during this process, some of them improved their levels of socialization, as in all phases of the DS creation process, the students helped each other, and shared their ideas. Thus, they could each also have the chance to improve their friendships whilst working together. While Sultan and Hussain (2012) emphasized that collaborative learning enhances students' social and reflective skills; McLeod (1985), Brody and Davidson (1998), and Cohen (1991) all stressed the major roles of collaborative learning as promoting learners' social skills, increasing interaction between them, and enabling them to develop their social competences (as cited in Sultan & Hussain, 2012). In this regard, many studies (Craig et al., 2001; Demirer, 2013; Mello, 2001; Thang et al., 2014; Smeda et al., 2010; Yuksel et al., 2011; Zull, 2002 as cited in Hung et al., 2012) indicated that storytelling and digital storytelling provides more interaction among learners, enhances their levels of friendships, improves their socialization skills, and encourages them to interact more with each other. Based on the interview results and the observations of the current study, it can be said that DST might help students improve their friendships, reflect their ideas with their peers, understand the importance of collaboration and foster socializing with their classmates. Lastly, as an important finding, the observations of the researcher revealed that all of those advantages encouraged some students to work in a group for their future classroom activities. Even though some of them had never experienced working in a collaborative group before, they were eager to collaborate with their classmates in future activities. This finding also supported the contribution of DST to students' collaborative learning experiences.

5.1.4.2.6. Disadvantages of collaborative work

Despite the fact that collaborative work provided some advantages during the DS creation process in the students science course, there were also some disadvantages reported by them in this group work.

Divergence having occurred among group members was the most declared disadvantage. Since sharing ideas and having different opinions in group work is inevitable, students sometimes had disagreements while discussing what they should do in any phase of the DS creation process. However, the researcher observed that only one subgroup were unable to manage this issue successfully. They often had disagreements during the study, but they did eventually managed to write their stories, and create their DSs. Other groups overcame such problems in a shorter period of time.

Another disadvantage of working in a group was *Workload*. Just a few students expressed this problem. According to their opinions, if a group member was capable of doing a specific job in the group, other members might let them just do it and not take part in the task, therefore the workload increased for the subgroup member who took on the task. Sadik (2008) also reported similar problems seen with his study groups. This situation might occur due to low motivation levels of students. If they had no interest or low levels of interest in the process, they may not want to do their tasks. Another reason might be that those students had no experience of working in a collaborative learning environment; and even though the researcher provided guidance to those students, they still could not achieve the goals in terms of group tasks. Therefore, the workload for some of the students in groups would have increased as a result of their inaction.

On the other hand, the students stated that sometimes some group members might not have fully accomplished what they should have; hence the workload become unfair for the other group members who would have to complete the other subgroup member's task as well as their own.

Apart from those disadvantages, the researcher's observations showed that sometimes *Communication Problems* occurred between subgroup members, but that most of the subgroups resolved those problems by themselves. Even though the number of students who mentioned the disadvantages of workload and communication problems was not that high, the researcher considered these problems to be of importance for group works, because, the less the students encounter such problems, the better their group works will be as a result.

5.1.4.2.7. Preferences of students

The third main theme emerged from collaborative groups' responses was about their *Preferences*. Their satisfaction of working in a group was examined by asking whether or not they would prefer to work collaboratively or individually for better learning during the DS creation process on a science course. The results indicated that the number of students who chose each of the strategies were very close to each other. Almost half of the students who worked in a collaborative group stated that they would have preferred to create their DSs individually. Those students emphasized that even though the process would be more difficult when working individually as compared to collaboratively, they believed that they could learn better when doing each of the tasks individually. They also declared that the distribution of roles in a group might negatively affect their learning process, because they had no chance to learn in detail what other group members were doing during the process – a result also found in Sadik’s (2008) study. Hence, the students wanted to do everything – story writing, storyboarding, and digital story creating – by themselves. On the other hand, the remaining students preferred to work in a group, as they were, during the DST process, highlighting the importance of sharing ideas with group members during group work. They believed that they could learn better when they shared their ideas with each other while narrating their stories and digitalizing them. They also stressed that working with their classmates allowed them to learn information about the course subjects that they did not know. Lastly, they believed that the workload for each subgroup member decreased through collaboration with their classmates.

In observing the preferences of the students, one can interpret that individual and collaborative learning plays a significant role for each student. In individual learning, each learner promotes their own learning individually, studies separately, actively accomplishes learning tasks by themselves, and takes responsibility for their own learning process (Brody, 1995). However, in collaborative learning, learners join forces and work together in order to accomplish specific learning tasks through communication with each other (Rau & Heyl, 1990). When Andersson and Rönnberg (1995) asserted that it is beneficial to apply individual learning for simple tasks, Laughlin, Bonner, and Miner (2002) stated that collaborative learning is beneficial for complex tasks. In addition, Kirschner, Paas, and Kirschner (2011) reported that cognitive load for individual learners decreases in simple tasks when compared to those who learn collaboratively; yet, the findings of the current study indicated the opposite when complex tasks are at hand. Based on the findings of the current study, even though some students found the DS creation process difficult for individual working, they still preferred writing stories and creating their digital stories individually; whereas, others wanted to work in a collaborative working group in order to decrease the workload and to share their ideas with their fellow group members. In this manner, it can be said that students’ learning preferences might play a significant role in their DST usage on a science course.

5.1.4.2.8. Skills in collaborative groups

The last theme under this section includes skills that might arise or improve in a collaborative group work as stated by some students. The interesting finding was that the number of students who mentioned such skills were not that many, because it was expected that since those students worked collaboratively during the process, the type of collaborative skills and the number of students talking about those skills would vary considerably compared to the other stated themes. In this regard, several students emphasized that they had improved their relationships with their classmates thanks to such group work. They could spend more time with their friends, and keep in touch with each other; so they believed that their communication skills improved during this process. Parallel to those findings, various research studies (Behmer, 2005b; Combs & Beach, 1994; Dakich, 2008; Ohler, 2008; Robin, 2006; Smeda et al., 2014a; VanderArk & Schneider, 2012; Yuksel et al., 2011) concluded that DST leads students to communicate more with each other and helps them to increase their level of communication skills. Relying on the findings of this study, it can be said that DST might increase the communication levels of students, particularly when used in a collaborative learning environment. It might also encourage shy students or those who have low levels of self-confidence to interact with their classmates.

In addition, a few students mentioned collaboration skill. They stated that they could collaborate more with their friends through helping each other in that group work. Thus, their collaboration skills improved during the DS creation process. Even though the number of students that mentioned this skill was low, the researcher's observations revealed that more than just the students who declared this skill had improved their collaboration skills, and engaged more with their peers in an active educational environment. The observations also clarified that those students were willing to help each other out with school tasks at some time in the future. As stressed by Standley (2003), students engage more with the content and the learning setting when they collaborate in small groups. In addition, the findings of this study regarding collaborative skills also conformed to many other published study results (Dakich, 2008; Mello, 2001; Ohler, 2008; Rooks, 1998; Smeda et al., 2014a; Yuksel et al., 2011). In this manner, the findings of the current study might lead to the interpretation that the use of storytelling/digital storytelling allows learners to engage in small group working that facilitates their collaborative activities, and enhances their collaboration skills. Applying DST in education might help educators create collaborative learning environments in which students can engage more with the content, construct their own knowledge, and realize meaningful learning.

Apart from those skills, since the students learned to criticize each other for their opinions on any phase of the DS creating process, one of them declared that her criticizing skill had improved during this study. In this sense, Behmer (2005b) and Wang and Zhan (2010) highlighted that students can learn how to criticize their peers' opinions and their products, and provide feedback with regard to their group activities during the DS creation process. Another student stated that she realized her ability to work in a group. Even though she was not used to working in a group and preferred studying by herself at the study's outset, she changed her mind after experiencing the DST process, stating that the DS creation process facilitated her working in a group, which was also emphasized by Robin (2008b) and Yuksel et al. (2011). Based on the researcher's observations, it can be said that it was especially the *Story Writing* phase which improved students' critical thinking skills rather than the *Storyboarding* or *Digital Story Creation* phases. Alterio (2003) also highlighted that storytelling enhances students' critical thinking skills. Since the story lines are created in this phase, students inherently criticized their thoughts during the study. Therefore, story writing sessions in particular can be integrated into various educational contexts in order to allow students to critically think, self-criticize and criticize their peers and thereby gain meaningful understanding.

5.1.5. Quality of DSs Created by Students

The last research question of this study examined the quality of the digital stories created by the students. Those DSs were examined by using a DS evaluation rubric that included various categories such as *Title and Title Page*, *Introduction of the Story and Characters*, *Dramatic Questions*, *Creativity*, *Pacing and Clarity of Speech*, *Quality of the Visuals and Recordings/Sounds*, the *Environment*, *General Structure of the Story*, *Grammar and Use of Language*, *Focusing on the Subject*, and *Content*. Some of those categories were gathered together in order to accurately report the results. Lastly, whilst the DSs created by the experimental groups were examined separately in the Results chapter of this study, the quality of the digital stories are discussed together in this section.

One of the major deficiencies of the students was that even though all of them found and used a *Title* for their written stories, a considerable majority of the digital stories were created without titles, forgetting to add their story titles to their DSs. Of the titles that were added, some in both experimental groups were found to be legible and intriguing. On the other hand, the *Title Page* that introduces the credits of the story was also mostly ignored by the students, and they also forgot to provide such information within their DSs too. Even though the researcher encouraged them to follow the evaluation rubric both before and during the creation of their DSs, these components were mostly ignored by the students. This situation could be associated with their lack of experience as none of them had created a DS or participated in such a project before, or perhaps they just wanted to focus on their stories.

The next category was about the *Introduction and the Characters* of the DSs. Most of the students created their DSs by just starting straight into the story lines. In other words, the frequency of the DSs beginning with an effective or intriguing introduction was not high for either of the experimental groups, with students not beginning their stories with any significant introduction by which they sought to grab their audiences' attention. On the other hand, even though some students poorly introduced their characters within their first DSs, this number decreased considerably when their second DSs were created. Those students had recognized the importance of their characters, and introduced them more carefully in their second DSs. Furthermore, the researcher's observations revealed that when the students found different people such as their parents or friends to review their stories, they were more motivated to introduce their characters, with some of them carefully introducing their characters before progressing to the writing of their stories. This result might be associated with the students' level of writing experience from their Turkish courses, as the more experience they had in writing might enable them to start off their stories with better introductions.

The next categories examined were *Dramatic Question* and *Creativity*. Almost half of the students in Experimental Group 1 could not apply these categories properly in either of their DSs. Their stories were mostly narrated in a routine mode, and either without or only including poor quality questions. However, some of the students did well in terms of these categories; asking questions to capture the audience's attention and used really creative ways of narrating. Besides, most of the subgroups in

Experimental Group 2 were successful in terms of using dramatic questions in their DSs. Those groups mostly used questions, both at the beginning and in the middle of the stories, in order to attract and capture their audience's attention. Considering the *Creativity* issue, almost half of them were found to have been pretty good, with students including different story lines whilst narrating their stories. Even though there is no enough evidence as to what extent DST affects the creativity of students, Ohler (2008) asserted that DST is a useful instructional instrument that leads students to improve their creativity and to deal with problems by applying creative techniques. In this sense, some of the students in the current study really created intriguing stories by using innovative metaphors. They were also able to attract their peers' attention, with their creative products also encouraging others to produce better stories and digital stories. With similar findings also reported by Sadik (2008), it could be interpreted that the quality of a peers' products can encourage other students to produce better DSs. In this case, it is essential to introduce high quality DSs to students in order to foster and encourage them to create stories of a similar quality level.

One of the interesting and important findings about the DSs created by the students was related to their *Pacing and Clarity* of speech features. When examining this category for the first and second DSs, while a notable improvement was seen for Experimental Group 1, this was not the case for Experimental Group 2. The number of poor DSs in terms of their pacing and clarity of speech category remarkably decreased in Experimental Group 1. In this sense, it can be said that the first experiences of the students in this individually working experimental group enabled them to create better products at the end of the process. On the other hand, there were still some problems seen in the collaborative working subgroups in terms of this category. Some of those subgroups could not use the microphones or headphones accurately while recording their voices, therefore it was difficult to hear and understand their DSs. Other than that, while some of them narrated their stories so fast their words could not be distinguished, others used a slow and monotone delivery during their DSs. Even though the researcher provided feedback on the first DSs to both experimental groups, the individual working group (Experimental Group 1) did a better job in terms of the pacing and clarity of speech.

In considering the Quality of Visuals and Recordings/Sounds of the created DSs, even though some students and collaborative groups could not adjust the level of their voices when recording or the background music when needed in their first DSs; the results concluded that the students had improved their recording skills and learned how to find and use relevant pictures with high level resolution in their second DSs. The observations clearly revealed that the quality level of the visuals and recordings/sounds in the DSs increased in parallel to the students' experiences and collaborative work. The more they re-recorded sounds and voices, the better the DSs they created. When some of the students were encouraged to draw their visuals by themselves and then used their own pictures in their DSs, some students learned how to use different keywords while searching for relevant pictures on the Internet. Thus, a considerable improvement in terms of visuality had appeared by the end of the study. Additionally, practices related to the previous tasks might have also played a serious part in the students' improvement.

The *Environment* and *General Structure* of the story was also examined for the created DSs. In Experimental Group 1, most of the students specified their story environments both DSs, providing relevant information about when and where the story events happened. On the other hand, even though almost all of the students used different words and verbs, and avoided using un-ended statements in their DSs, there were some problematic DSs seen in terms of the length and overall organization of the story for this experimental group. DSs appearing not to have a clear beginning or end was also found in Sadik's (2008) study. Additionally, while some DSs in the current study were created as too long in the first part, the feedback provided by the researcher enabled some of those students to decrease the length of the stories by a remarkable amount. Even so, there were still some long DSs seen in the second part. The length of the course subjects to be integrated to the stories might have been a major reason that affected these features of the DSs. On the other hand, the fluency of story lines and clear endings were also ignored in a remarkable number of DSs, with students just narrating their stories in a routine tone with, for example, only question and answer dialogue, or orally presented as if poorly lecturing a class. This was a major problem, especially in the first DSs; but the problem still existed in the second DSs too for some students. The researcher's observations showed that more guidance was needed particularly for these issues (overall story organization and length). In Experimental Group 2, most of the subgroups overlooked the environment issue in their first DSs; not clearly giving adequate information about where and when their story lines happened. Nevertheless, in their second DSs, they had taken the time to consider this information, and clearly let their audience know about the environment of their stories. Moreover, as in Experimental Group 1; students in this collaborative working study group (Experimental Group 2) also used different words and verbs and completed their statements with the right amount of detail. On the other hand, problems about the length and overall organization of the story also appeared in these collaborative subgroups. According to the results, these subgroups were hardly able to manage the length of their stories, with most DSs far longer than needed. They stated that their stories had become long due to the amount of course subjects included. Interestingly, this problem was common for both DSs. Unlike Experimental Group 1, they could not adjust the length of their stories even after receiving feedback about this issue for their first DSs. Even though several DSs in Experimental Group 2 had different and creative narrations, the existence of basic question and answer dialogue and lecture-styled narration was still seen to a noteworthy level. As emphasized for Experimental Group 1, students in Experimental Group 2 also required more guidance when it came to the appropriate organization of their stories.

The last examined issues were *Grammar and Use of Language*, *Focusing on the Subject*, and *Content* of the created DSs. The findings indicated that there was a remarkable improvement between the first and second DSs in terms of those issues in both experimental groups. Even where some grammatical mistakes had appeared in the stories, after feedback was given, some of the students corrected those mistakes during the DS creation process. The results supported that the DSs were not so problematic in terms of grammar or use of language issues, possibly owing to the previous practice where the students learned how to use their language accurately, and consider their grammatical errors. In addition, the same situation was seen for the issue of Focusing on the Subject. A few students divagated while they were writing their stories. It could be interpreted that most of the students were able to focus on the course subjects and story lines while both writing their stories and creating their DSs. Apart from those issues; there were just a few DSs rated as poor in terms of their content. In other words, most of the students gave the entire content with the right amount of detail in their DSs. Lastly, the DSs created by the students varied in terms of their length. While some of them were long enough, some DSs were too long. In this manner, the students' writing experience in other courses such as Turkish, might have affected their story writing quality. Furthermore, some students were used to writing stories, or they kept a diary in their daily life, and that prior experience might also have contributed to their story writing phases during this study.

When considering all of the evaluation criteria, the results of the current study in terms of the quality of the DSs created by the students conforms to some extent to previous study results reported by Sadik (2008) and Smeda et al. (2014b). While some of the components of the DSs were accurately applied by the students; some students and study subgroups did not perform well in integrating various elements into their DSs such as images, background music, and recordings. One of the main reasons behind the failure of those students might be their level of ability to handle technological issues (Smeda et al., 2014b). According to Kim et al. (2009), the level of learners' attitude toward utilizing technology may be affected by their prior experience with hands-on activities. In this sense, even though almost all of the students pointed out that the Photo Story program was easy to use, they did not have prior experience with the program or in creating a DS. Therefore, this lack of experience might have also affected the students' products. Another reason might be associated with their collaboration and communication levels, which were also reported as a problem for some groups in Sadik's (2008) study as well, with some of the collaborative groups experiencing difficulties in managing their group activities and intergroup communication problems. Other than that, some of the students in the current study who worked individually had a lack of communication skills either with their friends or with the researcher. Factors influencing the quality of the students' products might be the amount of time spent and the levels of planning between the DS creating phases. Both Sadik (2008) and Smeda et al. (2014b) found those factors as major activators in the DS creation process. Additionally, the last and possibly most important factor affecting the entire process and the quality of the DSs created by the students was their levels of "task value." According to Eccles et al. (1983), task value is the combination of intention and practical judgement to maintain a particular task in a learning environment (as cited in Velez & Cano, 2012); and Pintrich (1994) identified task value as an incentive factor which is critical for a specific task. The results and the researcher's observations in the current study indicated that the level of task value could be a major activator leading the students to the extent in which they engage to the DS creation process.

To summarize, even though there were some problematic issues related with the DSs in terms of their features, students from both of the experimental groups performed well when considering the entire DST process. While some problems were common to both experimental groups, there were also some differences seen in terms of the features of their DSs. Another considerable finding was that the female students paid more attention and expended more effort throughout the entire process. Most of them carefully followed the process, and the majority of their questions aimed at the researcher were from female students. Their levels of task value also supported these findings, with females having significantly higher task value scores than the males. As a result, most of the females' products (stories, storyboards, and digital stories) appeared to me more appropriate and acceptable when compared to those of their male counterparts.

