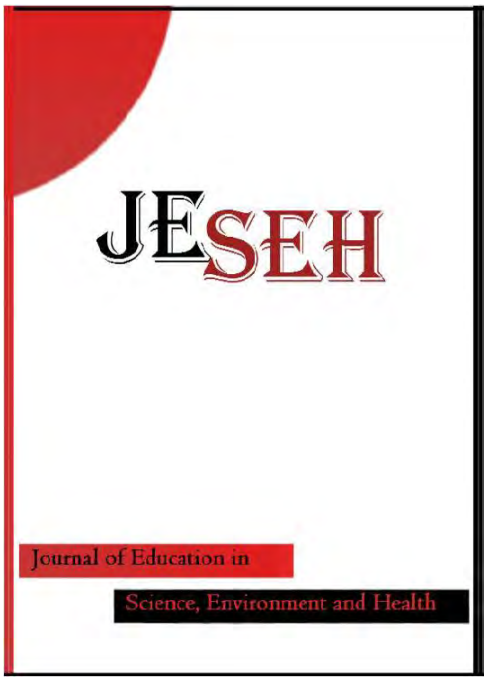

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Abstract

The aim of this study is to investigate the effects of guided inquiry activities supported by digital stories in the 6th grade science lesson on students' attitudes towards inquiry. The method of the study was determined as the embedded design, one of the mixed method research designs. 27 students from a public school located in the countryside participated in the study. In the quantitative dimension of the study, a single group pretest-posttest research design was used. Quantitative data were obtained through the Attitude Scale towards Research-Questioning. The qualitative dimension of the study was designed in accordance with the case study model. Qualitative data were obtained by using semi-structured weekly focus group interviews, teacher diaries and observation form. Quantitative data were analyzed with Mann Whitney U-Test, qualitative data were analyzed with descriptive and content analysis methods. As a result, thanks to the applied method, the attitude scores of the lower and middle group students towards inquiry converged to each other. Interviews with students and researcher diaries also support the results. It was revealed how the learning environment, teacher, student and lecturing affect the attitudes of the students participating in the studies towards inquiry.

Introduction

As people learn information and facts, they also learn feelings and values related to them. Attitudes are one of the factors that create behavior and are considered significant by researchers (Ajzen & Fishbein, 1977; Tavşancıl, 2014). The attitude studies carried out in the field of science between 1935-2005 mainly focus on the fields of "attitude towards science", "scientific attitude", "nature of science" and "interest in science career" (Blalock et al., 2008).

Students who learn how it feels when a question completely occupies the mind in the classroom environment can carry the effect of this feeling into their daily lives (Bruner, 2014). Even if it is not possible for them to find the answers to all questions with their own experiences, when the questions belong to the student himself, curiosity and interest will increase, and they will be more willing to develop answers by using information sources (Loxley et al., 2016). Inquiry approach emerges in preparing learning environments that will guide students to gain this ability. Inquiry is a learning approach examined under the framework of constructivist theory, and it refers to students' development of various attitudes and skills in the process of acquiring knowledge in addition to product and problem solving (Lim, 2001; Yakar & Baykara, 2014; Yaşar & Duban, 2009). An inquiry approach emerges in preparing learning environments that will guide students to gain this ability. Asking questions, which is the basis of the lessons planned in accordance with the inquiry approach, may be the most difficult stage of the process for some students. In this case, art, drama, poetry and storytelling provide the potential to attract students' attention and ask more questions (Loxley et al., 2016).

Storytelling is a tool that is used in all areas of social interaction in human communication and we also use it in the field of education to improve the learning experience. Today, with the widespread use of technology, storytelling has left its place to "digital storytelling" (Özpinar et al., 2017). Digital storytelling is a creative and effective way to explain social and natural phenomena. For this reason, the digital storytelling method used in science education contributes to the development of positive attitudes towards being literate individuals in a knowledge-based world (Crăciun et al., 2016). The value of digital storytelling, which was previously used in art, has been recognized by K-12 educators with the increasing use of technology in educational settings. Today, it provides benefits to educators and students in terms of integrating technology into learning environments at all levels, starting from preschool to university curriculum. The use of digital stories in lessons is effective in attracting students' attention, creating a creative and open-ended learning environment, and is considered very

important by education researchers in terms of combining technology and pedagogy (Robin, 2008; Smilack, 2013).

Inquiry-based activity is heard more and more as the variety of technologies and materials to support the inquiry learning experience as an educational tool increases and their use becomes more widespread (Kuhn et al., 2000). Technological applications that will facilitate students' inquiry processes and their use in daily science classes contribute to teaching and learning activities. Unlike science classrooms, where the procedures to be followed and the content to be learned in textbooks are clearly stated, technology-enabled, student-centered classrooms offer students flexible opportunities to manage their inquiry processes and monitor their progress (Kim et al., 2007). While there is some criticism, the majority of educators agree on the potential benefits of opportunities for students to engage in genuine inquiry (Kuhn et al., 2000). In addition, the ability of technology to overcome barriers to the implementation of classroom-based inquiry is emphasized (Kim et al., 2007). In line with these explanations, the suitability of the inquiry approach for technology-supported use emerges as an important element. For this reason, the aim of this study was determined as an in-depth examination of the effects of classroom inquiry activities supported by digital storytelling in science lessons on secondary school students' attitudes towards inquiry. It is thought that the study will make important contributions to the literature in terms of investigating the pedagogical effects of inquiry-based knowledge acquisition processes combined with digital storytelling technology on student attitudes.

Inquiry Approach

The inquiry-based learning approach follows the steps of Dewey's (1910) reflective thinking model. Accordingly, the problem is determined and explained in the first step, hypotheses are developed in the second step, the data is collected in the third step, the data are analyzed and interpreted to test the hypotheses in the fourth step, and, the results are obtained in the fifth step (Dimova & Kamarska, 2015). In this process, educational environments should be arranged in such a way that students learn about science and how to do science, allowing them to develop various skills (Akben, 2015). The duties and responsibilities of teachers and students in inquiry activities differ according to traditionalist methods. As a mentor with more experience and knowledge, teachers can guide students to better inquiry. However, instead of deciding what is appropriate or manageable at the beginning of the investigation, they need to follow their investigations closely throughout the process. In a way, this means that teachers do not have to use their authority to determine what is right for students. These explanations are Dewey's emphasis on the role of the teacher as an observer and listener of students' inquiry in the inquiry environment (Won, 2009). The teacher acts as an insightful guide in the problem solving process and guides the student in a common way for real research (Dostál, 2015). In the process, students' status rises from passive information receiver to active creator of understanding (Won, 2009). The roles assigned to teachers and students can determine the type of inquiry. Inquiry is of four types, depending on whether each of these duties and responsibilities is more teacher or more student centered (level of openness) (Akben, 2015). In guided inquiry-based activities, which is main subject of this study, the following essential features are considered (Martin-Hansen, 2002):

- The control of the process is mostly in the students.
- The teacher presents a research question to the students.
- Students in groups can help the teacher for making a decision on how to take next steps with the investigation.
- Students collect data. If the subject cannot be explored directly in the classroom, the teacher can provide data from a variety of sources.
- The teacher provides support to the students in designing the research.
- Comments, explanations and presentations are carried out by students.

Science courses in accordance with the inquiry approach supported by various methods and techniques have a positive effect on students' inquiry skills, inquiring thinking skills, their attitudes towards inquiry, and their views and perceptions towards inquiry (de Jong, 2010; Kachergis et al., 2017; Koyunlu Ünlü, 2015; Manalo & Chua, 2020; Özer, 2019; Ryplova, 2017).