5.2. Implications for the Practice

Before reading the implications of this study, readers should be conscious that the target of the current study was selected using convenience sampling, so that the implications are provided based on the findings gathered from the selected study group. According to the results, the middle school students who participated in this study had positive attitudes toward using DST in science education, and the main implication that was derived from the findings of this study is that DST can be used as a pedagogical tool in order to contribute to middle school students' academic achievement and the use of learning strategies. Other implications and suggestions for practitioners are described as follows;

- An orientation introducing the process, presenting appropriate and adequate DS samples should be provided in order to attract the students' attention and to increase their levels of engagement into the DS creation process.
- Adequate time should be given for students; particularly those with low-level technology skills prior to starting the DS creation process.
- Before commencing implementation, adequate writing and DS creation practices should be provided in order to encourage students to engage more and enable them to finish all parts of the DS creation process.

- Practitioners should always be alerted toward potential technological problems, and always have alternative solutions on hand in order to efficiently maintain the process.
- Practitioners should schedule their study phases at certain times so as to prevent delays due to technological problems and student-related issues.
- Practitioners should know that students might need more guidance, particularly during the storyboarding phase. Therefore, the storyboarding phase should be elaborated in order to encourage students to pay more attention while storyboarding what they narrate.
- Practitioners should enable their target groups to apply all components of a DS in order to create high quality digital stories.
- DST could be used for different courses (e.g., math, social sciences, Turkish, English) which students have particular difficulties in understanding.
- DSs cannot be efficiently integrated into all subjects of any course. Therefore, courses whose subjects are considered appropriate to create a digital story would be the best courses to select.
- Practitioners should consider the distribution of their collaborative groups, if any. Characteristics of mixed groups in terms of gender factor might influence study results and might support different findings in order to make relevant comparisons.
- Homogeneity of the collaborative groups in terms of gender distribution should be determined in order to create homogeneous groups where possible, and considering their task value levels.
- Task value levels of students have strong relationships between their interests to the process and the products they create. Therefore, practitioners should examine their target groups' task value levels in order to find out whether or not they need additional incentives.
- Even though the participants of the current study thought it better if they distributed roles by themselves, they preferred that the roles be distributed by the researcher due to their initial difficulties. Practitioners distributing group member roles (within collaborative study groups) might be more beneficial; especially for groups that have experienced previous problems with this issue. This could result in better equalization of the group workload between the group members.

- Strategies applied by students for starting and maintaining their stories can change from one story to another. For instance, one student might have started writing their first story by identifying the story characters first and then writing the story; however, the same student might change their strategy by identifying the scenario first and then starting to write the second story. Hence, examining the frequencies of strategies separately for each story could be more informative, rather than determining them together as in the current study. In doing so, practitioners can analyze the applied strategies in detail, and thereby more easily identify differences or improvements with regard to students' strategies while writing different stories.
- Lastly, the practitioners should know that students can expect to share their products with their related communities, such as their friends or younger students at the end of the DS creation process. By considering this issue, short DS presentation sessions can be organized in order to give students the opportunity to share their products with others. This might increase the motivation and engagement levels of students in the DS creation process.

5.3. Recommendations for Further Research

One of the main purposes of the current study was to determine the effects of digital storytelling on the academic achievement and learning strategies of middle school students in science education. Based on the results, even though there was only a significant difference with the collaborative groups' metacognitive strategies scores, use of DST in a science course contributed more to the students' academic achievement and other learning strategies scores when compared to the Control Group. Additionally, the attitude scores of the students toward creating digital stories on a science course indicated that the students enjoyed the process and that most of them were eager to use DST and to create DSs in their courses. In this regard, the results and observations of the current study suggest that researchers conduct different further studies, particularly in the scope of K-12 science education, in order to gather more evidence as to whether or not DST usage significantly affects students' academic achievement and their learning strategies use.

As reported in many studies in the related literature, time was a major constraint for the current study. In line with the students participants' suggestions from this study, the effects of DS creation over a long period of time should be investigated. For instance, research could be conducted as a term-based project. During a full semester, students could work on their DST projects in order to facilitate their learning process. In this manner, further research studies might consider this suggestion in order to examine whether or not DST affects students' achievement, learning strategies use, as well as their attitudes toward creating DSs, their opinions about DS creation, and examining the quality of the DSs created by students over long time period.

One of the notable findings of the current study was that all of the students found the science course to be the most appropriate and popular course in which to create a DS. Additionally, when asked to choose an alternative course in which to create a DS and to support their decision with reasoning, most students wanted to create a DS on subjects that they faced the most difficulties understanding. The results claimed that students perceived DST as a pedagogical tool that facilitates their learning process. In the sense of these results, further research studies might apply DST in topics where students have shown difficulties in understanding, and to examine the effects of such a practice.

Another recommendation taken from the students of the current study was that they mostly emphasized that if they took on different roles as a character in a story, and they could role-play that story on a stage as in a theatre, then the DST process would be more effective and instructive for both them and also for other students as well. The students suggested that they transfer knowledge about any subject of a course to their peers via applying DST within a stage-based environment. Some of them also stressed that if they were on stage, they could not only portray a character in a story, but also use pictures of objects as being narrated in the stories (e.g., each student could hold up a picture related to the story on stage while another student narrates). The idea being that it would be like crafting *live digital storytelling* that might attract the attention of further researchers in this area. In this manner, it may be useful to determine whether or not role-playing makes a difference in terms of the students' levels of engagement, their learning strategies use, and their levels of academic achievement.

As previously stated, even though the storyboarding phase was found unnecessary by some students in the current study, and similar results were also reported in the literature; some authors assert that this phase is useful, particularly for planning the

DST process. In this manner, adult learners or university students can easily handle this process; nevertheless, the researcher's observations showed that young learners especially encounter difficulties in managing the storyboarding phase. Therefore, future research studies might be conducted in different educational contexts in order to find out whether or not elimination of the storyboarding phase still facilitates the DS creation process for K-12 students; or how different solutions/incentives might be applied in order to encourage students' involvement in the storyboarding phase.

Lastly, the most substantial recommendation for related further research is with regards to the effectiveness of DST in terms of gender differences. Even though the current study did not primarily focus on the effect of gender difference on student achievement, learning strategies use, or quality of their products in the scope of DST on a science course, the observations and significant task value and attitude differences between female and male students led the researcher to consider the weight and significance of the gender variable. Despite the fact that insufficient evidence exists in the related literature regarding the effect of gender differences on DST usage; in the current study, evidence showed that female students paid more attention and performed better throughout the entire DST process. Most female students attentively followed the process, and the majority of questions the researcher responded to were from females. Additionally, the females' levels of task value and attitudes toward creating a DS in a science course were significantly higher than for the males, and most of their products (stories, storyboards, and digital stories) appeared more accurate when compared to the male students. In this sense, the findings and observations of the current study suggests to carry out further research that considering the effect of gender difference on the DS creation process in various contexts of K-12 education in order to gain a better understanding about the gender variable affect.

In conclusion, as investigating the literature in the scope of DST usage for science education in Turkey, there seems limited published studies available. Of those studies, while some (Balaman, 2017; Karakoyun & Yapıcı, 2016; Kotluk & Kocakaya, 2015) were conducted with university students on physics and biology courses, one study (Kotluk & Kocakaya, 2015) was carried out with 10th grade physics students. Additionally, three master's theses (Büyükcengiz, 2017; Torun, 2016; Ulum, 2017) were based on research with 6th and 7th grade science students, whilst one doctoral dissertation (Kahraman, 2013) was conducted with 9th grade physics students.

Hence, if the number of studies conducted through science education with different age groups increases, more valid and reliable findings might be gathered in order to truly examine the effects of DST usage in detail for the related subject area.

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APPENDICES

APPENDIX A: ETHIC COMMITTEE PERMISSION FORM

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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21.03.2014

Gönderilen : Prof. Dr. Zahide Yıldırım
Bilgisayar ve Öğretim Teknolojileri Eğitimi

Gönderen : Prof. Dr. Canan Özgen
IAK Başkanı

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğrencisi Mithat Çiçek'in "Comparison of Traditional Digital Storytelling, Constructivist Digital Storytelling and Traditional Instruction Approaches in regard to Achievement, Motivation, Self-Regulation, Satisfaction and Attitude" isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

21/03/2014

Prof.Dr. Canan Özgen
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkanı
ODTÜ 06531 ANKARA

APPENDIX B: CONSENT FORM

Bu çalışma ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü'nde doktora öğrencisi olan Arş. Gör. Mithat Çiçek tarafından Prof. Dr. Zahide Yıldırım gözetiminde yapılmaktadır. Çalışmanın genel amacı; Fen eğitiminde yapılandırmacı eğitim yaklaşımına göre digital hikâyeleme yönteminin kullanımının etkilerini incelemek ve bu süreci değerlendirmektir.

Çalışma süresince zaman zaman video kamera ve ses kayıt cihazı ile kayıt altına alınacaksınız. Bu kayıtlar da dâhil olmak üzere çalışma süresince elde edilen bilgiler ve gözlemler sadece bilimsel yayınlarda kullanılacaktır. Herhangi bir kişisel bilgi paylaşılmayacaktır.

Çalışma boyunca görüşleriniz beklenen sonuçların elde edilmesine katkıda bulunacaktır. Bu çalışmaya katıldığınız/katılıma izin verdiğiniz için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğretim üyelerinden Prof. Dr. Zahide Yıldırım ile (Tel: 312 210 36 79; E-posta: zahidey@metu.edu.tr) ya da araştırma görevlisi Mithat Çiçek (Tel: 312 210 75 19; E-posta: mthatccek@gmail.com) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

Adı - Soyadı   Tarih

İmza

----/----/-----

APPENDIX C: MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE (MSLQ)

Sevgili Öğrenciler,

Aşağıda yer alan ölçekte demografik özelliklerinize ve Fen Bilimleri dersinde kullanılabilecek öğrenme stratejilerinize ilişkin çeşitli sorular yer almaktadır. Bu soruları size en uygun gelen seçeneği işaretleyerek cevaplayınız. Soruların doğru veya yanlış cevabı yoktur. Lütfen her soruyu içtenlikle cevaplayınız ve soruları boş bırakmayınız.

Bu sorulara vereceğiniz cevaplar gizlidir, yalnızca araştırma amacıyla kullanılacak ve kesinlikle hiç kimse ile paylaşılmayacaktır.

Ayırdığınız zaman ve değerli katkılarınız için çok teşekkür ederim.

Arş. Gör. Mithat ÇİÇEK
Orta Doğu Teknik Üniversitesi
Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

1. Sınıfınız: ....
2. Cinsiyetiniz: ☐ Kız ☐ Erkek
3. Geçen dönemki Fen Bilimleri dersi notunuz: ....
4. Fen Bilimleri dersinde daha önce hiç dijital hikâye izlediniz mi? ☐ Evet ☐ Hayır
5. Fen Bilimleri dersinde daha önce hiç dijital hikâye oluşturdunuz mu? ☐ Evet ☐ Hayır
6. Sizce dijital hikaye oluşturmanın **zorluk derecesi** nedir?

   ☐ Çok kolay ☐ Kolay ☐ Kararsızım ☐ Zor ☐ Çok zor
7. Size bilgisayar bilgi ve beceri düzeyiniz nasıl?

   ☐ Çok iyi ☐ İyi ☐ Orta ☐ Kötü ☐ Çok kötü

Öğrenme Stratejileri Ölçeği

Yanlış Doğru

Benim için Kesinlikle Yanlış 1 2 3 4 5 6 7 Benim için Kesinlikle Doğru

Bu ölçeği Fen Bilimleri dersini dikkate alarak doldurunuz.	Kesinlikle Yanlış						Kesinlikle Doğru
1. Bu derste verilen kaynakları okurken düşüncelerimi düzenlememe yardımcı olması için konuların başlıklarını ve alt başlıklarını çıkarırım.	1	2	3	4	5	6	7
2. Ders sırasında başka şeyler düşündüğüm için genellikle önemli noktaları gözden kaçırırım.	1	2	3	4	5	6	7
3. Genellikle bu derse, konuları bir başkasına anlatarak hazırlanırım.	1	2	3	4	5	6	7
4. Genellikle dikkatimi toparlayabileceğim yerde dersime çalışırım.	1	2	3	4	5	6	7
5. Bu dersle ilgili kaynakları okurken, kendime konuya odaklanmama yardımcı olacak sorular sorarım.	1	2	3	4	5	6	7
6. Bu derse çalışırken o kadar sıkılır ya da kendimi tembel hissederim ki, planladığımdan daha önce çalışmayı bırakırım.	1	2	3	4	5	6	7
7. Bu derste söylenen ya da bu dersle ilgili okuduğum bilgilerin, doğru olup olmadığını genellikle sorgularım.	1	2	3	4	5	6	7
8. Bu derse çalışırken konuları kendi kendime tekrar ederim.	1	2	3	4	5	6	7
9. Bu dersin konularını öğrenmek benim için önemlidir.	1	2	3	4	5	6	7
10. Bu dersle ilgili herhangi bir şey okurken kafam karıştığında, okuduklarıma döner ve bu karışıklığı gidermeye çalışırım.	1	2	3	4	5	6	7
11. Bu derse çalışırken, okuduğum bilgilerin ve derste tuttuğum notların üzerinden geçip en önemli noktaları bulmaya çalışırım.	1	2	3	4	5	6	7
12. Bu derse çalışmak için ayırdığım zamanı iyi değerlendiririm.	1	2	3	4	5	6	7
13. Ders kitaplarını anlamakta zorlandığımda, bu kitapları okuma yöntemimi değiştiririm.	1	2	3	4	5	6	7
14. Derste verilen ödevleri bitirmek için sınıftaki diğer arkadaşlarımla birlikte çalışmayı denerim.	1	2	3	4	5	6	7
15. Bu derse çalışırken, derste tuttuğum notları ve kitapları tekrar tekrar okurum.	1	2	3	4	5	6	7
16. Derste ya da okuduğum kitaplarda bir görüş, yorum ya da sonuç verildiğinde, bunların doğruluğunu destekleyen yeterli kanıt olup olmadığına karar vermeye çalışırım.	1	2	3	4	5	6	7
17. Bu derste yaptıklarımızdan hoşlanmasam da derste başarılı olmak için çok çalışırım.	1	2	3	4	5	6	7
18. Bu dersin konularını düzenlememe yardımcı olması için basit şemalar, tablolar ya da şekiller çizerim.	1	2	3	4	5	6	7
19. Bu dersi çalışırken, çalıştığım konuları arkadaşlarımla tartışmak için genellikle zaman ayırırım.	1	2	3	4	5	6	7
20. Dersin konularını bir başlangıç noktası olarak görür ve bu konularla ilgili kendi düşüncelerimi getirmeye çalışırım.	1	2	3	4	5	6	7
21. Bir çalışma planına bağlı olarak ders çalışmak bana zor gelir.	1	2	3	4	5	6	7
22. Bu derse çalışırken, ders notları, kitaplar ve tartışmalar gibi farklı kaynaklardan edindiğim bilgileri bir araya getiririm.	1	2	3	4	5	6	7
23. Yeni bir konuyu ayrıntılı çalışmadan önce genellikle konuların nasıl düzenlendiğini gözden geçiririm.	1	2	3	4	5	6	7
24. Çalıştığım konuyu anlayıp anlamadığımdan emin olmak için kendi kendime sorular sorarım.	1	2	3	4	5	6	7

Bu ölçeği Fen ve Teknoloji dersini dikkate alarak doldurunuz.	Kesinlikle Yanlış						Kesinlikle Doğru
25. Dersin gereklerine ve öğretmenin öğretme şekline uyacak biçimde ders çalışma yöntemimi ayarlamaya çalışırım.	1	2	3	4	5	6	7
26. Bu derste işlenen konuların yararlı olduğunu düşünüyorum.	1	2	3	4	5	6	7
27. Öğretmenden iyi anlamadığım konuları açıklamasını isterim.	1	2	3	4	5	6	7
28. Bu dersteki önemli kavramları bana hatırlatması için anahtar kelimeleri ezberlerim.	1	2	3	4	5	6	7
29. Ödevlerde zorlandığım zaman, ya ödevi yapmaktan vazgeçerim ya da sadece kolay kısımlarını yaparım.	1	2	3	4	5	6	7
30. Bu derse çalışırken yalnızca okuyup geçmek yerine, neyi öğrenmem gerektiğine karar vermeye ve konuyu düşünmeye çalışırım.	1	2	3	4	5	6	7
31. Bu derste öğrendiğim konuyla diğer derslerdeki konular arasında olabildiğince bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
32. Bu derse çalışırken sınıfta tuttuğum notları gözden geçirir ve önemli konuların başlık ve alt başlıklarını çıkarırım.	1	2	3	4	5	6	7
33. Bu dersle ilgili kitapları okurken, önceden bildiğim konularla bağlantısını kurmaya çalışırım.	1	2	3	4	5	6	7
34. Derslerime belli bir yerde çalışırım.	1	2	3	4	5	6	7
35. Derste öğrendiğim bilgilerle kendi düşüncelerim arasında bağlantı kurmaya çalışmak hoşuma gider.	1	2	3	4	5	6	7
36. Bu derse çalışırken, derste tuttuğum notlardan ve okuduğum kaynaklardan konunun ana fikrini çıkarırım.	1	2	3	4	5	6	7
37. Bu dersteki herhangi bir konuyu anlamadığım zaman, sınıfımdaki başka bir öğrenciden yardım isterim.	1	2	3	4	5	6	7
38. Okuduğum kitaplarla derste öğrendiğim kavramlar arasında bağlantı kurarak bu dersin konularını anlamaya çalışırım.	1	2	3	4	5	6	7
39. Bu dersin ödevlerini zamanında yaparım.	1	2	3	4	5	6	7
40. Bu dersle ilgili bir görüş okuduğumda ya da duyduğumda, bu görüşün alternatiflerini düşünürüm.	1	2	3	4	5	6	7
41. Bu ders için önemli olabilecek noktaların listesini çıkarır ve bu listeyi ezberlerim.	1	2	3	4	5	6	7
42. Bu derse düzenli olarak devam ederim.	1	2	3	4	5	6	7
43. Dersin konuları ilgimi çekmese ve çok anlamlı gelmese bile, bu konuların tamamını bitirinceye kadar çalışırım.	1	2	3	4	5	6	7
44. İhtiyacım olduğunda yardım isteyebileceğim öğrencileri belirlemeye çalışırım.	1	2	3	4	5	6	7
45. Bu derse çalışırken iyi anlamadığım kavramları belirlemeye çalışırım.	1	2	3	4	5	6	7
46. Diğer etkinlikler yüzünden, genellikle bu derse pek zaman ayıramadığımı fark ederim.	1	2	3	4	5	6	7
47. Bu derse çalışırken, her aşamada yapacaklarımı belirlemek için kendime hedefler koyarım.	1	2	3	4	5	6	7
48. Notlarımı tutarken bir karışıklık olursa daha sonra bu karışıklığı mutlaka düzeltirim.	1	2	3	4	5	6	7
49. Sınavdan önce tuttuğum notları ya da kitapları okumak için genellikle zaman bulamam.	1	2	3	4	5	6	7
50. Kitaplardan edindiğim bilgileri, anlatım ve tartışma gibi diğer sınıf etkinliklerinde de kullanmaya çalışırım.	1	2	3	4	5	6	7
51. Bu derste işlenen konular hoşuma gidiyor.	1	2	3	4	5	6	7
52. Bu derste işlenen konuları anlamak benim için çok önemlidir.	1	2	3	4	5	6	7
53. Bu dersin konularına çok ilgi duyuyorum.	1	2	3	4	5	6	7
54. Bu derste öğrendiklerimi diğer derslerde de kullanabileceğimi düşünüyorum.	1	2	3	4	5	6	7

APPENDIX D: ATTITUDE TOWARD USING DIGITAL STORYTELLING SCALE

Sevgili Öğrenciler,

Aşağıda yer alan ölçekte demografik özelliklerinize ve Fen Bilimleri dersinde dijital hikâye kullanımına yönelik tutumlarınızı ölçen dört adet soru yer almaktadır. Bu soruları size en uygun gelen seçeneği işaretleyerek cevaplayınız. Soruların doğru veya yanlış cevabı yoktur. Lütfen her soruyu içtenlikle cevaplayınız ve soruları boş bırakmayınız.