Digital Storytelling Method

The origin of the term digital story is often cited by Dana Atchley and Joe Lambert, who conducted workshops in California in the early 1990s by founding the Center for Digital Storytelling (Hartley, 2010; Matthews-DeNatale, 2013; Robin, 2008). According to Lambert (2010), a good digital story has 7 basic elements:

perspective, dramatic question, emotional content, narration, music, economy and rhythm. In essence, digital stories are the scenarios and vocalizations of an event or thought that a non-media professional writer deems important, then enriching it with various multimedia tools such as images, ambient sounds, and music in the computer environment and sharing it with the audience in the form of a 3-5 minute long video online or offline (Matthews-DaNatele, 2008; Robin, 2008). In the field of education, the process of creating a digital storytelling is generally similar, whether by teacher or student (Dogan, 2007; İnceelli, 2005; Kearney, 2011). The digital storytelling process generally takes place in three stages: pre-production, production and post-production. These stages include writing, creating a scenario, controlling the flow by preparing a storyboard, researching audio and visual multimedia materials, creating the digital story with the help of a software program, and presenting the digital story (Jakes & Brennan, 2005; Kearney, 2011).

When the digital storytelling process in the science lesson was enriched with creative drama activities, the students' scientific creativity and attitudes towards the lesson differed positively (Akgül, 2018). Digital storytelling studies carried out jointly in China and Finland revealed that Chinese students in the 10-11 age group preferred to use systematic and mental problem situations while preparing their digital stories, while Finnish students preferred to use daily life situations (Niemi et al., 2018). Digital story course materials prepared by prospective teachers with inquiry-based learning approach attracted the attention of preschool students and facilitated their learning. This situation reduces the resistant behaviors of teacher candidates towards research and technology (Konokman & Yanpar Yelken, 2016). Teachers and pre-service teachers think that the lessons taught with digital story materials are fun, embody abstract information, are suitable for problem-based learning and project-based learning, and contribute to in-depth learning. For these reasons, they are willing to bring the digital storytelling method to their classrooms (Anılan et al., 2018; Crăciun et al., 2016; Dogan, 2007; Gakhar, 2007; Sadik, 2008; Shelton et al., 2017; Yuksel Arslan et al., 2016). However, some studies draw attention to the fact that digital storytelling takes a long time, teachers are not qualified enough to use technology, there are not enough reliable information sources on the internet, and difficulties may be encountered in accessing technological tools (Anılan et al., 2018; Çiçek, 2018; Dogan, 2007; Sadik, 2008). Digital storytelling can be used to initiate open-ended discussions in the learning environment (Robin, 2008). 12-part digital story course materials containing authentic scenarios and discussion bubbles were prepared for 74 students attending financial accounting courses at a university in Singapore. The questions in the stories brought real-life situations to the classroom and formed the basis of the weekly discussions. Accordingly, digital story course materials provide appropriate pedagogical opportunities for decision making, context formation, and approaching issues from different angles (Suwardy et al., 2013). Considering the studies in the literature, we can confer that inquiry-based lessons supported by digital stories at the introductory stage can be used to draw attention, create a discussion environment in the classroom and present a problem situation.

This study sought answers to the following research questions:

1. How did the applied method affect the attitudes of lower, middle, and upper group students towards inquiry?
2. What is the effect of the application process of inquiry activities supported by digital stories on student attitudes in terms of learning environment, teacher, student, and lecturing sub-dimensions?

Method

Model of the Research

Embedded mixed method was used in this study. Yıldırım and Şimşek (2016) defined the mixed method in accordance with the pragmatist philosophy, which aims to examine the research question in a multidimensional and in-depth manner. In the quantitative dimension of the study, one group pretest-posttest research design, which is one of the pre-experimental research designs, was used. The qualitative dimension of the research was designed in accordance with the case study model. Case studies are based on "how" and "why" questions and allow the researcher to examine an event in depth (Yıldırım & Şimşek, 2016).

Participating Students and Implementation Process

Convenience sampling method was used to determine the student attendees. The appropriate sample includes people available for the study. Researchers who have administrative difficulties in randomly selecting participants generally use the appropriate sample (Best & Khan, 2017). The studies started with the participation

of 30 6th grade students from a public school located in the countryside. However, during the analysis of the data, the data obtained from 3 students with attendance problems were excluded. It is known that the students participating in the studies have not previously taught with activities based on digital storytelling method and research-inquiry approach. In some quotation sentences, expressions such as G1, G2, B1, B2 mean girl-boy student codes.