Bu sorulara vereceğiniz cevaplar gizlidir, yalnızca araştırma amacıyla kullanılacak ve kesinlikle hiç kimse ile paylaşılmayacaktır.

Ayırdığınız zaman ve değerli katkılarınız için çok teşekkür ederim.

Arş. Gör. Mithat ÇİÇEK
Orta Doğu Teknik Üniversitesi
Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

Dijital Hikâyeleme Yöntemine İlişkin Tutum Ölçeği

Sınıfınız: .... Cinsiyetiniz: ☐ Kız ☐ Erkek

1. Fen Bilimleri dersinde dijital hikaye oluşturma **.......** bir fikirdir.	kötü	1	2	3	4	5	6	7	iyi
2. Fen Bilimleri dersinde dijital hikaye oluşturma **........** bir fikirdir.	mantıksız	1	2	3	4	5	6	7	mantıklı
3. Fen Bilimleri dersinde dijital hikaye oluşturma fikrinden **..........**	hoşlanmam	1	2	3	4	5	6	7	hoşlanırım
4. Fen Bilimleri dersinde dijital hikaye oluşturma **...........**	zevksizdir	1	2	3	4	5	6	7	zevklidir

APPENDIX E: ACHIEVEMENT TEST

Ad - Soyad: **Numara:**

SORULAR

1. Eşeysiz üremede;

   1. Oluşan yavrular bütün özellikleri bakımından hem ana canlıya hem de birbirine benzerdir.
   2. Kalıtsal çeşitlilik vardır.
   3. Dişi ve erkek üreme hücreleri birleşerek zigotu oluşturur.

   ifadelerinden hangileri **yanlıştır?**

   A-) Yalnız I B-) I ve II C-) II ve III D-) I, II ve III

2. Bazı canlılar yenilenme ile kendilerinin aynısı yeni canlılar oluşturur.

   Buna göre aşağıdaki canlılardan hangisinde gerçekleşen yenilenme, üreme amaçlı **olamaz?**


A-) Planarya

B-) Kertenkele

C-) Deniz Yıldızı

D-) Toprak Solucanı

3. Ana canlı üzerinde tomurcuk şeklinde bir veya daha fazla çıkıntı oluşur. Bu çıkıntılar olgunlaşarak ana canlıdan ayrılır ya da ana canlıya bağlı kalarak koloni oluşturur.

   Yukarıda tanımı yapılan eşeysiz üreme şekli aşağıdaki canlılardan hangisinde **görülür**?


A-) Hidra

B-) Söğüt

C-) Bakteri

D-) Kertenkele

4. Aşağıda verilen canlılardan hangisinde iç döllenme **görülmez?**

   A-) Tavşan B-) Yılan C-) Kurbağa D-) Serçe

5. ✡ Aslan ✡ Maymun ✡ Kaplumbağa ✡ Tavuk ✡ Fok ✡ Yılan

Yukarıda verilen hayvanlardan **kaç tanesinde** yavru bakımı görülür?

A-) 6 B-) 5 C-) 4 D-) 3

6. Aşağıdaki tabloda dış ve iç döllenme yapan canlılar verilmiştir.

	Dış Döllenme yapan canlılar	İç Döllenme yapan canlılar
1	İstavrit	At
2	Kurbağa	Papağan
3	Hamsi	Yunus
4	Balina	Kurbağa

Buna göre kaç numaralı kısımda yer alan canlılar **yanlış** yazılmıştır?

A-) 4 B-) 3 C-) 2 D-) 1

7. Üreme hücreleri ile meydana gelen üremeye .... adı verilir.

Yukarıdaki tanımda boş bırakılan yere aşağıdakilerden hangisi **gelmelidir**?

A-) Eşeysiz Üreme B-) Eşeyli Üreme C-) Vejeteryan Üreme D-) Tomurcuklanma

8.

Yumurta Hücresi	Sperm Hücresi
1-) Stoplazması çoktur.	5-) Stoplazması azdır.
2-) Spermden daha küçüktür.	6-) Yumurtadan daha büyüktür.
3-) Dişi üreme hücresidir.	7-) Erkek üreme hücresidir.
4-) Çekirdeği vardır.	8-) Çekirdeği vardır.

Yukarıdaki tabloda üreme hücreleri ile ilgili özellikler numaralandırılmıştır.

Buna göre kaç numaralı özellikler **yanlış verilmiştir?**

A-) 1 ve 5 B-) 2 ve 6 C-) 3 ve 7 D-) 4 ve 8

9. Yumurta hücresi ile dişi organ arasında var olan ilişki erkek organla aşağıdakilerden hangisi arasında **vardır**?

A-) Taç yaprak B-) Çiçek C-) Polen D-) Çiçek sapı

10. Yavrunun yumurtadan yarı gelişmiş halde çıkarak büyüme ve gelişmesini dışarıda tamamlaması olayına **başkalaşım** denir.

Buna göre aşağıdaki canlılardan **hangisi** başkalaşım geçirir?

A-) Balina B-) Kurbağa C-) Kuş D-) Timsah

11. I. Öglena II. Toprak Solucanı III. Patates

Yukarıdaki canlıların üreme şekillerinin sıralaması aşağıdakilerden hangisinde **doğru verilmiştir?**

A-) Bölünme, Tomurcuklanma, Vejetatif

B-) Bölünme, Yenilenme, Vejetatif

C-) Yenilenme, Vejetatif, Tomurcuklanma

D-) Tomurcuklanma, Bölünme, Yenilenme

12. Tozlaşma ile ilgili aşağıda verilenlerden hangisi **yanlıştır**?

A-) Su, rüzgar ve hayvanlar tozlaşmaya yardımcı olur.

B-) Polenlerin dişicik borusuna taşınması ile tozlaşma gerçekleşir.

C-) Polenlerin yumurta ile birleşmesine tozlaşma denir.

D-) Erkek organdaki polenlerin serbest kalması ile tozlaşma başlar.

13. ✡ Öglena ✡ Bira Mayası ✡ Kavak ✡ Planarya ✡ Hidra ✡ Patates

Yukarıda verilen canlılardan **kaç tanesinde** eşeysiz üreme görülür?

A-) 6 B-) 5 C-) 4 D-) 3

14. Hayvanların üremesi ile ilgili;

I. Kurbağa, balık ve suda yaşayan omurgasız hayvanların üremesi suda gerçekleşir.

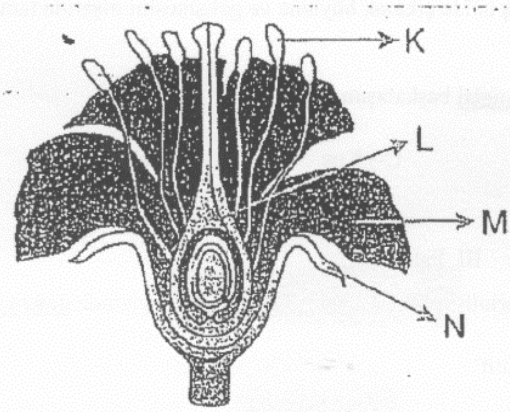
II. Suya bırakılan yumurta ve spermler korunmasızdır.

III. Suda yaşayan hayvanlar yavru olma ihtimalini artırmak için çok fazla yumurta ve sperm hücresi üretirler.

İfadelerinden hangileri **doğrudur**?

A-) Yalnız I B-) I ve II C-) II ve III D-) I, II ve III

15.



Yukarıdaki çiçek modelinde bazı yapılar K,L,M,N ile gösterilmiştir.

Buna göre K, L, M, N yapıları aşağıdakilerden hangisinde **doğru verilmiştir?**

A-

K	Başçık
L	Yumurtalık
M	Çanak Yaprak
N	Taç Yaprak

B-)

K	Başçık
L	Yumurtalık
M	Taç Yaprak
N	Çanak Yaprak

C-)

K	Sapçık
L	Tepecik
M	Taç Yaprak
N	Çanak Yaprak

D-)

K	Yumurtalık
L	Başçık
M	Çanak Yaprak
N	Taç Yaprak

16.

1. Tohum, çimlenmeden önce içinde depolanan besini kullanır.
2. Tohumun yaprakları tohum çimlendikten sonra çıkar.
3. Çimlenme esnasında bitki fotosentez yapar.
4. Yapraklar genç bitkinin besin üretmesini sağlar.

Yukarıda verilen kaç numaralı ifade **yanlıştır?**

A-) 4 B-) 3 C-) 2 D-) 1

17. Aşağıdaki tabloda bulunan hayvanlara ait olan özellikler (+), olmayan özellikler (-) ile gösterilmiştir. İşaretlemeler yapılırken iki hayvanda hata yapılmıştır.

Hayvan	Dış Döllenme	Dış Gelişme	İç Döllenme	İç Gelişme
Baykuş	+	+	-	-
Zebra	-	-	+	+
Kurbağa	+	+	-	-
Kertenkele	-	-	+	+

Buna göre hangi iki hayvanda yapılan işaretleme **hatalıdır?**

A-) Baykuş - Zebra

B-) Zebra - Kurbağa

C-) Kurbağa - Kertenkele

D-) Baykuş – Kerkentele

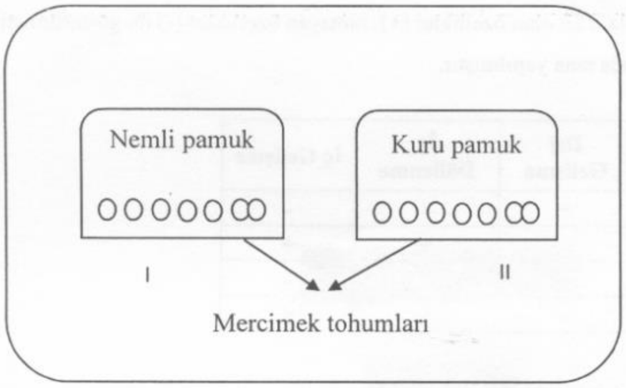
18. Aşağıda bir bitkinin gelişim sürecinde gerçekleşen olaylar verilmiştir.

- Döllenme
- Çimlenme
- Tozlaşma
- Tohum ve meyve oluşması

Buna göre olaylar sıraya konulduğunda **baştan ikinci** sırada hangisi yer alır?

A-) Döllenme B-) Çimlenme C-) Tozlaşma D-) Tohum ve meyve oluşması

19.



Ortam sıcaklığının 22 C olduğu aydınlık bir ortamda, mercimek tohumları yukarıdaki kaplara konuluyor. I. kaba nemli pamuk, II. kaba kuru pamuk yerleştiriliyor.

Buna göre yapılan deneyde aşağıda sorulan sorulardan **hangisine** cevap aranmaktadır?

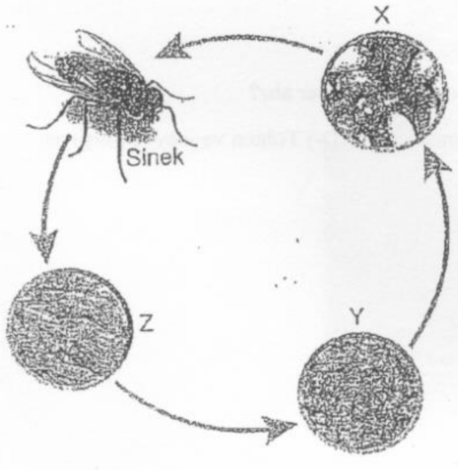
A-) Çimlenme için ışık gerekli midir?

B-) Çimlenme için ortam sıcaklığı önemli midir?

C-) Su, çimlenme için gerekli midir?

D-) Karbondioksit, çimlenme için gerekli midir?

20. Aşağıdaki şemada bir sineğin başkalaşım evreleri gösterilmiştir.



Buna göre X,Y,Z yerine yazılabilecek kavramlar aşağıdakilerden hangisinde doğru verilmiştir?

	X	Y	Z
A-)	Pupa	Larva	Yumurta
B-)	Yumurta	Pupa	Larva
C-)	Larva	Yumurta	Pupa
D-)	Pupa	Yumurta	Larva

Aşağıdaki ifadelerde boş bırakılan yerleri kutucuk içinde yer alan uygun kelimelerle tamamlayınız.

Eşeyli Üreme	Döllenme	Çimlenme
Bölünerek	Çanak Yaprak	Meyve
Eşeysiz Üreme	Vejetatif Üreme	Zigot
Erkek Organ	Tozlaşma	Taç Yaprak

21. Dişi ve erkek üreme hücrelerinin birleşerek çekirdeklerinin kaynaşmasına .... denir.
22. Döllenme sonucu oluşan hücreye .... adı verilir.
23. .... çiçekteki parlak, hoş kokulu, dikkat çekici ve renkli yapılardır.
24. Çiçekli bitkilerde erkek organın başçık kısmında oluşan polenlerin dişi organın tepecik kısmına gelmesine .... denir.
25. Amip, öglena, paramesyum, bakteri gibi canlılar .... ürer.
26. Tohumun içinde bulunduğu yumurtalık gelişerek .... 'yi oluşturur.
27. .... gül, çiçek, patates gibi canlılarda görülür.
28. .... için su, nem, uygun sıcaklık ve oksijen gereklidir.
29. Yeşil renkli olan .... da fotosentez gerçekleşir.
30. Erkek üreme hücresi olan polenler .... da üretilir.
31. Tek bir canlıdan döllenme olmadan, kalıtsal olarak kendisinin aynısı yeni canlıların oluşmasına .... adı verilir.

Aşağıdaki ifadelerin başına doğru ise "D", yanlış ise "Y" yazınız.

32. .... Çimlenme için ışık gereklidir.
33. .... Rejenerasyonla üreme eşeyli üreme çeşididir.
34. .... Sürüngen, kuş ve memelilerde dış döllenme görülür.
35. .... Yarasa ve penguen yumurtlayarak çoğalır.
36. .... Bir bitkinin hayat döngüsü tozlaşma ile başlar.
37. .... Hidra, mercan, medüz ve bira mayası tomurcuklanarak ürer.
38. .... Eşeysiz üreme ile meydana gelen yavrular kalıtsal özellikleri bakımından hem ana canlının, hem de birbirlerinin tıpatıp aynısıdır.
39. .... Her memeli türünün bi doğumdaki yavru sayısı, doğum yaptığı dönem ve gebelik süresi gibi özellikleri aynıdır.

40. Tohumun çimlenmesinden çiçeğin oluşumuna kadar geçen süreci oluşum sırasına göre **anlatınız**.

....

....

....

....

....

....

....

....

41. Çiçek, çiçekli bitkilerin üreme organıdır. Bazı çiçekli bitkiler eşeyli üreme yerine eşeysiz üreme çeşidi olan vejetatif üreme ile nesillerini devam ettirirler. **Neden**?

....

....

....

....

....

....

....

....

....

42. Çiçekli bitkilerin çiçeksiz bitkilere göre ne gibi **üstünlükleri vardır**?

....

....

....

....

....

....

....

....

APPENDIX F: DIGITAL STORY CREATION PROCESS EVALUATION FORM

Dijital Hikayeleme Süreci Değerlendirme Formu

Sınıfınız: .... **Cinsiyetiniz:** ☒ **Kız** ☐ **Erkek**

1. Aşağıdaki elektronik cihazlardan hangisine sahipsiniz? Birden fazla seçeneği işaretleyebilirsiniz.

( ) Masaüstü bilgisayar ( ) Laptop

( ) Tablet bilgisayar ( ) Akıllı Telefon

2. Evinizde internet bağlantısı var mı?

( ) Evet ( ) Hayır

3. Günlük ortalama kaç saat bilgisayar kullanıyorsunuz?

( ) 1 saatten az ( ) 1-2 saat arası ( ) 2-3 saat arası ( ) 3 saatten fazla

4. Öğretmenin Dijital Hikayeleme hakkında yeteri kadar bilgi verdi mi?

( ) Evet verdi ( ) Hayır vermedi

5. Öğretmenin photostory programını kullanabilmen için yeteri kadar bilgi verdi mi?

( ) Evet verdi ( ) Hayır vermedi

6. Öğretmeninin flash bellekte verdiği "dijital hikaye dosyaları" dijital hikaye oluşturman için yeterli miydi?

( ) Evet yeterliydi

( ) Hayır yetersizdi

( ) Eğer yetersiz olduğunu düşünüyorsan flash bellekte başka nelerin olmasını isterdin?

....

7. Photostory programını kullanırken zorlandın mı?

( ) Evet, zorlandım ( ) Hayır, zorlanmadım.

8. Hikayeni yazman için verilen süre yeterli miydi?

( ) Evet yeterliydi ( ) Hayır yetersizdi

9. Senaryo taslağını (resim çizme bölümü) oluşturman için verilen süre yeterli miydi?

( ) Evet yeterliydi ( ) Hayır yetersizdi

10. Dijital Hikayeni oluşturman için verilen süre yeterli miydi?

( ) Evet yeterliydi ( ) Hayır yetersizdi

11. Öğretmenin dijital hikaye oluşturma sürecinin tamamında sana yeteri kadar yardımda bulundu mu?

( ) Evet yeterliydi ( ) Hayır yetersizdi

12. **Hikayeni yazarken aşağıdaki yöntemlerden hangilerini kullandın? Birden fazla seçeneği işaretleyebilirsin.**

( ) Önce karakterlerimi belirledim

( ) Önce hikayemin senaryosuna karar verdim

( ) Önce hikayemi yazdım daha sonra Fen Bilimleri konusunu hikayemin ilgili yerlerine ekledim.