Implementation Process

One year before the beginning of the applications, pilot studies were carried out on a different group of students studying at the same school. The implementation process was redesigned after identifying the difficulties that could be encountered in the process in a rural school with disadvantaged conditions. Before the application, the students were informed about the process and the Attitude Scale towards Research-Questioning (ASTRQ) pre-test application was carried out. By evaluating the ASTRQ pre-test results, lower, middle, and upper group students were determined. For this, the method of determining the group interval coefficient was used (Güler, 2011).

$$\frac{\text{Highest Score on the Test - Lowest Score on the Test}}{\text{Number of Groups to be Created}}$$

Two students from the lower (n=7), middle (n=9) and upper (n=11) groups were selected by random assignment to conduct the focus group interviews. 6 groups were formed in a heterogeneous structure and each of the focus group students was ensured to be in a different group. After this stage, activities were carried out for 4 weeks with the leadership of the researcher teacher and the participation of an outside observer. Within the scope of this study, 6 lesson plans following the stages of the 5E teaching model were prepared in accordance with the achievements within the scope of the "Solar System and Eclipses" unit. These plans were supported by digital stories in engagement stage and include 6 different guided inquiry activities, each of which lasted two hours, and were used in the lessons after taking expert opinion. Student activity sheets were named according to the digital stories in the introductory phase of the lessons. The lesson plan of the "Asteroid Belt" activity related to the solar eclipse of the implementation process is shared with Figure 1, Figure 2 and Figure 3 below as an example:

Engagement: The digital story called "Asteroid Belt" is opened on the smart board and watched by the class. Students write down the information they heard in the story under the pictures on the storyboard.

Figure 1. Storyboard view of the Asteroid Belt event

The following questions are answered through classroom discussions based on the digital story.

1. Where are asteroids found?
2. What does asteroid mean?
3. Why are asteroids not planets?
4. What are Pizza and friends curious about?
5. What are you curious about?

Exploration: With the question "What are you curious about?" the whole class is directed to the research question "Are asteroids and meteorites hitting the Earth the same?" Students are asked to take the material boxes through the material supervisors in accordance with the in-group work division. The groups design asteroids in the size and shape they want using their ceramic dough. The teacher examines the products of the groups, chooses two of the largest models, dries the asteroid models they have chosen with the help of a hair dryer and attaches them to a rope. Two students rotate the models tied to the string in the classroom and have them collide. Students guess and argue about what the scattered pieces are as a class.

Explanation: Groups are directed to research in order to reveal the reality of the discussion results and observations and to answer the questions set in the "What are you wondering about?" section at the beginning of the lesson. Studies are recorded in the relevant diagrams in the activity papers.

At this stage, there were also open research questions that students were curious about. For example; during the interview held on 23.10.2019, M1 said:

> *"Write down the question you are most curious about. I asked the question, "When will a meteorite hit Earth?" The digital story impressed me a lot. I'm going to go and investigate this question."*

Elaboration: During the exploration phase, the largest pieces scattered around by the impact of collision are selected and left on the sand in a transparent bucket from afar. The shapes formed on the sand are evaluated in terms of size and depth.

Figure 2. Pieces dropped in the sand

Evaluation: By showing craters on the surface of the Moon, students are asked to rank them according to size and time of fall. The lesson is completed by filling out the student diaries.

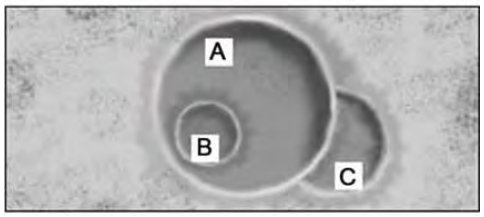

Figure 3. The visual in the evaluation question

Data Collection Tools

Quantitative data were obtained through the ASTRQ. There are three types of data collection methods in qualitative research: in-depth open-ended interview, direct observations and written documents (Best & Kahn, 2017). In this study, qualitative data were collected in accordance with the diversification approach. Thus, it is aimed to reach clearer findings through complementary data on student attitudes towards research and inquiry.