( ) Hikayemi senaryo taslağı şeklinde, yani sahnelere ayırarak yazmaya başladım.

( ) Fen bilimleri kitabındaki konuların sırasına göre hikayemi yazdım.

( ) Konuların sırası karışık olacak şekilde hikayemi yazdım.

( ) Diğer (Lütfen belirtiniz)...

13. **Hikayeni yazarken aşağıdaki yollardan hangisine başvurdun?**

( ) Tamamen hayal gücümü kullanarak hikayemi yazdım

( ) Başımdan geçen bir olayı anlatarak hikayemi yazdım.

( ) Gelecek hayallerimle ilgili olacak şekilde hikayemi yazdım.

( ) Bir filmden/çizgi filmden/oyundan/kitaptan esinlenerek hikayemi yazdım.

( ) Diğer (Lütfen belirtiniz)..

14. **Dijital hikayeni oluştururken aşağıdaki kaynaklardan hangilerini kullandın? (birden fazla seçeneği işaretleyebilirsin)**

( ) Dersin kitabını

( ) Kaynak kitapları

( ) Kendi notlarımı, defterimi

( ) İnterneti

( ) Diğer (lütfen belirtiniz)..

15. **Dijital hikayeleme oluşturma sürecindeki aşamaları zorluk derecesine göre sıralayınız. (1= Zor, 2= Orta, 3= Kolay)**

( ) Hikaye yazma aşaması

( ) Storyboard (resimleştirme) oluşturma aşaması

( ) Dijital hikaye oluşturma aşaması (photostory kullanma aşaması)

16. **Fen bilimleri dersinde dijital hikaye oluşturman konuyu derinlemesine öğrenmene yardımcı oldu mu?**

( ) Evet oldu ( ) Hayır olmadı

17. **Fen bilimleri dersinde dijital hikaye oluşturman konuyu tekrar etmene/pekiştirmene yardımcı oldu mu?**

( ) Evet oldu ( ) Hayır olmadı

18. Aşağıdaki dijital hikaye oluşturma aşamaları konuyu öğrenmene ne düzeyde katkı sağladı? En fazla katkı sağlayandan en az katkı sağlayana göre sıralayınız. (1= En çok katkı, 2= Orta Derece, 3=En az katkı)

( ) Hikaye yazma aşaması

( ) Storyboard (resimleştirme) oluşturma aşaması

( ) Dijital hikaye oluşturma aşaması (photostory kullanma aşaması)

19. Dijital hikayeni oluştururken aşağıdaki adımlardan hangilerinde EN ÇOK zorlandın?

( ) Hikayemle ilgili resimleri bulmada

( ) Resimleri hikayemin akışına göre sıralamada

( ) Hikayeme yazı eklemede

( ) Hikayeme ses/müzik eklemede

( ) Hikayemin ses kaydını yapmada

( ) Sahnelerimin ekranda kalma süresini ayarlamada

( ) Hikayemin toplam süresini ayarlamada

( ) Diğer (Lütfen belirtiniz)...

20. Dijital hikayeleme süreci ile ilgili aşağıdakilerden hangisini yapmak istersin?

( ) Herhangi bir Fen Bilimleri konusu ile ilgili **dijital hikaye oluşturmak** isterim

( ) Herhangi bir Fen Bilimleri konusu ile ilgili hazırlanmış bir **dijital hikayeyi izlemek** isterim.

( ) Hem dijital hikaye **oluşturmak** hem de hazırlanmış bir **dijital hikayeyi izlemek** isterim.

( ) İkisini de **istemem.**

21. Fen Bilimleri dersinde dijital hikaye oluşturma ile ilgili aşağıdakilerden hangisini tercih edersin?

( ) Her ünite ile ilgili bir tane dijital hikaye oluşturmak isterim.

( ) İstediğim herhangi bir ünite ile ilgili bir dijital hikaye oluşturmak isterim.

( ) Performans görevi olarak istediğim herhangi bir ünite ile ilgili bir dijital hikaye oluşturmak isterim.

( ) Diğer (Lütfen belirtiniz)...

APPENDIX G: DIGITAL STORYTELLING EVALUATION RUBRIC

Kriter	Açıklama	Yetersiz	Orta Düzeyde Yeterli	Yeterli
Başlık	Konuyla ilgili yaratıcı ve ilgi çekici başlık buldum	1	2	3
Başlık Sayfası	Resim ya da farklı yazı tipinin olduğu, yazarların isimlerinin ve tarihin yazılı olduğu başlık sayfası oluşturdum.	1	2	3
Giriş	Akılda kolay kalan, etkili bir giriş yaptım.	1	2	3
Karakterler	Karakterleri resimleriyle birlikte açık bir şekilde verdim, kullanıcıların her karakteri rahatlıkla anlamasını sağladım.	1	2	3
Dramatic Soru	Hikâyemde kullanıcıların ilgisini çekmesi için soru(lar) sordum.	1	2	3
Yaratıcılık	Kullanıcıların ilgisini çekmek için yaratıcı/farklı anlatımlara yer verdim, hayal gücümü kullandım.	1	2	3
Konuşma	Karakterleri hayata geçirmek için uygun uzunlukta metinler kullandım.	1	2	3
	Hangi karakterin hangi anda konuştuğunun rahatlıkla anlaşılmasını sağladım.	1	2	3
	Konuşma hızıma ve vurgulara dikkat ettim.	1	2	3
Ses/Resim Kalitesi	Hikâyemde kullandığım ses kaydının ve seslerin açık ve anlaşılır olmasına özen gösterdim.	1	2	3
	Hikâyemde kaliteli ve konuyla ilgili resimler kullandım.	1	2	3
Ortam	Hikâyenin nerede ve ne zaman geçtiğini belirtmek için yalın ifadeler kullandım.	1	2	3
Genel Yapı	Sonu olmayan ifadeler kullanmadım.	1	2	3
	Hikâyeyi anlatan farklı fiiller kullandım.	1	2	3
	Hikâyenin dikkat çekici ve sürükleyici olmasına özen gösterdim.	1	2	3
	Hikâyemi iyi organize ettim. Bir fikrin ya da bir ekranın bir diğerini açık geçişlerle ve mantıklı bir şekilde takip etmesini sağladım.	1	2	3
	Hikâyenin son halinin okunabilir, açık ve ilgi çekici olmasını sağladım.	1	2	3
Yazım-İmla	Yazım hatasının olmamasına özen gösterdim. Karakter ve yer isimlerini tutarlı bir şekilde verdim.	1	2	3
Konuya Odaklanma	Tüm hikâyenin konuya odaklı olması ve okuyucuyu konunun dışına çıkarmamaya çalıştım.	1	2	3
İçerik	Hikâyem ünitenin temel kavramlarını kapsadı.	1	2	3

APPENDIX H: OBSERVATION GUIDE

Bireysel Çalışan Öğrenciler İçin:

Sınıf Ortamındaki Aktiviteleri:

Laboratuvar Ortamındaki Aktiviteleri:

Ev Ortamındaki Aktiviteleri (Öğrenci söylemlerinden):

Teknolojik Altyapılarıyla ilgili Gözlemler:

Genel Gözlemler:

Grup Halinde Çalışan Öğrenciler İçin:

Sınıf Ortamındaki Aktiviteleri:

Laboratuvar Ortamındaki Aktiviteleri:

Ev Ortamındaki Aktiviteleri (Öğrenci söylemlerinden):

Teknolojik Altyapılarıyla ilgili Gözlemler:

Genel Gözlemler:

APPENDIX I: INTERVIEW FORM FOR INDIVIDUAL GROUP

Merhaba ………………

Öncelikle, bu çalışmaya gönüllü olarak katıldığın ve bu görüşmeye zaman ayırdığın için teşekkür ederim. Bildiğin gibi yaklaşık 3 ay boyunca sizlerle Fen Bilimleri dersi kapsamında iki ünite ile ilgili hikâyeler yazıp, görsel taslaklar hazırladık ve en sonunda hepiniz dijital hikâyelerinizi oluşturdunuz. Tüm bu süreç ile ilgili sana birtakım sorular yöneltmek istiyorum. Senin de izninle görüşmemizi kaydedeceğim, ancak kaydedilmesini istemediğin kısımlar olursa söyleyebilirsin. Görüşme süresince sorulara vereceğin cevaplar gizli tutulacak olup sadece bu çalışmanın sonuçlarını raporlamada kullanılacaktır. Ayrıca kişisel bilgilerin bu çalışmanın hiçbir yerinde kullanılmayacaktır. Görüşmeye istediğin zaman ara verebiliriz ya da istediğin anda görüşmeyi sonlandırabiliriz.

Sormak ya da söylemek istediğin herhangi bir şey var mı? Yoksa eğer ve kendini hazır hissediyorsan görüşmeye başlayabilir miyiz?

Görüşme Soruları

1. Fen Bilimleri dersinde dijital hikâyeler oluşturman konusunda ne düşünüyorsun?
    a. Olumlu yönleri neler? Neden, örnek verebilir misin?
    b. Olumsuz yönleri neler? Neden, örnek verebilir misin?
2. Dijital hikâye oluşturduğun Fen Bilimleri dersi konuları hakkında bilgi birikiminin arttığını düşünüyor musun? Evet/Hayır? Bu süreç konuları öğrenmenize katkıda bulundu mu? Nedenleriyle açıklayabilir misin?
3. Dijital hikâye oluşturma sürecinde dersin konularını öğrenmene en çok hangi aşama katkı sağladı? Nedenleriyle açıklayabilir misin?
    a. Hikâye yazma aşaması
    b. Görsel Taslak (Storyboard) oluşturma aşaması
    c. Dijital hikâye oluşturma aşaması

4. Hikâye oluşturduğun konuyla gerçek hayat arasında ilişkiler kurabildin mi? Örneklerle açıklayabilir misin?
5. Hikâye oluşturmanın herhangi bir kişisel becerini geliştirdiğini düşünüyor musun? Bu beceriler nelerdir? Neden bu becerileri geliştirdiğini düşünüyorsun?
6. Hikâye oluştururken ne gibi güçlüklerle karşılaştın? Açıklayabilir misin? Bu güçlükler nasıl çözülebilir, önerilerin nelerdir?
7. Başka bir derste dijital hikâye oluşturmak ister misin? Neden?
8. Fen Bilimleri dersinde dijital hikâyelerin kullanılması konusunda önerilerin var mı? Bu yöntemin daha etkili olabilmesi için neler önerirsin? Neden?
9. Eklemek istediğin başka bir şey var mı?

APPENDIX J: INTERVIEW FORM FOR COLLABORATIVE GROUP

Merhaba ………………

Öncelikle, bu çalışmaya gönüllü olarak katıldığın ve bu görüşmeye zaman ayırdığın için teşekkür ederim. Bildiğin gibi yaklaşık 3 ay boyunca sizlerle Fen Bilimleri dersi kapsamında iki ünite ile ilgili hikâyeler yazıp, görsel taslaklar hazırladık ve en sonunda hepiniz dijital hikâyelerinizi oluşturdunuz. Tüm bu süreç ile ilgili sana birtakım sorular yöneltmek istiyorum. Senin de izninle görüşmemizi kaydedeceğim, ancak kaydedilmesini istemediğin kısımlar olursa söyleyebilirsin. Görüşme süresince sorulara vereceğin cevaplar gizli tutulacak olup sadece bu çalışmanın sonuçlarını raporlamada kullanılacaktır. Ayrıca kişisel bilgilerin bu çalışmanın hiçbir yerinde kullanılmayacaktır. Görüşmeye istediğin zaman ara verebiliriz ya da istediğin anda görüşmeyi sonlandırabiliriz.

Sormak ya da söylemek istediğin herhangi bir şey var mı? Yoksa eğer ve kendini hazır hissediyorsan görüşmeye başlayabilir miyiz?

Görüşme Soruları

1. Fen Bilimleri dersinde dijital hikâyeler oluşturman konusunda ne düşünüyorsun?
   a. Olumlu yönleri neler? Neden, örnek verebilir misin?
   b. Olumsuz yönleri neler? Neden, örnek verebilir misin?
2. Dijital hikâye oluşturduğun Fen Bilimleri dersi konuları hakkında bilgi birikiminin arttığını düşünüyor musun? Evet/Hayır? Bu süreç konuları öğrenmenize katkıda bulundu mu? Nedenleriyle açıklayabilir misin?
3. Dijital hikâye oluşturma sürecinde dersin konularını öğrenmene en çok hangi aşama katkı sağladı? Nedenleriyle açıklayabilir misin?
   a. Hikâye yazma aşaması
   b. Görsel Taslak (Storyboard) oluşturma aşaması
   c. Dijital hikâye oluşturma aşaması

4. Hikâye oluşturduğun konuyla gerçek hayat arasında ilişkiler kurabildin mi? Örneklerle açıklayabilir misin?
5. Hikâye oluşturmanın herhangi bir kişisel becerini geliştirdiğini düşünüyor musun? Bu beceriler nelerdir? Neden bu becerileri geliştirdiğini düşünüyorsun?
6. Hikâye oluştururken ne gibi güçlüklerle karşılaştın? Açıklayabilir misin? Bu güçlükler nasıl çözülebilir, önerilerin nelerdir?
7. Başka bir derste dijital hikâye oluşturmak ister misin? Neden?
8. Fen Bilimleri dersinde dijital hikâyelerin kullanılması konusunda önerilerin var mı? Bu yöntemin daha etkili olabilmesi için neler önerirsin? Neden?
9. Dijital hikâye oluştururken arkadaşlarınla birlikte çalışmanın kolaylıklarını / zorluklarını örnekler vererek açıklayabilir misin?
10. Grupla birlikte dijital hikâye oluşturduğun süreçte herhangi bir kişisel becerinin geliştiğini düşünüyor musun? Ya da daha önce kendinde fark etmediğin bir özelliğini fark edebildin mi? Örneklerle açıklayabilir misin?
11. Grup arkadaşlarınla birlikte dijital hikâye oluşturduğunda konuyu öğrenmene ya da pekiştirmene katkısı olduğunu düşünüyor musun? Evet/Hayır? Açıklayabilir misin?
12. Eklemek istediğin başka bir şey var mı?

APPENDIX K: INTER-RATER RELIABILITY RESULTS

Tables placed below represent the themes and codes that raters had agreement and disagreement on.

Codes that raters had agreements on

Themes	Codes
Positive Sides of DS Use in Science Education	Rehearsal Reinforcement Supporting the exams Learning better Using in real life
Negative Sides of DS Use in Science Education	Time issue • Affecting other exams negatively • Affecting other exams negatively, time issue • Preventing to rest
Level of Knowledge	Increasing knowledge about the course Providing permanent knowledge
Reasons for DS Phase Choosing	I learn better by writing Because digital story creating process is fun, so I easily remember what I did Because digital story has both visuals and sounds I use my imaginary while writing a story so I learn better Recording while creating a digital story
Real Life Relationships	Inspiration … from movies … from books … from a book … from a cartoon Using imagination Using real life names in DS Using future job
Individual Skills	Realizing the ability to create a DS Improving ICT skills Improving ability to create a DS Improving story writing skills Improving drawing skills Realizing the ability to write a story Having experienced in writing a story Memorization skill Remembering skill Recognizing imagination skill
Difficulties met in DS Process	Finding characters Meetings for collaboration Difficulties in using PC Time issue Finding/choosing pictures Adding music Recording
Reasons for choosing another course to create DS	Because this course is my favorite course To make this course more entertaining Because the subjects of this course are proper to create a digital story Because I have difficulties in understanding of this course

Suggestions	Animating in a natural environment Distribution of roles by the instructor A new future to record, (recording just by writing) Working individual is better Rehearsing (as a theatre) Creating a DS for a course that the student is not good at. Wishing more colleagues for recording Willingness to work in a group A common decision for a subject and DS
Advantages of being a group member	Time issue / Easiness Learning how to share Exchange of ideas Distribution of roles
Disadvantages of being a group member	Work load • when a specific work exists • when somebody in group does not do what s/he has to Divergence
Skills in group	Realizing the ability to work in a group Improving communication with friends Responsibility • Learning to take responsibilities Improving at recording (**role play, imitation**) Improving the story writing skill
Preferring to work in group or individual?	Learning better in a group • Exchange of ideas Learning better individually • Distraction occurs when studying with a friend • More difficult, but learning better individually • Communication problems

Codes that raters had disagreements on

Themes	**Codes**
Positive Sides of DS Use in Science Education	Helping to effort for studying Time management Helping to remember the subject In-depth learning Performance increase in course Helping to answer the questions in mind
Individual Skills	Improving the technological background Having ability to make decisions
Difficulties met in DS Process	Storyboarding Scene duration Deadline issue
Suggestions	Creating DS for other courses
Advantages of being a group member	Learning how to change one’s tune
Skills in group	Learning to take responsibilities

APPENDIX L: RESEARCHER'S WRITTEN FEEDBACK

Dijital Hikâyenizi Oluştururken Dikkat Etmeniz Gereken Hususlar

- ✓ Hikâye uzunluğu 4-6 dk. arasında olmalıdır. (Hikâyenizin çok uzun ya da çok kısa olmamasına dikkat ediniz.)
- ✓ Hikâyenizi yazarak değil de genellikle ses kaydı şeklinde anlatınız.
- ✓ Bazı ekranlarda yazılar kullanabilirsiniz.
- ✓ Resimleriniz hikâyelerinizle alakalı olmalıdır.
- ✓ Resimlerinizin kaliteli olması gerekir.
- ✓ Yazım/Ses kaydı hataları yapmayınız.
- ✓ Resmin ekranda kalma süresi ile anlatım süreniz aynı olmalıdır.
- ✓ Bir resim ekranda çok uzun süre kalmamalıdır.
- ✓ Sesinizin anlaşılır olması gerekir.
- ✓ Kullandığınız müzikler/sesler kendi sesinizi bastırmamalıdır.
- ✓ Konunuza odaklanmalısınız, giriş kısımlarını kısa tutabilirsiniz.

APPENDIX M: STORY SAMPLE

ORMANDAN GELEN SES

(Güzel ve yemyeşil bir ağacın her dalında ağaçtan yapılan malzemeler- kalem, defter, masa, sandalye vs.- sallanır. Üzerindeki kara bulut içerisinde yangını,baltayı,kızgın bir güneşi barındırır ve şimşekler çakar. Kalemlerden oluşan öykü başlığı yazımız efektler ile birlikte belirir ve efe karakteri koşarak ağacı kurtarmaya gitmekle kısa bir özet havasında hikayeye giriş yapılır.)
Efe her akşam olduğu gibi "Ormandaki Hayat" çizgi filmini izliyordu. Annesi Efe'ye resim ödevini yapması gerektiğini hatırlattı. Resim yapmayı sevmeyen Efe, içerlenerek odasına gitti ve bir ağaç resmi çizmeye başladı. Çizdiği ağaçlar istediği gibi olmayınca resim kâğıtlarını yırtmaya başladı. Sinirini kağıtlardan çıkaramayan Efe elindeki kalemi de fırlattı (fırlayan kalem duvara sert bir şekilde çarptı ve geri çalışma masasına düştü), hırsını ondan çıkarırcasına (Efe tekrar kalemi duvara fırlattı ve kalem tekrar çalışma masasına geri geldi bu durum bir kaç kez daha devam etti). Efe duruma anlam veremedi (korkulu bakışlar attı) hiç beklenmeyen bir durum oldu ve kalem Efeyle konuşmaya başladı. Efe şaşkınlıkla kaleme bakarken;

Kalem- (ucu kırılmış arkası ısırılmış tahta kalem) - Bize neden böyle davranıyorsun? Biz senin hayatını kolaylaştırmaya çalışıyoruz. Bir çevrene baksana bu masa, sandalye, kapı, dolap, pencere ve o yırttığın kâğıt senin için buradalar. Korumak yerine neden hırsını bizden çıkarıyorsun.

Efe- (Şaşkınlıkla kaleme bakarak) - Affedersin, ben sadece ödevim için gereken resmi yapamadığım için kendime sinirlenmiştim. Sana zarar vermek değildi niyetim, ben doğayı ve ormanları çok severim aslında.

Kalem- İnsanlar farkında olmadan ormanlara sürekli zarar veriyorlar, seni de o bilinçsiz insanlardan birisi sandım. O zaman bizi daha yakından tanımaya ve korumaya ne dersin? Biz hepimiz ormanın bir parçasıyız hepimiz bir ormandan geldik. Huzuru, sevgiyi, sağlığı barındıran ormanlarımızdan. (Orman manzaraları ve doğa güzellikleri görsel olarak vurgulanır.)

Efe- Ormanlar hakkında daha fazla bilgi sahibi olmayı, senin ve arkadaşlarının hikayelerini dinlemeyi çok isterim! (Meraklı ve heyecanlı bakışlarla öne atılarak.)

Kalem- Ormanlar ağaçlarla birlikte diğer bitkiler, hayvanlar, toprak, hava, su, ışık ve sıcaklık gibi fiziksel çevre faktörlerinin oluşturduğu karşılıklı bir dönüşüm içerisinde dünya yaşamına katkı sağlayan ekosistemdir. (Görsel efektlerle ekosistem gösterilir.) Günlük hayatta kullandığınız ürünlerin bir çoğu ormanlardan tedarik edilmektedir. Farkında olmayabilirsin ama çevrendeki ürünlerin bir çoğu ormansal kaynaklıdır. (Tekrar odadaki ahşap eşyalara odaklanılır.)

Efe- Sen ne kadar çok şey biliyorsun böyle! (Şaşkınlığı devam etmektedir Efe'nin)

Kalem- Kağıt, kalem, masa, sandalye, gardrop, resim çerçevesi, bazı enstrümanlar, kapı, çatı, mobilya, ağaç vazo, yerdeki parke ve daha niceleri ağaçlardan yani ormanlardan tedarik edilir. Ormanların bunların yanı sıra çok fazla yararı vardır insanlara, bilmiyor musun? (bilmiş bir tavır ile Efe'yi denemek ister kalem)

Efe- Bu kadarını ben de biliyorum.

Kalem- Yaşamınızdaki yerini saymakla bitmez (Tüm maddeler görselleri ile birlikte sergilenir.)
-yapacak ve yakacak hammadde kaynağıdır,
-su kaynağıdır ve yeraltı sularının oluşmasını sağlar,
-erozyonu önler,su taşkınlarını önler,
-yaban hayatını ve av kaynaklarını korur,
-iklim üzerindeki olumlu etkileriyle sıcağı ve soğuğu dengeler
-su buharını yoğunlaştırarak yağmura dönüşmesini sağlar,
-insanların eğlenme ve dinlenme amaçlarına hizmet ederken, beden ve ruh sağlığı-üzerine olumlu etkiler yapar,
-hava kirliliği ve gürültüyü önler,
-insanlara çeşitli iş alanları sağlar,
-ülke turizmine katkıda bulunur.

Efe- Evet bilmiyorum diyemem elbette ormanların bazı yararlarını biliyordum ama ormanların insan hayatında bu kadar fazla kullanıldığını bilmiyordum. (Mahçup bir tavra geçerek) Oysa ormanlar insan hayatının devamlılığı için her alanda kullanılıyormuş. Sadece gözle görülen yararlarının yanında dolaylı olarak da birçok faydası varmış.

Kalem- Ormanlar, doğal güzellikleri ve sayılmayacak kadar çok faydalarıyla iyi baktığımız takdirde tükenmez bir doğal kaynaktır. Fakat ormanlar yok oluyor! İnsanlar ona bilinçli ya da bilinçsizce zarar veriyor.(Artık kalem Tedirgin ve uyarıcı bir ses tonuyla zor durumda olduklarını anlatır.)

Efe- Ben bilmeden zarar verdim. Kendimi çok suçlu hissediyorum. (Efe artık gerçekten suçluluk hissetmektedir yaptıklarından dolayı)

Kalem- Az önce yaptığın çok küçük bir zarardı, çoğu insan da senin gibi istemsiz olarak doğaya ve ormanlara zarar veriyorlar. Ama asıl sorun bilerek ve isteyerek zarar veren insarlarda. Onların yaptığı yıkımlar daha büyük ve ölümcül oluyorlar.

Efe- Aklım almıyor, insanlar kendi hayatları için bu kadar önemli olan ormanlara nasıl zarar verebiliyorlar? (Efe artık olanları sorgulamaktadır.)

Kalem- Ormanlara zarar veren en önemli etkenler (Tekrar tüm maddeler görsellerle desteklenir.)
-yangınlardır.
-sıcak geçen yazlarda yer altı sularının çekilmesi, insanların suları bilinçsiz kullanması ile birlikte yaşanan kuraklıklar.
-bazı besi hayvanlarının ormanlık alanlarda otlatılması ve taze fidanları yiyerek yeni büyüyecek ağaçları engellemeleridir.
-kaçak ağaç kesimleridir.
-plansız yerleşim ve hava kirliliğidir.
-su kaynaklarının insan eliyle yer değiştirmesidir.
-kesilen ağaçların yerine yenilerinin dikilmemesidir.

Efe- Çok üzüldüm bunların hepsini biz mi yapıyoruz. Ama sizi seviyoruz.

Kalem-Biz de sizi seviyoruz, fakat bir an once önlem alınmazsa ormanlar yok olacak. Türkiye'de dikkatsizlik ve ihmal ormanları yakmaya devam ediyor. Ülke genelinde 1996-

2005 yılları arasında çıkan toplam 18 bin 915 yangının büyük bölümünün dikkatsizlik, ihmal ve kaza sonucu başladığı belirlendi. Bu yangınlarda yaklaşık 100 bin hektar ormanlık alan tahrip oldu.
Söz konusu dönemdeki toplam 18 bin 915 orman yangının:
(Tüm rakamsal değerler yazı olarakta belirtilir kolay takip edilebilmesi için)
-Yüzde 14'ünün kasten çıkarıldığı,
-Yüzde 7'sinin yıldırım düşmesi sonucu,
-Yüzde 23'ünün bilinmeyen nedenlerle,
-Yüzde 56'sının ise ihmal, dikkatsizlik ve kazayla başladığı tespit edildi.
Dikkatsizlik ve ihmalin yanı sıra bilinçsizlik de ormanların hızla yok olmasında önemli bir yere sahiptir. Suların bilinçsiz tüketimi ve ormanlar için gerekli su ihtiyacının kaşılanmaması, ormanların otlatılması, kesilen ağaçların yerine yenilerinin dikilmemesi, ve bunun gibi bir çok neden bilinçsizlik sonucu ormanların yok olmasına sebep olmaktadır.

Efe- Peki nasıl engel oluruz, nasıl ormanları koruyabiliriz? (Artık efe suçluluk duygusunu yenmek için girişimlerde bulunmaktadır.)

Kalem- yeter ki insan oğlu istesin, önlem almak için yapılabilecek bir çok şey var. (Tekrar tüm maddeler görsellerle desteklenir.)
- Ağaç kesimlerine engel olunmalıdır.
- Ormanlara zarar veren hayvanların (kıl keçileri) ormanlardan uzaklaştırılması gerekir.
- Yanan veya kesilen ağaçların yerine yenilerinin dikilmesi gerekir.
- Yakıt olarak odun kullanımı azaltılmalıdır.
- Ağaçtan yapılan eşyaların daha dikkatli kullanılması gerekir.
- İnsanlar ormanın önemi hakkında bilgilendirilmelidir.

Çocuk- Peki ben ne yapabilirim?

Kalem- (Tekrar tüm maddeler görsellerle desteklenir.)
-Ormanda kesinlikle ates yakmamalısın.
-Piknik yaptığınız alanı temiz bırakmaya özen göstermelisin.
-Kağıtları mümkün olduğunca çift taraflı kullanmalısın; kağıt israfından kaçınmalısın.
-Hafif kağıt kullanmalısın. Hafif kağıdın üretimi sırasında daha az enerji ve daha az hammadde kullanılır.
-Geri dönüşümlü kağıt kullanmalısın.
-Geri dönüşümü yaşamının bir parçası haline getirmelisin.
-Topladığınız kağıtları düzenli olarak atık kağıt alım merkezlerine göndermelisin.
Mümkün olduğunca e-posta, modem yoluyla faks gibi alternatif iletişim araçlarını kullanmalısın.
-Bilgisayarından çok gerekmedikçe kağıt çıktısı almamalısın.
-Dosyalarını bilgisayar ortamında saklamalısın.
-Alişverişlerinde bir kez kullanılıp atılan kağıt torbalar yerine, bez torba kullanmalısın.
-Enerji tasarrufuna özen göstererek ormanlar üzerindeki baskıyı azaltmaya yardım etmelisin.
-Giderek artan enerji gereksinimi yeni santrallerin kurulmasını gerektirmekte, bu da hava kirliliği, asit yağmurları yoluyla ormanları tehdit etmektedir.O yüzden enerji kullanımına dikkat etmelisin.
-Elektrikli aletleri kullanmadığın sürece prizden çekmelisin.

Efe- Peki kalem, bunların hepsini dikkate alıp uygulayacağıma söz veriyorum. Çünkü ormanlar bizim hayatımızda çok önemli yere sahipler, onlara saygı göstererek kendimize yarar sağlamış oluyoruz. Beni bu konuda bilgilendirdiğin için teşekkür ederim. (Efe artık rahatlamıştır ve bilinçli olmanın huzurunu yaşamaktadır.)

Efe derin bir düşünceden sonra, daha da bilinçli olarak ödevine odaklanır.
Annesi odasına girdiğindeki manzara karşısında şaşkındır. Efe odasını toplamış ve ödevini bitirmiş halde gülümseyerek onu karşılar. Annesi onu somurtkan bir halde ödevini yapmaya çalışacağını düşünürken bu değişimi merak eder oğlundaki.

Anne- Efecim ödevini bitirmişsin oğlum aferin sana, bakabilir miyim?

Ödevine bakan anne oğlunun yapmış olduğu resme hayranlıkla bakarak.

Anne- ne kadar güzel çizmişsin, sanki ormanın sesini duyar gibi.

Efe- evet anne ormanın sesine kulak verdim ve ağaçları ve ormanları çok seviyorum. Sen de seviyorsun değil mi?

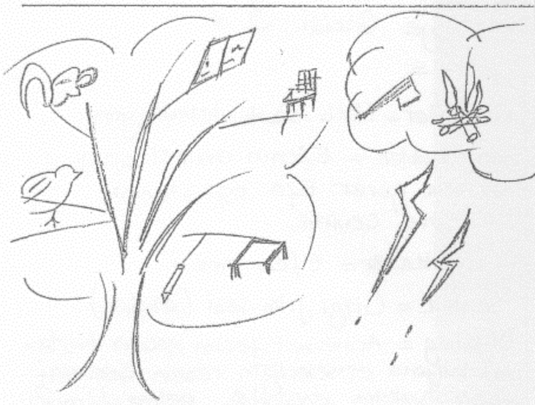
Anne- Elbette Ormanlar bizim hayat kaynağımız Efecim.

Efe- Ben de artık bir orman bekçisiyim o zaman anne. Zarar veren karşısında beni bulur ☺
(karşılıklı gülüşürler)

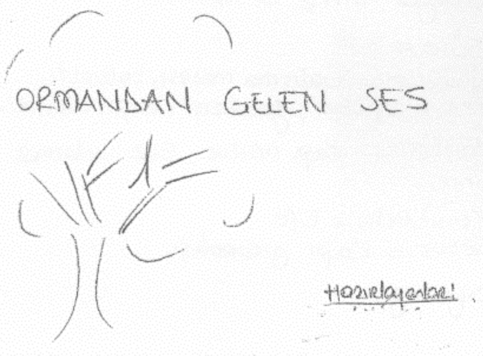
APPENDIX N: STORYBOARD SAMPLE

– ORMANDAN GELEN SES –

# Giriş Ekranı 1 #
Süre = 5 - 10 sn.
Nesneler = Ağaç, masa, sandalye, kalem defter, kuş, sincap
Hareketler = Ağaç üzerindeki nesneler sallanır.
Karakterler = –
Sesler = Orman ve hayvan sesleri
Diyalog = –



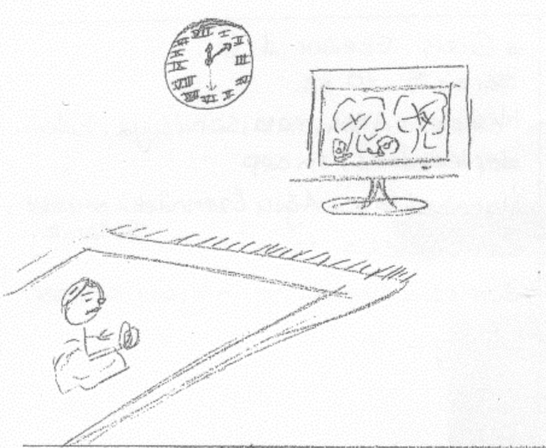
Giriş Ekranı 2
Süre =
Nesneler = Ağaç, masa, sandalye, kalem defter, kuş, sincap, şimşek
Hareketler = Bulut kayarak gelir.
Karakterler = –
Sesler = Orman ve hayvan sesleri, yangın sesi, gökgürültüsü ve şimşek
Diyalog = –



Giriş Ekranı 3
Süre =
Nesneler = Başlık, Hazırlayanlar
Hareketler = Giriş Ekranı 2'nin opaklığı azalır, başlık ve hazırlayanlar kayarak ekrana gelir.
Karakterler = –
Sesler = Orman ve hayvan sesleri.
Diyalog = –

(1)

ORMANDAN GELEN SES



Hikaye Girisi 1

Süre =

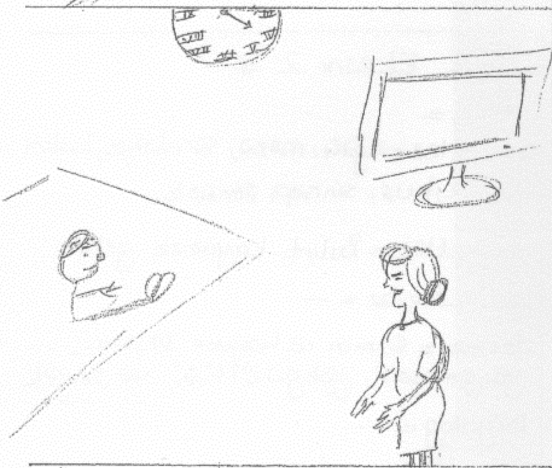
Nesneler = Halı, saat, televizyon

Hareketler = Ormandaki Hayat çizgi film videosu oynar.

Karakterler = Efe

Sesler = Çizgi filmin sesi.

Diyalog = —



Hikaye Girisi 2

Süre =

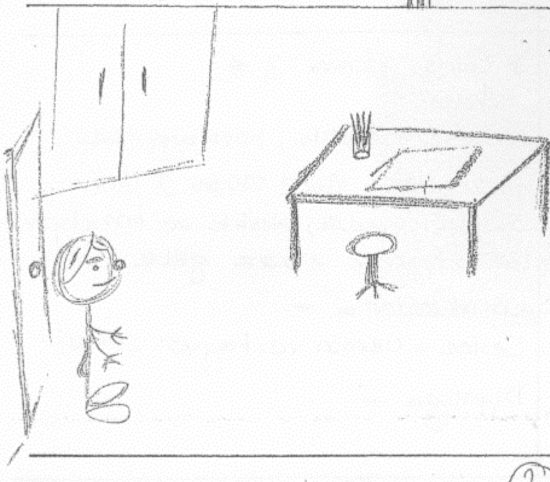
Nesneler = Halı, saat, televizyon

Hareketler = Efenin annesi ana ekrana girer. Efe bakışlarını annesine çevirir.

Karakterler = Efe, Annesi

Sesler = Çizgi film sesi (azalır)

Diyalog = Anne = Efecim, geçen hafta-dan buyana ertelediğin resim ödevini yapma vaktin sencede gelmedimi?



Hikaye Giriş 3

Süre =

Nesneler = Çalışma masası, kalemlik, resim kağıtları, gardırop, kapı, tabure.

Hareketler = Kapı açılır, Efe odasına girer.

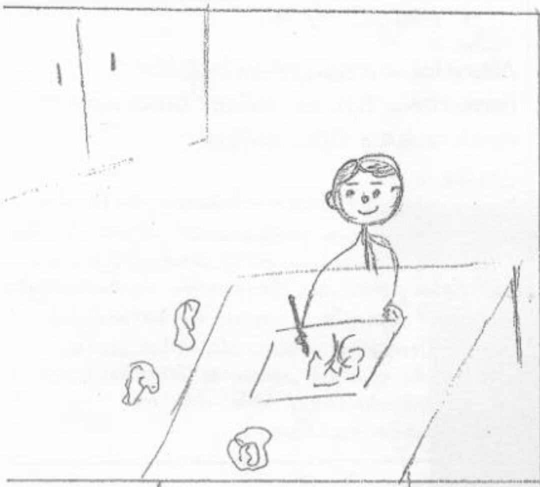
Karakterler = Efe.

Sesler = Kapı gıcırdısı.