Attitude Scale towards Research-Questioning (ASTRQ)

ASTRQ, which was applied as a pre-test before the application and a post-test after the application, is a 13-item, 5-point Likert-type scale developed by Ebren Ozan et al. for secondary school students. The lowest score can be

obtained from the test is 13, and the highest score is 65 (Ebren Ozan et al., 2016). ASTRQ contains items that examine student attitudes in three sub-dimensions: curiosity, signification and avoiding. There are positive and negative questions such as "I believe that research is an important part of our lives" and "It seems ridiculous to me to do research by forming a group with my friends" in the scale. If the answers to the test items are three or more, the alpha (α) coefficient developed by Cronbach is used. A reliability coefficient of 0.70 or higher is considered sufficient for test scores to be reliable (Büyüköztürk, 2017). The ASTRQ was administered as a pilot to the students from the surrounding schools with a structure similar to the group in which the study was applied, and the reliability coefficient for this study was calculated as 0.807.

Observation Form and Teacher's Diaries

In qualitative research, observations are often used to collect first-hand data (Yıldırım & Şimşek, 2016). Since the teacher of the course is also the person conducting the research, he is in the role of "participating observer" (Best & Kahn, 2017). The participant observer noted his observations in the teacher diaries at the end of each lesson. Although note-taking is a frequently used technique of recording observations, it causes oversight (Yıldırım & Şimşek, 2016). For this reason, in order to support the researcher's diaries, 27 item observation form was prepared that the application process, which is thought to affect the attitudes of students towards research and inquiry by taking expert opinion, was evaluated as "yes", "partially", "no" in terms of learning environment, teacher, student and lecturing sub-factors. The observation form was filled in repeatedly for each lesson with the participation of an outside observer.

Focus Group Interview Questions

Focus group students L1, L2 to represent the subgroup; M1, M2 to represent the middle group; U1 was named as U2 to represent the upper group. While preparing the interview form, opinions were taken from experts in the field and pilot applications were made. Accordingly, focus group interviews were completed in 4 weeks in total, from the pre-implementation to the post-implementation. With 22 open-ended questions in the interview form, it was investigated how the lower, middle, and upper group students' attitudes towards inquiry changed depending on the application process.

Validity-Reliability Check

The reliability of the study is supported by making the qualitative measurement tools clear, precise and understandable, considering the readiness and motivation of the students for the interviews, and adjusting the interview time at the optimum level (Güler, 2011). For this study, reliability was controlled with a similar approach. It is important to collect data by more than one method and use that data obtained to confirm the validity and consistency of the results (Yıldırım & Şimşek, 2016). In this study, the data collected by quantitative methods were supported by data collected by qualitative methods. In order to ensure the reliability of the findings related to group interviews and researcher diaries, the research data were read repeatedly by the researcher.

Analysis and Interpretation of Data

Since the research was modeled according to the mixed research method, quantitative and qualitative data were collected together. Quantitative data were analyzed using the SPSS 22 Statistical Program. In order to understand how the lower group students differ from the middle and upper group students, and the students in the middle group from the students in the upper group, unrelated measurements Mann Whitney U-Test were used. Qualitative data obtained from focus group interviews and researcher diaries were evaluated with descriptive and content analysis methods. The descriptive analysis was carried out by evaluating the data in line with the research questions and establishing cause-effect relationships between the findings through direct quotations. During the content analysis, codes were determined according to the concepts extracted from the data (Yıldırım & Şimşek, 2016). With an inductive method, the researcher read the raw data obtained from the focus group interviews several times, line by line, and tried to determine the important dimensions within the framework of the importance of the research. More than one code was extracted from some explanations according to the depth of the data. The items in the observation form were marked as "yes", "partially" and "no" and the frequency values of the data collected on the basis of activity were calculated.

Findings and Interpretation

Attitudes of Lower, Middle and Upper Group Students towards Inquiry

In experimental studies with a small number of participants, the Mann Whitney U-test is often used to understand whether the scores between two unrelated samples differ significantly (Büyüköztürk, 2017). The Mann Whitney U-test results, which were conducted to determine how the ASTRQ pre-test scores of the lower, middle, and upper group students differ from each other, are given in Table 1.

Table 1. ASTRQ pre-test scores according to student groups Mann Whitney U-Test results

Compared Groups	N	Mean Rank	Sum of Ranks	U	p
Lower	7	4.00	28.00	.000	.001*
Middle	9	12.00	108.00		
Lower	7	4.00	28.00	.000	.000*
Upper	11	13.00	143.00		
Middle	9	5.00	45.00	.000	.000*
Upper	11	15.00	165.00		

p*<.05

When the findings in Table 1 are examined, the ASTRQ pre-test scores of the lower, middle, and upper group students differ significantly from each other before the application (U=.000, p<.05). When the mean rank is examined, it is seen that the students in the lower group have lower attitudes than the students in the middle and upper groups, and the students in the middle group have lower attitudes than the students in the upper group. The Mann Whitney U-test results, which were conducted to determine how the ASTRQ post-test scores of the lower, middle, and upper group students differ from each other, are given in Table 2.

Table 2. ASTRQ post-test scores according to student groups Mann Whitney U-Test results

Compared Groups	N	Mean Rank	Sum of Ranks	U	p
Lower	7	7.36	51.500	23.500	.395
Middle	9	9.39	84.50		
Lower	7	4.86	34.00	6.000	.003*
Upper	11	12.45	137.00		
Middle	9	6.61	59.50	14.500	.008*
Upper	11	13.68	150.50		

p*<.05

When Table 2 is examined, it is seen that the attitude scores of the lower group students approached the attitude scores of the middle group students after the application. There was no statistically significant difference between the ASTRQ post-test scores of the students in the lower and middle groups (U=23.500, p>.05). A significant difference was found between the attitude scores of the middle and upper group students (U=14.500, p<.05). Similarly, a statistically significant difference was observed between the ASTRQ post-test scores of the lower and upper group students (U=6.000, p<.05). When the mean rank is examined, the attitude scores of the upper group students are higher than the students in the middle and lower groups after the application.

The data obtained through the focus group interviews showed that the lower and middle group students' attitudes towards inquiry were different from the upper group students. While the importance of inquiry is to obtain information for lower and middle group students and the information obtained in this way is to be memorable; for upper group students, it is in the form of reaching the right information by comparing the information in various information sources. This result explains the quantitative findings. In the last interview with the focus group students, the question "Why is it important to make inquiries about the information we read and hear in life?"

> *U1: "For example, we do not know some information, we can find it by searching. First I research and then I question whether the information is true or false. Maybe I need that information, I'll ask my teachers. There was a bug in the news, it was drying up all the nut branches, but it was rare. Maybe that insect is wrong, or they put a picture of another insect, by mistake. I do research, I look on the internet, and it turns out to be true."*

> *U2: "We are curious; is that information wrong or correct? I research and question, just to be sure. I also question some people, maybe they've heard of it and they don't know why. One day, our neighbor's animal fell off the rock, I didn't see it, they told my father, and he told us. I went and looked at our neighbor's house, the cow had nothing."*

The upper group students support each other's views on the importance of doing inquiry.

The effect of the applied method and approach on students' attitudes towards research and inquiry is understood from the answers given to the question *"How do you evaluate yourself about participating in the studies we carried out this week?"* directed to the students in the focus group interviews held on 23.10.2019:

> *L1: "When you made the first group, teacher, I was very excited. I was wondering how to do something. We started to get to know the planets, and my curiosity lessened a bit, but as I did new things, I became excited and happy. When I needed a book, my group friends would assign me, I would bring it. We were answering the questions on the activity sheet with the information we gained from those books."*

Similarly, to the question *"What kind of positive or negative differences are there between the science lessons we have studied before and the lessons we are currently studying?"*

> *U1: "We used to not experiment a lot, now we do a lot of experiments. We used to not watch digital stories, now we do. We used to not arrange the rows differently, but now we arrange them differently. These are positive for me. We didn't do research before. Now you bring a computer, a phone and we are doing research. This is positive for me. Since we did not do research in the past, some of them did not know computers, now they do."*

Accordingly, it can be said that the approach applied in the process of carrying out the activities positively affects the attitudes of 6th grade students towards inquiry.