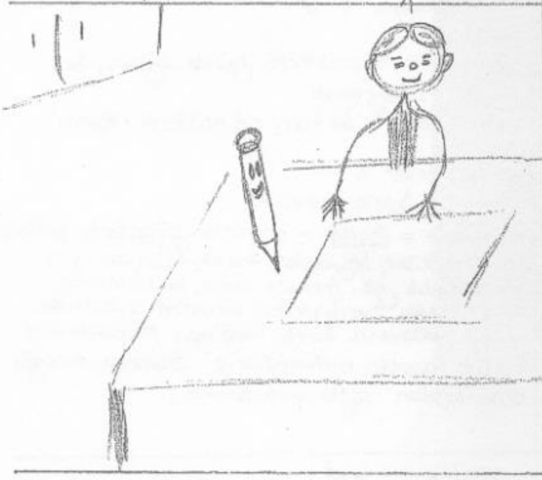
Diyalog = -

(2)

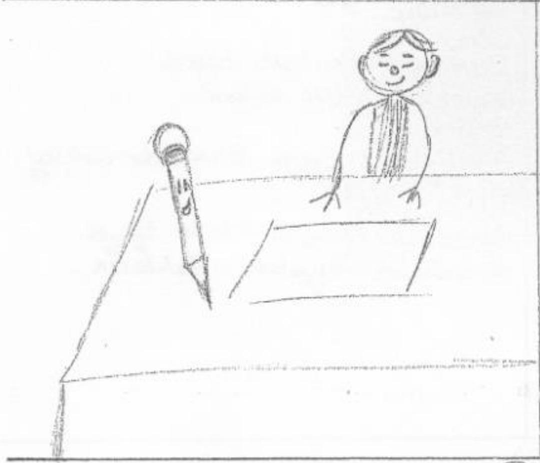
ORMANDAN GELEN SES



Hikaye 1
Süre =
Nesneler = Masa, resim kağıtları, dolap, kalem.
Hareketler = Efe resim çizer, resim kağıtlarını buruşturup atar ve kalemini duvara fırlatır.
Karakterler = Efe
Sesler = Kağıt buruşturma sesi, kalemin duvara vurması.
Diyalog = –



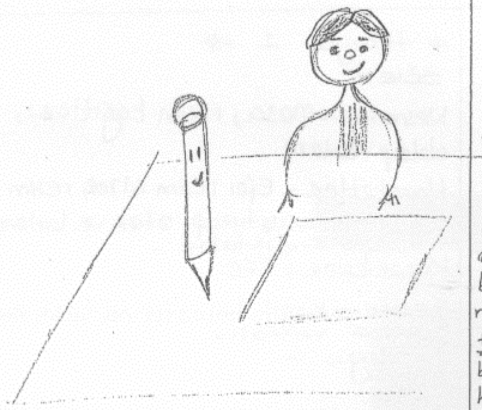
Hikaye 2
Süre =
Nesneler = Masa, resim kağıdı, dolap
Hareketler = Kalem dik bir şekilde durur ve konuşur.
Karakterler = Efe, kalem
Sesler = –
Diyalog = Bize neden böyle davranıyorsun, biz senin hayatını kolaylaştırmaya çalışıyoruz. Çevrene bir baksana bu masa, sandalye kapı dolap pencere ve yırttığın kağıt senin için burdalar, korumak yerine neden hırsını bizden çıkarıyorsun?
(Kamera eşyalara odaklanır)



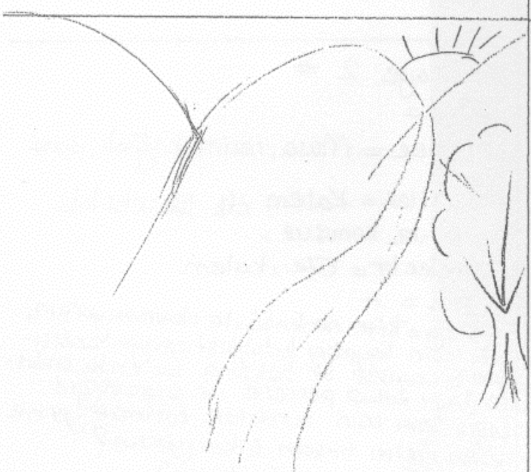
Hikaye 3
Süre =
Nesneler = Masa, Kağıt,
Karakterler = Efe, Kalem
Sesler = –
Diyalog = Efe – Affedersin, ben sadece ödevim için, gerekli resmi yapamadığım için kendime sinirlenmiştim. Sana zarar vermek değildi niyetim. Ben doğayı ve ormanları çok severim.
Hareketler = Kalem sağa sola sallanır, Efe konuşur.

③

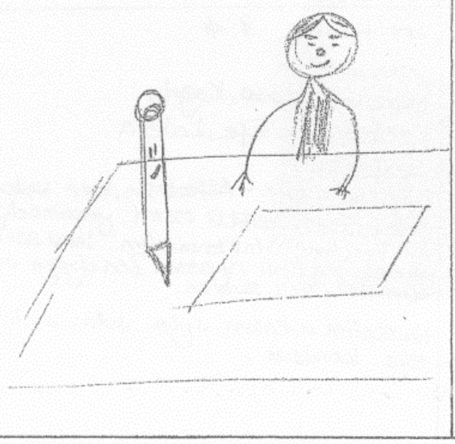
ORMANDAN GELEN SES



\# Hikaye 4 #
Süre =
Nesneler = Masa, resim kağıtları
Hareketler = Efe ve kalem konuşuyorlar.
Karakterler = Efe, Kalem.
Sesler = —
Diyaloglar = Kalem = - İnsanlar farkında olmadan ormanlara sürekli zarar veriyor. Senide o bilinçsiz insanlardan birisi sandım. O zaman bizi daha yakından tanımaya ve korumaya ne dersin? Hepimiz ormanın bir parçasıyız.
Efe – Ormanlar hakkında daha fazla bilgi sahibi olmayı senin ve arkadaşlarının hikayelerini dinlemeyi çok isterim.
(Efe ayağa kalkar.)



\# Hikaye 5 #
Süre =
Nesneler = Ekosistem, güneş, ağaç, su, çiçekler, hayvanlar
Hareketler = Birkaç ekosistem resmi geçer.
Karakterler = —
Sesler = Doğa sesleri
Diyaloglar = Kalem – ormanlar ağaçlarla birlikte diğer bitkiler, hayvanlar, toprak, hava, su ışık ve sıcaklık gibi fiziksel çevre faktörlerinin oluşturduğu karşılıklı bir dönüşüm içerisinde dünya yaşamına katkı sağlayan ekosistemdir. Günlük hayatta kullandığımız ürünlerin birçoğu ormanlardan sağlanmaktadır.

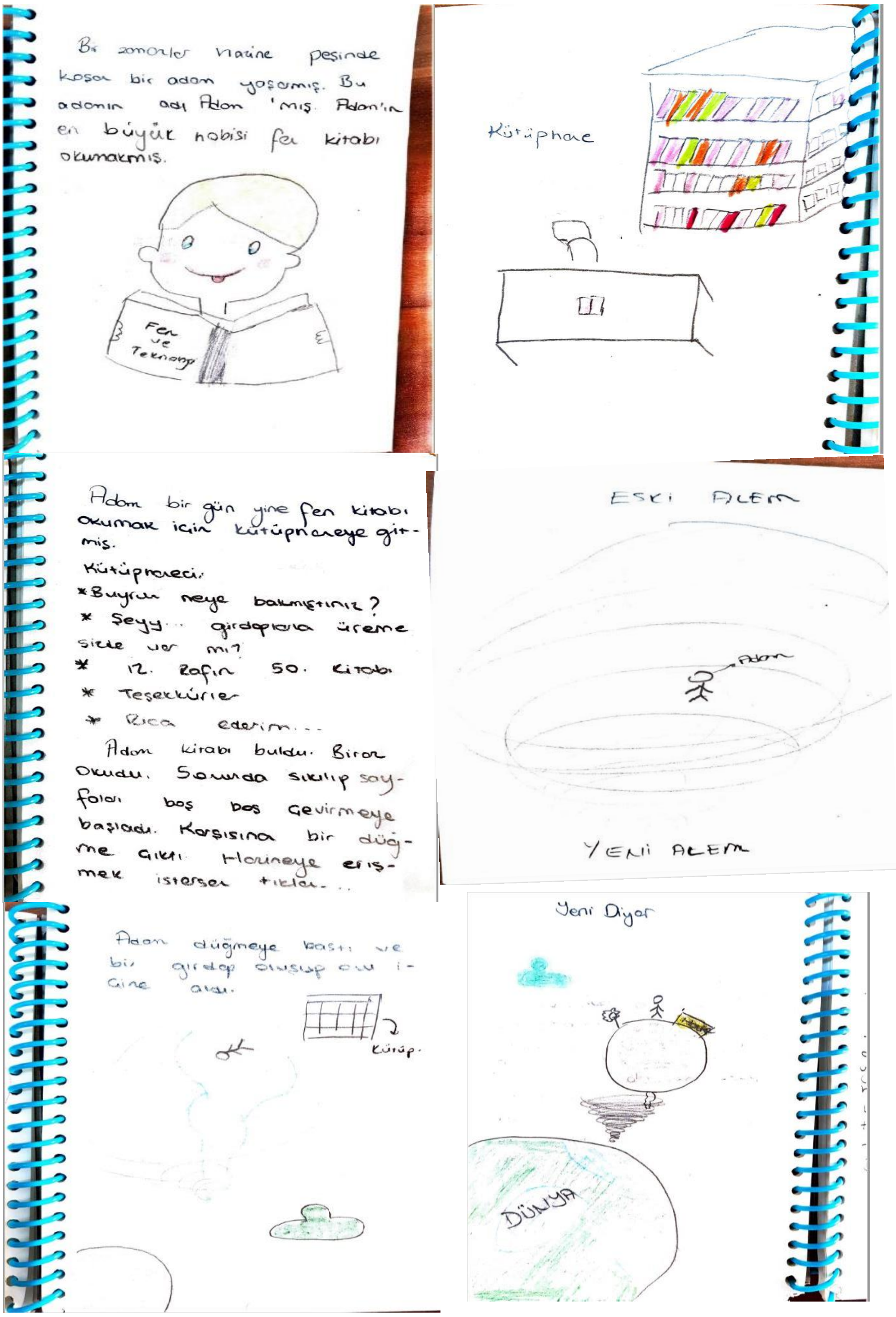


\# Hikaye 6 #
Süre =
Nesneler = Masa, resim kağıdı.
Karakterler = Efe, kalem.
Sesler = -
Diyaloglar = Efe = Sen nekadar çok şey biliyorsun böyle?
Hareketler = Kamera tekrar Efe'ye ve odadaki eşyalara odaklanır.

④

APPENDIX O: STORY EXAMPLES FROM STUDENTS

Example 1



Adan çok korkmuştu. Bir yardım isteyecekti. Sonunda birini buldu.

Adan:

- Merhaba... Ben Adan. Bu diyarın içine düştüm. Senin adın ne?
- Ben bakteri. Harize için geldin değil mi. Sana bir ipucu. Bu işine yarayacak. Ben daha birçok tek hücreli canlı gibi bölünerek ürerken bira mayası üzerinde tomurcuklar oluşturarak onu üstünde tomurcuklanarak üre. Bunun yanı sıra deniz yıldızı rejenerasyon ile bitkilerin bir kısmı da vejetatif üreme ile çoğalırlar, dedi.

Adan:

- Peki şimdi ne yapmalıyım?

Bakteri:

- Sola dön papatya sana bir ipucu daha verecek.

(Adan papatyanın yanına gider.)

Adan:

- Merhaba, ben Adan şeyy..

Papatya:

- Ahh biliyorum biliyorum. Normalde taç yapraklarımın kokularıyla böcekleri üzerlerine çekmesi gerekir ama bu bakteri bana yapıştı gitmiyor...

Üzüntüden erkek organın üstündeki tepeciğin içindeki polenlerim çıkamıyor.

- EEE Burda bana ne?
- Ne demek bana ne? Sen çok bencilsin. Bu nedenle polenlerim tozlaşma yapamıyor. Dolayısıyla da dişi organımın son bölümü olan yumurtalık da polenleri alamıyor. Yani döllenerek zigot ve sonra da embriyoda yeni bir tohum oluşturamıyorum. Bu tohumu yapamadığım için de meyvem olamayacak, o meyve asla

Papatya

Çimlenemeyecek, benim yeni bir bitkim olmayacak... (Ağlar) Çanak yapraklarım fotosentez yapmayı kesti. Artık onların yeşil renkleri bir işe yaramıyor. Çiçek sapım beni dallarımda ayıra ayıracak. Çiçek tablam ise erkek organ, dişi organ, taç yaprak ve çanak yaprakları taşımaktan illallah etti. Yeter Artık! Yeteeer! Senin gibi meraklılar ise erkek organlarımı sıkıntıdan bir bir koparıp sapçık ve başçıklarında ayırıyor.

Adam:

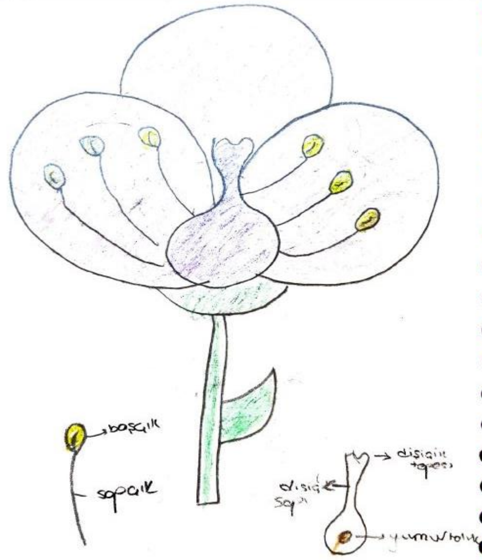
- Artık bana yardım edecek misin?

- Offf tamam... İleriden sağa dön. İstemi Yabgu var orada sana sorular sorup hazineyi verecek

- Çok Teşekkür ederim.

- Rica ederim. O bakteriyi de görürsen çiçek sapından düşmesini söyle.

(Adam İ. Y.'nun yanına gider)



(Yoga yapan İstemi Yabgu)

İstemi Yabgu:

- Söyle evlat. ...nak.

Adam:

- Ben pap...

İ. Y.

- Her şeyi görürüm. Ne istediğini söyle.

Adam:

- Nasıl gördün?

İ. Y.

- Ben görürüm...

Adam:

- Nasıl Yani?

İ. Y.

- Ne istiyorsuuun?

- Evime dönüp hazineyi almak.

İ.Y.

- O zaman soruları cevapla

Adam:

- Niye?

İ.Y.

- Burada bilginin bir karşılığı olmalı

Adam:

- Peki offf...

İ.Y.

- Bir bonusun var. Bileme-diğin soruda kullan. Ne kadar doğru cevap

o kadar altın..

Adam:

- Peki...

İ.Y.

- Başlayalım.

7 iki bölümden oluşur. Bölümle-rinden birinde polenler bulunur.

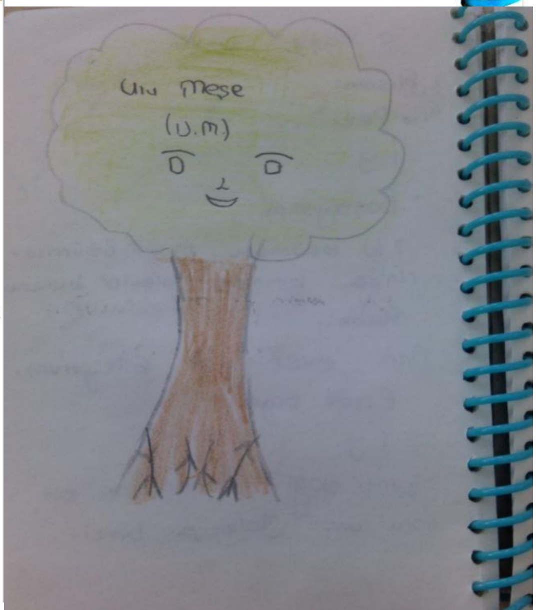
Adam:.

Haa evet evet biliyorum.

Erkek organ.

İ.Y.

- Evet doğru Sırada zor bir soru var. Yalnızca bitki-



lerde görülen üreme şekli nedir?

Adam:

- Toplam kaç soru var?

İ.Y.

- 3

Adam

- Ulu meşeye başvuracağım.

(Ulu Meşe gelir.)

U.M.

- Vejetatif Üreme

Adam:

- Teşekkürler U.M.

U.M

- Rica Ederim.

Adam:

- Sıradaki lütfen...

İ.Y.

- Çimlenme nedir?

Adam:

- Bitkinin su Güneş ışığı gibi faktörlerle yeşerip tohum yapma-sı için gerekli olaya çimlenme denir.

İ.Y.

- Tebrikler. $\frac{3}{3}$ yaptın. Harita Şurada.

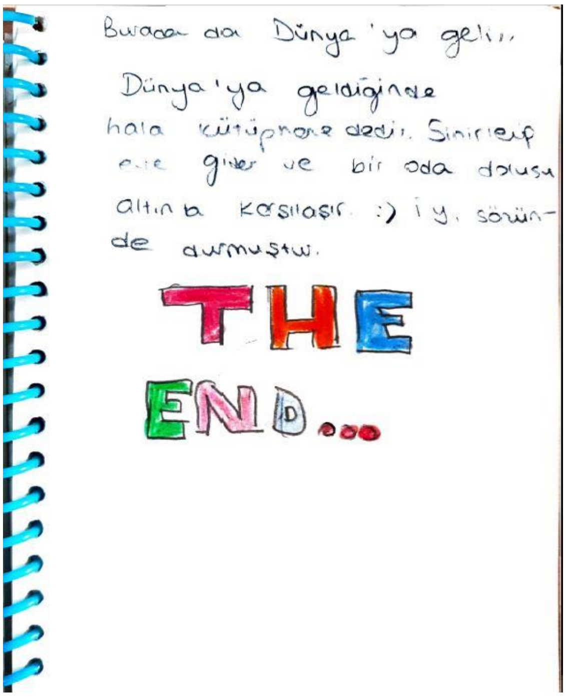
Adam:

- Tanıştığıma memnun oldum.

İ.Y.

- Berae

Hazineyi açar. Bakmaya çalışırken içine düşer.
DÜNYA



Buradan da Dünya'ya gelir.
Dünya'ya geldiğinde
hala kütüphane dedi. Sinirlenip
eve gider ve bir oda dolusu
altınla karşılaşır. :) İy. sözün-
de durmuştur.
THE
END...