The Effect of Learning Environment, Teacher, Student and Lecturing Factors on Student Attitudes

In order to follow the inquiry approach, the data obtained with the 27-item observation form filled by an outside observer were presented under the headings of learning environment, teacher, student, and lecturing, supported by researcher diaries and focus group interviews. The frequencies of the data obtained from the repeated observations for each activity were calculated according to the answers given to the questions "yes", "no", "partially" and presented in the order of the observation date in tables.

Findings regarding the Learning Environment Sub-Factor in the Observation Form

In the observation form, there are 8 question sentences belonging to the learning environment sub-factor. Through these questions, the suitability of the classroom atmosphere for inquiry was checked.

Table 3. Findings regarding the learning environment sub-factor in the observation form

ENVIRONMENT	Frequency (f)		
Observation Date	Yes	Partially	No
9 October 2019	5	2	1
11 October 2019	6	2	0
18 October 2019	6	1	1
23 October 2019	5	2	1
25 October 2019	6	2	0
30 October 2019	7	1	0

According to Table 3, the problems arising from the learning environment have been reduced between the first and last activity. The students said the following about the negative situations experienced in the learning environment:

> *M1: "Digital stories affect our activities well, but sometimes there is no sound, some days the sound is not understood, and some do not allow us to listen."*

When the digital stories are heard well, it is understood from the teacher diaries that the students turn to the topics and concepts that will be covered that day.

> *"I asked them to take notes as they listened to the digital story, then asked them to answer the questions. They listened to the story again and completed their deficiencies." (11.10.2019)*

It has been observed that the measures taken regarding the learning environment during the implementation process have a positive effect on the process.

> *"There were no questions other than our subject at the stage of curious questions, there were also questions from within the digital stories." (11.10.2019)*

As a result of the content analysis of the focus group interviews, six main codes were reached in the learning environment sub-factor of the implementation process. The frequency values of these codes are given in Table 4 on a weekly basis.

Table 4. Codes and frequency values related to the learning environment sub-dimension in focus group discussions

ENVIRONMENT Codes	Second Interview (f)	Third Interview (f)	Fourth Interview (f)
Smart board	0	4	1
Activity papers	4	7	3
Computer and phone	0	3	2
Class arrangement	1	2	0
Books	0	5	0
Experiment materials	2	6	5

Table 4 revealed that, activity papers and experimental materials in the learning environment sub-dimension of the application process were most effective on student attitudes towards inquiry. According to the focus group interviews, the students consider the activity papers as important course materials where they follow the digital stories, record their research, write their questions and answers to the questions:

> *U1: "We develop better thanks to the papers you provide while doing research. We were answering the questions on the paper according to the picture we saw on the smart board, we were writing that information on the paper."*

In the example above, during the third interview, we see the answer given by the U1 student to the question "Which stage of the activity process would make you happier?" L2 from the students in the lower group to the same question: *"When you handed out the papers, we were flying high. A friend of ours was jumping. We wondered the questions on the paper and answered all of them. It was a lot of fun.*" In the interview with the middle group students, the codes of "experimental materials" and "activity papers" were determined.

Activity papers are also course materials that students hand over to the teacher for checking. Behavioral reactions of the students about the activity papers were reflected in the researcher diaries as follows:

> *"I handed out the activity papers that were filled in the previous lesson, but the evaluation stage was not completed. The students immediately asked where we went wrong, and they started to examine the papers with curiosity." (25.10.2019)*

The diversity of the materials used contributed to the attitudes towards inquiry by enabling the students to try different ways and to be active in the lesson. The students expressed how they used the materials in their hands while doing the experiment as follows:

> *U1: "We were measuring planets; my group friends were measuring with meters. I took the rope out, wrapped it around the planet, looked with a ruler and found how many centimeters it was. I felt good then because I attended the class."*

Focus group students said the following about their group friends who do not have the opportunity to use computers in their daily lives:

> *U2: "In the past, we did not do research with computers in classes, now you bring computers and telephones, we do research. These are positive for me. Some did not know how to use computers, but now they do."*