Example 2

ZUKUFUTOKUNO FURIJEKI HAYVANLAR
KONUŞUYOR

(Avusturya'da geçen bu hikayede Lepistes'e Lepotikos deniyor)

Dedektif Alan'ın vakayı çözmesine çok az kalmıştı. Bu vakada madur Mary'nin hayvanları çalınıyordu... Örneğin doğurarak çoğalan tek balık olan lepotikos'u çalınmış-tı. Bu hayvanların değerli olmasının bir nedeni de ko-nuşabilmeleri ve bu özellikleriyle Zukufutokuno Furijeki operasyonunda kullanmalarıydı. Alan hayvan-ların Mary'nin ev sahibi Herry tarafından çalındı-ğını düşünüyordu.

Alan:
- Bu Herry'i nerede görebiliriz?

Mary
- Hayvan barınağı yakınlarında bir deposu var.

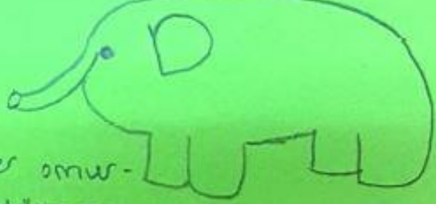
Alan:
- Teşekkürler...

(Depoya gider. Orada Herry yoktur.) Bir pengu-en görür.

Penguen:

- Teşekkür ederim. Benim adım Pingin. Uçamayan bi, kuş türüyüm. Yumurta ile dünyaya benim kadar tat-lı penguenler getiririm. Bizde yaşam döngüsü iç döllenme yumurtlama ve dış gelişme şeklinde olur. Yavrularıma bakarım.

(Oradan bir fil),



- Ben de bir memeli türüyüm. Pingin ve diğer omur-galıların aksine iç döllenme ve iç gelişme sonucu dünyaya geldim. Yavrularımı süt ile besleyip onlara bakarım! Onları doğurarak dünyaya getiririm.

(Yılan:)

-Sizi gidi susmak bilmeyen omurgalılar tissss. En ö-nemli yeri anlatmadınız tıss! Anlamadan dinliyor yavrucak tıs-ss. İç döllenme; yavrunun anne karnında döllenmesi, dış döllenme dış ortamda döllenmesidir. Bunun yanında dış gelişme yavrunun gelişimini dış ortamda tamamlaması, iç gelişme ise gelişimi anne karnında tamamlanmasıdır. Tıss! Bizde ise dış döllenme dış gelişme görülür. Yavrularıma bakmam. Tısss!

Kurbağa:

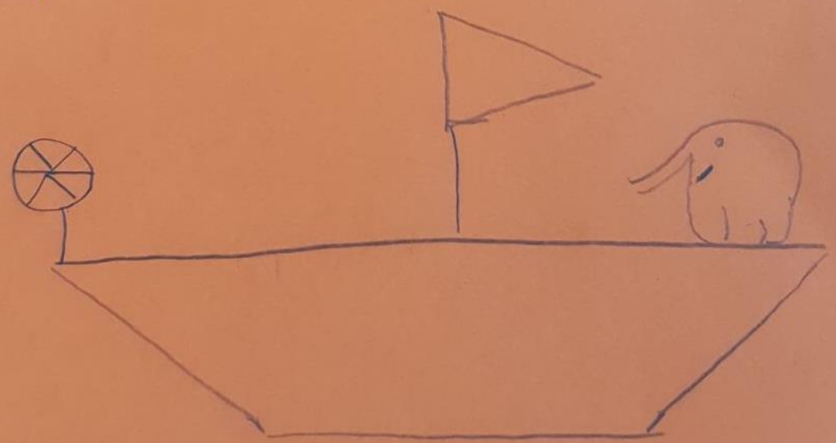
- Bize geveze diyen bak! Sus da artık ben konuşayım Tıstırık kar-des. Ben ~~kurbağa~~. Aynı yılan Tıstırık gibi çoğalırım. Ancak ondan farkım; ben başkalaşım geçiririm.

Önce yumurta oldum. Sonra larva oldum yumurtadan çıkıp. Bir süre sonra adım iribaş oldu. Bacaklarım biraz gelişti sonra. Akciğer ve deri solunumu yapmaya başladım. Bir süre sonra bu hale geldim. Artık karada yaşıyorum. Ön bacaklarım kısadır arka bacaklarım ise uzun. Vırrak.

(O esnada Ala ölecek üzere bir balık gördü.)

Ala:

- Arkadaşımız ölmek üzere! Ona yardım edelim. Bir an önce onu denize yetiştirelim. (O sırada fil Firişkolonya elinde motorlu bir gemiyle gelir. "bu gemi uçak da gidebiliyor") der. (Gemiye binerler)



Alan:

-Bana su lazım.

Pingin:

-Benim yükseklik fobim var!

Tıstırık:

- Pullarım diken diken oldu.

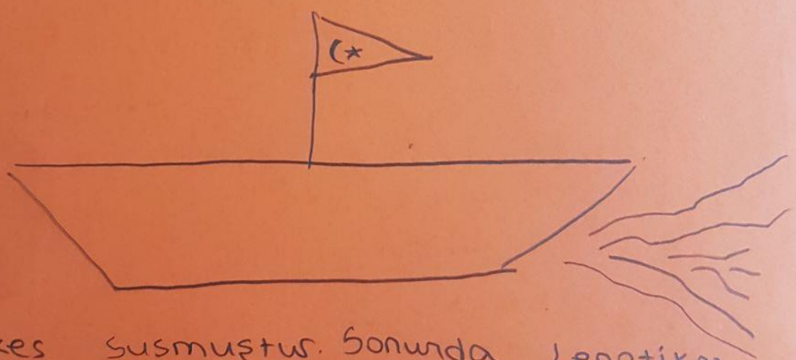
Firişkaonisya:

-Dümene biri geçsin!

Lepotikos (Alan'ın elindeki balık):

- Ölmek üzereyim çabuk olun!

(Alan geminin dümenine geçer. Roketleri çalıştırır. Uçmaya başlarlar.)



Herkes susmuştur. Sonunda Lepotikos ölmeden önce Mary'nin evine varırlar.

Mary:

-Nerede kaldınız!

Alan:

-Çabuk! Lepotikos'u suya koy!

(Lepotikos suya konulur)

Alan:

- Şimdi anlat bakalım, neymiş bu operasyon?

Mary:

- Hayvanlar bu şekilde fen derslerine girerek çocuklara ders verecekler.

Alan:

- Çok harika bir şey bu onlaşıla ders vermeye benden başladılar. ☺

Mary:

- Evet olabilir.

Alan:

- Çok şey öğrendim bu operasyondan çook! Ancak Herry'i yakalayamadım.

(O sırada oradan bir ses gelir. Ben de kurbağa gibi çoğalırım! Denize çok yumurta bırakırım. Bazılarından yavru çıkar bazılarından çıkmaz!)

Gülüşürler ☺ (Kapı çalar) Herry içeri girer

Herry:

- Hayvanlarımı benden aldın, derhal evimi boşaltacaksın! Kira da vermiyorsun! Çık dışarı! Çıııık!

(Bu çığlıkları duyan dedektif Alan çıkagelir) - Asıl sen dışarı çık! Anayasanın 832.513. kanununa göre deliler ev sahibi olamaz ve hayvanları

alıkoyacak kadar deli olduğundan ömür boyu tımar-
hanede yatacaksın. Ayrıca işin iyi yanı ce-
zai ehliyetin olmadığından hapis yada taz-
minat ceza olmayacak. (O sırada kimse
Mary'nin kaybolduğunu fark etmez) 5 dakika
içinde polis gelir. Harry Jackson mu?

Harry:

- Buyrun, ne olmuştu?

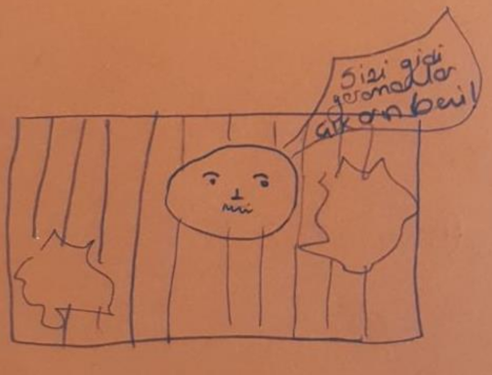
(Alan oraya girip olayı anlatır) (Deli olduğu anlaşılan
Harry tımarhaneye götürülür)

Polis:

- Artık burada yaşayacaksın bay deli¿

Harry:

- Hayıııır!



APPENDIX P: STORYBOARD EXAMPLES FROM STUDENTS

1

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):
Yeşil, Hasan Amca'nın tarlası

Ses (*müzik, ses efektleri*):
Rüzgar sesi

Hikaye (*ekranda seslendireceğiniz metin*):
Yapraklar ağaçtan uçar.

Süre:
Resim (*genel ya da özel, biliniyorsa eğer yeri*):

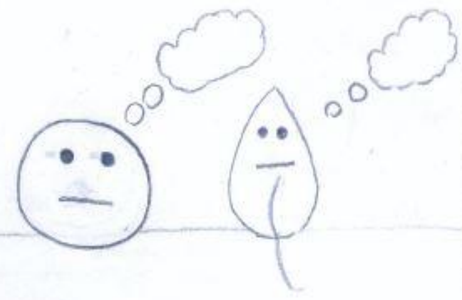
2

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):
Hasan Amca'nın tarlası

Ses (*müzik, ses efektleri*):
Tohum: Ilgın'ın sesi / Yaprak: Zeynep'in sesi

Hikaye (*ekranda seslendireceğiniz metin*):
Tohumlar ve yapraklar kimin daha önce çiçek olacağını tartışırken Hasan Amca tarlaya girer ve sessizlik duşur.

Süre:
Resim (*genel ya da özel, biliniyorsa eğer yeri*):



3

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Hasan Amca'nın
tarlası

Ses (*müzik, ses efektleri*):

Su ve rüzgar sesi

Hikaye (*ekranda seslendireceğiniz metin*):

Hasan Amca yeni tohum-
ları toprağa ditmek için
hazırlanır. Tohumlar top-
rağa gömülür. Hasan Am-
ca'da dinlenmek için
eve gider.

Süre:

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

4

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Hasan Amca'nın tarlası

Ses (*müzik, ses efektleri*):

Konuşturma;
Ilgın ve Zeynep'in sesi

Hikaye (*ekranda seslendireceğiniz metin*):

Hemen ardından ağaçtan toplan-
mış meyveler:
- Çocuklar ben hepinizden önce
çiçek oldum.
Tohum ağlayarak:
- Ben yapraktan daha önce çiçek o-
lacağım değil mi?
Meyve gülerek:
- Senin çiçek olmana çok az kal-
dı ama yaprağın çiçek olması biraz
zor.
Yaprak ağlar ve meyvelere:
- Nasıl olur? Peki sen nasıl meyve verdin?

Süre:

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Arka plan'ın rengi su yeşili efekler yandan gelen bir sayfa yazı tipi kalın olabilir.

Ses (*müzik, ses efektleri*):

Giriş müziği çalabilir

Hikaye (*ekranda seslendireceğiniz metin*):

Hikayenin adı geçmektedir.

Süre: Kapak.

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

ARKADAŞLIK BİTKİSİ

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Arka planda bitki resimleri olabilir yazı tipi kalın siyah yazı başlıklar ise renkli olabilir.

Ses (*müzik, ses efektleri*):

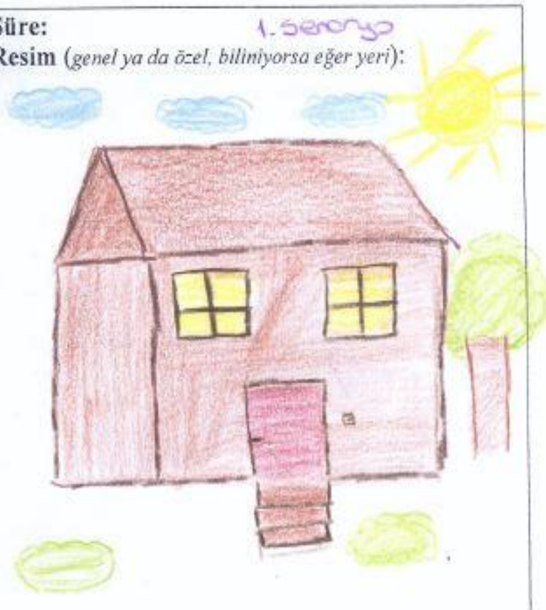
Kuşların sesi olicak

Hikaye (*ekranda seslendireceğiniz metin*):

Sabah olmuş güneş doğarken Sümeyra yatağından kalkmış yüzünü yıkamaya gidiyordu. Annesi aşağıdan kahvaltı hazı diye bağırdı. Yüzünü yıkadı üstünü değiştirdi ve merdivenlerden aşağıya inmeye başladı. Ahşap merdivenlerden çıkan ses çok hoşuna gidiyordu

Süre: 1. senaryo

Resim (*genel ya da özel, biliniyorsa eğer yeri*):



Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Arka planın resmi bir orman resmi olur yazılar yine aynı yazılar.

Ses (*müzik, ses efektleri*):

Ses ormandaki canlıların sesi ve yağmur damlalarının sesi

Hikaye (*ekranda seslendireceğiniz metin*):

Annesi yine o güzel elleriyle bir sürü şey hazırlamış kokusu yukarıya kadar gelmişti. O güzel yemekleri yedikten sonra ormana gitmeye karar verdi. Gece yağmur yağmıştı. Ormanın içi yemyeşil ağaçlardan geceden kalma yağmur damlaları yere düşüyordu.

Süre: 2. senaryo

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Ses (*müzik, ses efektleri*):

Hikaye (*ekranda seslendireceğiniz metin*):

Ormanda kuşların sesi vardı. Sümeyra o mavi bisikletine bindi. Ormanın çiçeklerinin bol olduğu yere gitti, ve papatya toplamaya başladı. Sümeyra'nın çiçeklere çok ilgisi vardı acaba çiçeklerde hayvanlar ve insanlar gibi üreme yapıyor mu diye düşünürken biryandanda Annesinin en sevdiği çiçek menekşe ve lavanta olduğu için onlardanda toplayıp bir büket hazırladı.

Süre: 3. 〃 〃

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

5

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Hasan Amca'nın tarlası

Ses (*müzik, ses efektleri*):

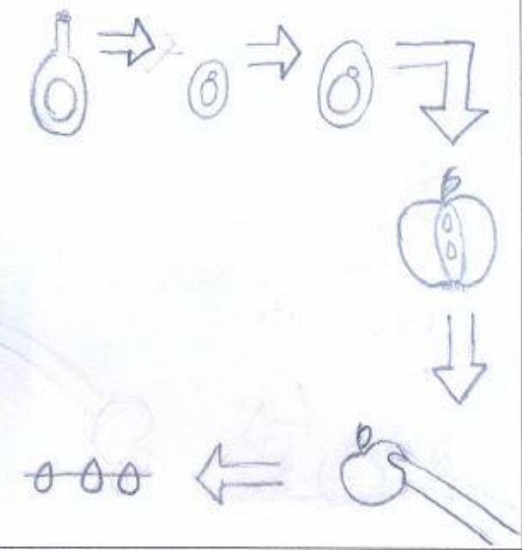
Konuşturma:
Ilgın'ın sesi

Hikaye (*ekranda seslendireceğiniz metin*):

Meyve:
- Ben ilk olarak tozlaştım ve döllendim. Döllendikten sonra zigot oluşturdum. Zigot biraz daha gelişerek embriyoyu oluşturdu. Ardından tohum ve meyvem oldu. Meyvemi Hasan Amca topladı. Tohumu yeni bir bitki oluşturması için toprağa gömdü.
Yaprak çiçek olamayacağını anladı. Çünkü o daha döllenmemişti bile.
Peki sizce yaprak çiçek olabilecek mi?

Süre:

Resim (*genel ya da özel, biliniyorsa eğer yeri*):



6

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Hasan Amca'nın evi

Ses (*müzik, ses efektleri*):

Meryem'in ve Tuğçe konuşturması
Ilgın'ın sesi

Hikaye (*ekranda seslendireceğiniz metin*):

Hasan Amca eve geldiğinde karısı Meryem Hanım çocuğu Tuğçe'ye bir şeyler anlatıyordu. Hasan Amca, Tuğçelere yaklaştı:
- Meryem ne anlatıyorsun Tuğçe'ye?

Süre:

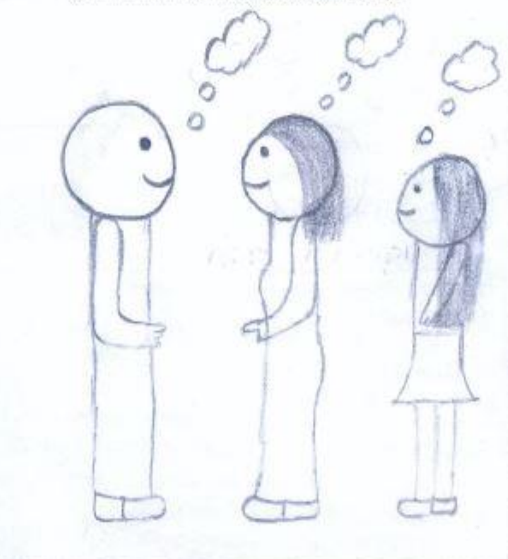
Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):
Hasan Amca'nın evi

Ses (*müzik, ses efektleri*):
Ilgın'ın sesi
konuşturma

Hikaye (*ekranda seslendireceğiniz metin*):
Meryem Hanım, Hasan Amca ve Tuğçe konu-
şurlar.

Süre:
Resim (*genel ya da özel, biliniyorsa eğer yeri*): 7

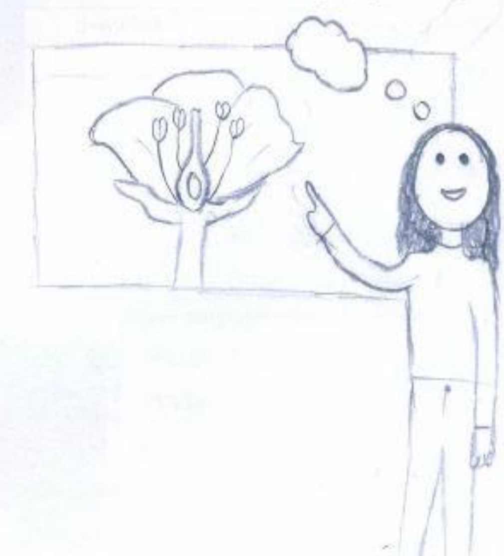


Dizayn (*arka plan rengi, yazı tipi, özel efektler*):
Tuğçe'nin sınıfı

Ses (*müzik, ses efektleri*):
Öğretmenin sesi
Ilgın'ın sesi

Hikaye (*ekranda seslendireceğiniz metin*):
Tuğçe okula gitmiştir.
Öğretmeni çiçeğin kı-
sımlarını anlatıyordur.

Süre:
Resim (*genel ya da özel, biliniyorsa eğer yeri*): 8



Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Yine arka planda bitki ve çiçek resimleri olabilir yazı tipi aynı.

Süre: 4. ״

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Ses (*müzik, ses efektleri*):

Burada ses kullanmayacağım.

Hikaye (*ekranda seslendireceğiniz metin*):

Papatyalardan kendine bir taç yaptı. Çok eğleniyordu. Annesi bu çiçekleri görünce çok sevinecekti. Eve doğru bisikletiyle yola aldı. Eve girdiğinde annesi onun için bir kazak örüyordu. Koşarak annesine sarıldı ve ona topladığı çiçekleri annesine uzattı.

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Arka planında çiçek resimleri yazı tipi aynı

Süre: 5. ״

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Ses (*müzik, ses efektleri*):

Ses koymak istemiyorum.

Hikaye (*ekranda seslendireceğiniz metin*):

Annesi sevinçle kızının uzattığı o rengarenk çiçekleri alıp kokladı. Sonra kızına sımsıkı sarıldı ve onu öptü. Annesi Sümeyra'ya ördüğü kazağı gösterdi ve daha bitmedi dedi.

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Ana planda bir bükette çiçek resmi

Ses (*müzik, ses efektleri*):

ses kayıtları

Hikaye (*ekranda seslendireceğiniz metin*):

(konuşma ...) Sümeyra annesine topladığı çiçekleri su dolu bir kaba koydu. Sonra şarkı söyleyerek yukarı odasına çıktı. Çalışma masasının üzerinde duran okuma kitabını aldı ve okuma köşe-sine geçti. Perdeyi açık manzaraya doğru kitabını okumaya başladı.

Süre: 6

Resim (*genel ya da özel, biliniyorsa eğer yeri*):

Dizayn (*arka plan rengi, yazı tipi, özel efektler*):

Ses (*müzik, ses efektleri*):

Hikaye (*ekranda seslendireceğiniz metin*):

Bir iki saat geçtikten sonra kitabını masanın üzerine bıraktı ve yemek için aşağıya indi yemeğini yedi.

(konuşma ...) Güneş yavaş yavaş batıyordu.

Süre: 7

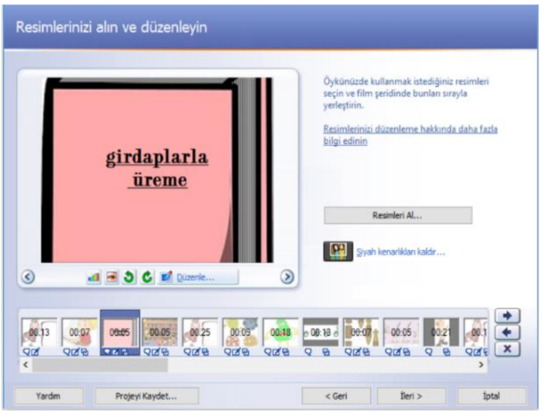
Resim (*genel ya da özel, biliniyorsa eğer yeri*):

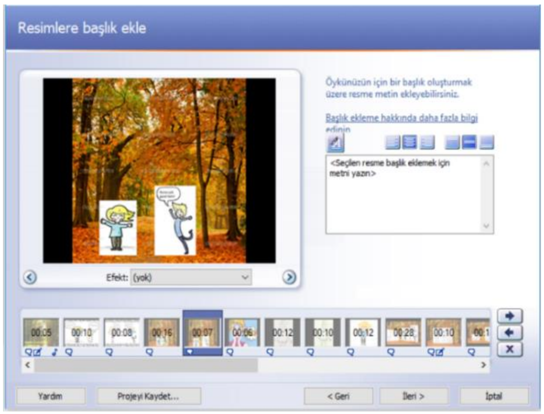
APPENDIX Q: DIGITAL STORY EXAMPLES FROM STUDENTS

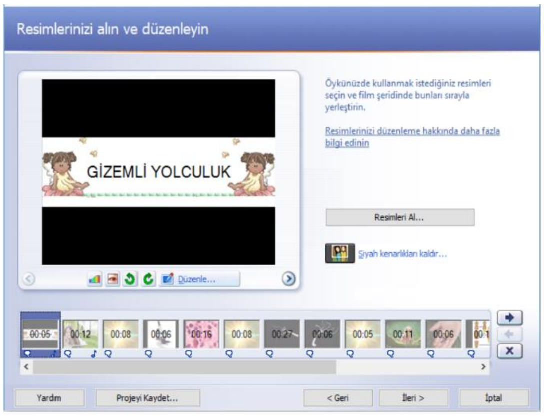
Example 1 (Screens of a DS)

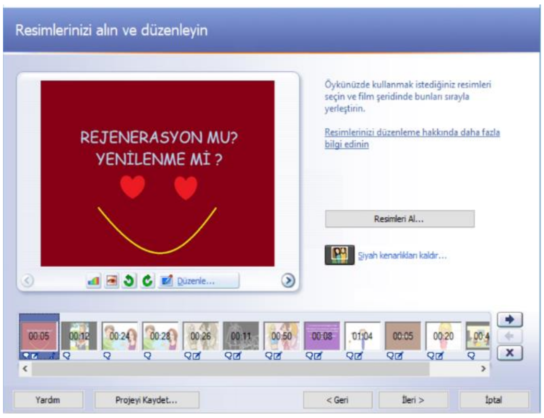

Kurbağa,Kele-
bek vb. hayvan-
lar..

Other Examples – (First DS Screenshots from Photo Story 3 Program)

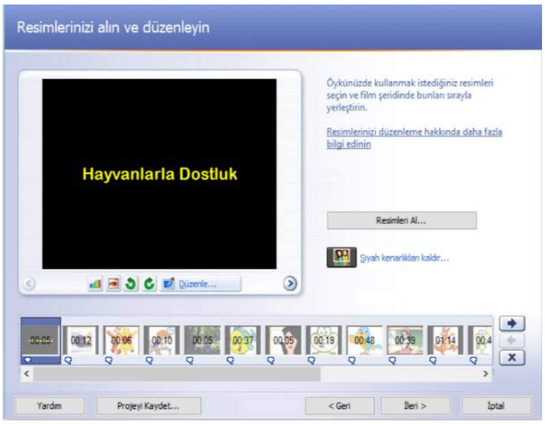


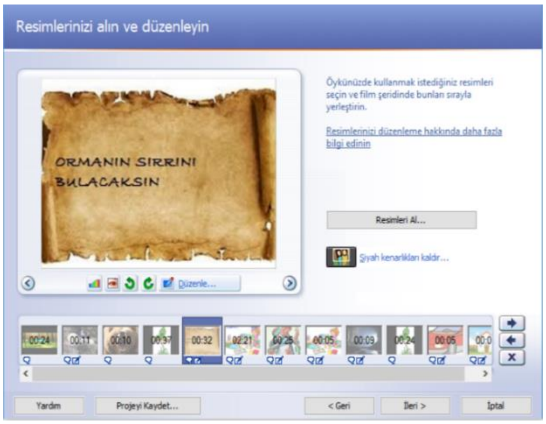




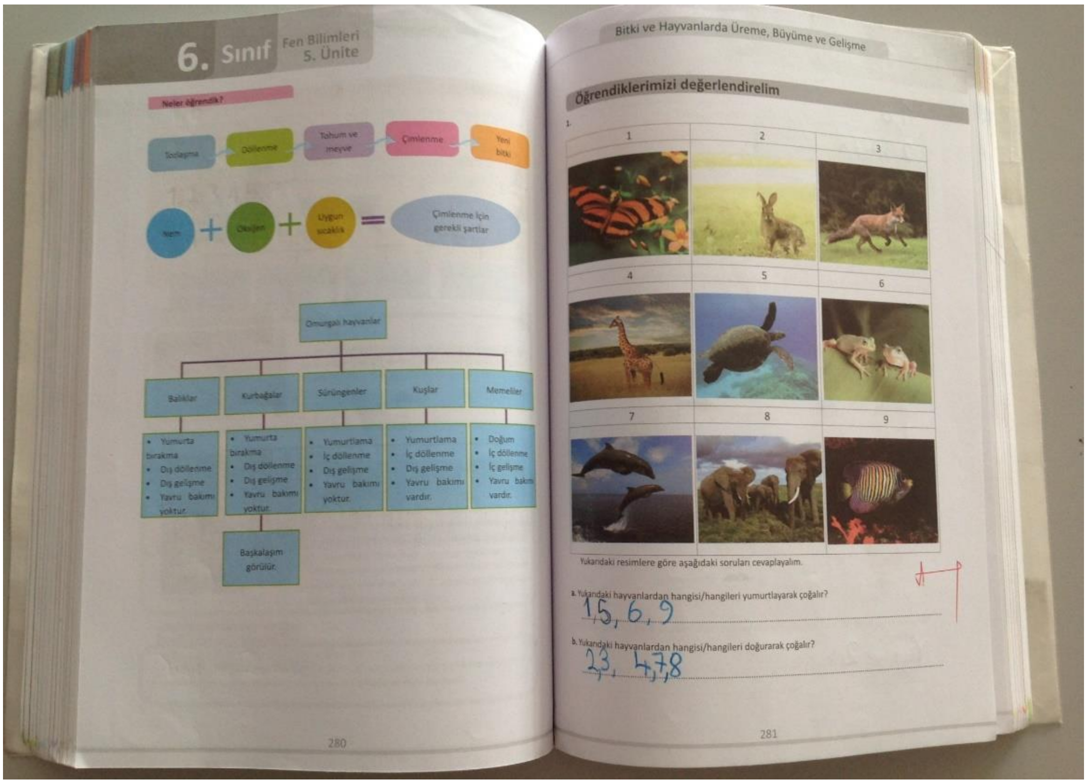


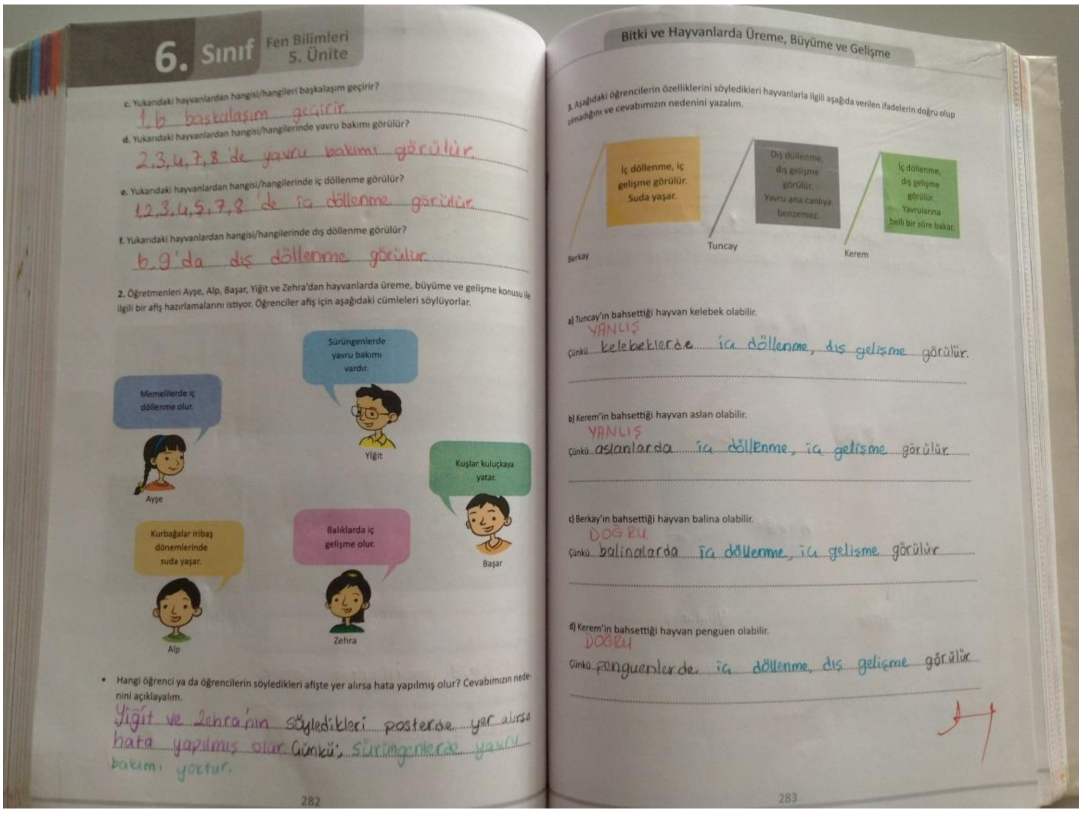
Other Examples – (Second DS Screenshots from Photo Story 3 Program)

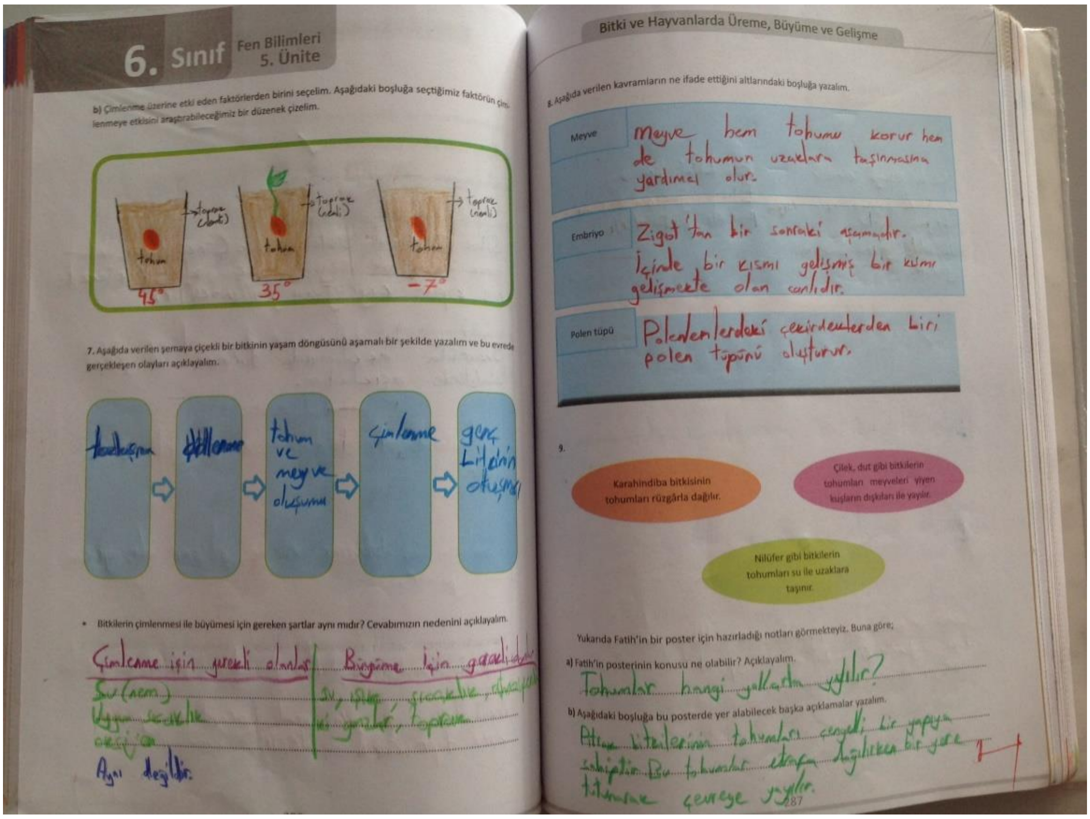


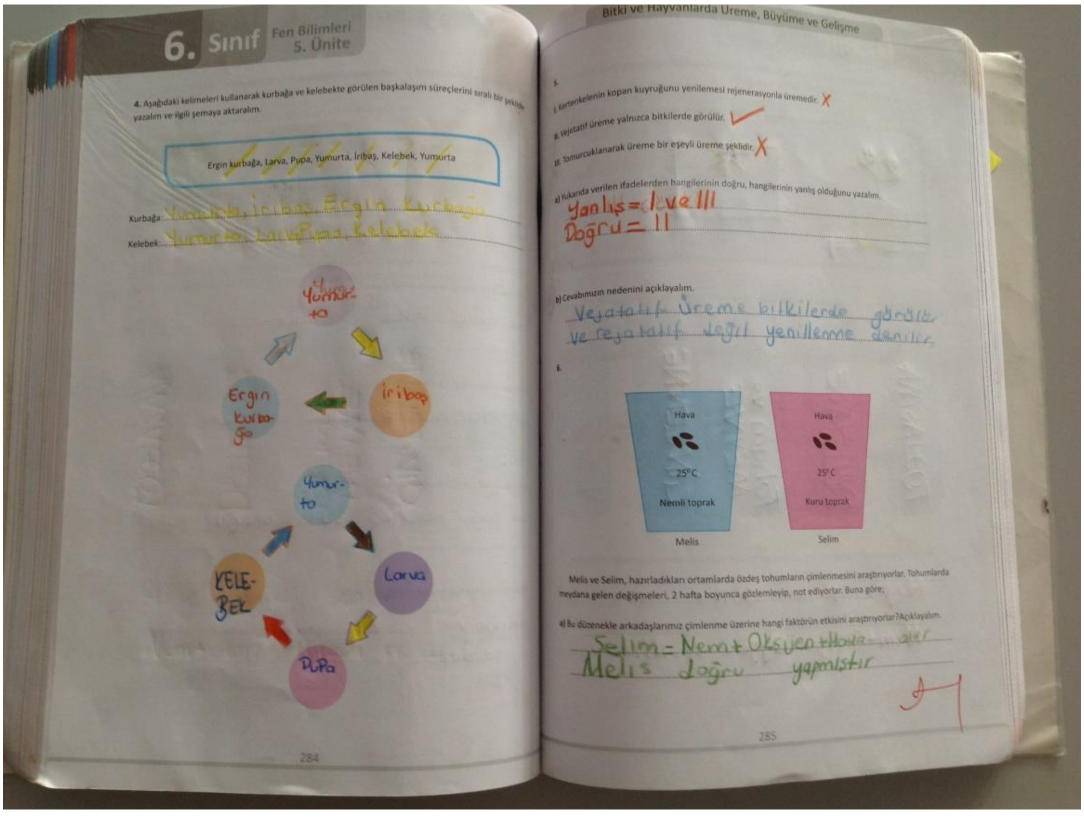


APPENDIX R - CONTROL GROUP'S HOMEWORK ASSIGNMENTS









VITA

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Advanced English

INTERNATIONAL CONFERENCE PAPERS

Cicek, M., Karademir, T., & Yurttas, G. (2011). Adaptivity of social network-based data collection tools to the education environments: A design sample. In *International Conference on New Horizons in Education – 2011 Proceedings Book* (pp. 164-169). Procedia.

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