> *M1: "There are some of them, my teacher, when we have a lesson with you, they do not go home during lunch break and do research on the computer."*

Students are willing to share the information they have learned from the books brought to the classroom environment as research material. The researcher wrote the following in his diary about the books that are thought to have a positive effect on students' attitudes towards inquiry:

> *"Today, one of the female students came to me and said, 'Since I am 11 years old, I have circled the Sun 11 times. I learned this from these books,' said she." (30.10.2019)*

When the focus group students were asked about the positive changes in science lessons, the lower, middle and upper group students mentioned the changes related to the classroom layout:

> *L2: ''You used to not make rows into groups, now we do groups. We formed a group with our friends, and we have more fun."*

Findings regarding the Teacher Sub-Factor in the Observation Form

In the observation form, there are 6 question sentences belonging to the teacher sub-factor. Thanks to these questions, the teacher's guiding status of the students in the inquiry process was checked.

Table 5**.** Findings regarding the teacher sub-factor in the observation form

TEACHER	Frequency (f)		
Observation Date	Yes	Partially	No
9 October 2019	2	3	1
11 October 2019	5	1	0
18 October 2019	4	1	1
23 October 2019	5	0	1
25 October 2019	6	0	0
30 October 2019	6	0	0

According to the observation results in Table 5, all negative situations related to teacher roles disappeared in the last two activities. As a result of the coding of the focus group interviews, three main codes were reached in the teacher sub-factor of the implementation process. The frequency values of these codes are given in Table 6 on a weekly basis.

Table 6. Codes and frequency values related to the teacher sub-factor obtained from focus group interviews

TEACHER Codes	Second Interview (f)	Third Interview (f)	Fourth Interview (f)
Teacher's duties and responsibilities	2	4	5
Correcting feedback and using reinforcers	0	2	1
Asking questions and guidance	0	3	0

In the teacher sub-factor, three different codes were reached: duties and responsibilities, which are thought to affect student attitudes towards inquiry, asking questions and being directive, giving feedback-correction and using reinforcement. The reason for gathering the most findings in the field of duties and responsibilities was explained by the changes made by the teacher in the classroom and the rich course materials prepared for the students.

> *U1: "You are preparing papers for us, sir, we do research thanks to those papers, and we develop better. It is also useful for us to bring a computer."*

In the second interview, the upper group students were asked, "Is there a difference in the roles of teacher and student compared to the science lessons we have taught before? How do you evaluate?" Students responded as:

> *"The teacher cleaned and organized the classroom. Formerly, some of them did not listen to the lesson, now they listen and participate."*

The examples mentioned were coded as "teacher's duties and responsibilities". The students were asked to evaluate themselves and at which stage of the activities they were happier. Thus, we can deduce that the feedback given by the teacher has an affective effect on student attitudes*:*

> *M2: "When we were preparing the distance scale of the planets, when you said that we made the multiplications wrong, we thought it was right, we were very upset."*

> *L1: "We are also happy when our teacher says well done to us. When we work on that question and pay attention and reach the result, the teacher says well done."*

With the inquiry approach supported by digital stories, the behavioral attitudes of the students in the course of the lesson tended to prefer doing research. During the activities, the students tried to give answers based on research to the questions their teachers asked them to guide them. This situation was reflected in the teacher's diary as follows:

> *"The Group Blues mistook the celestial body (Moon) in the third picture as Mercury. When I asked them to justify their guesses, they said, 'Because there are so many craters on it.' "Well, is Mercury the only celestial body with such a surface?" I asked. Then, they asked permission, "Can we take a book?" and they did research from the books." (20.10.2019)*

Findings regarding the Student Sub-Factor in the Observation Form

In the observation form, there are 8 question sentences belonging to the student sub-factor. These questions were prepared to follow the students' interactions with their group mates, teachers and the entire class, and their interest in the activities.

Table 7. Findings regarding the student sub-factor in the observation form

STUDENTS	Frequency (f)		
Observation Date	Yes	Partially	No
9 October 2019	3	5	0
11 October 2019	4	4	0
18 October 2019	3	4	1
23 October 2019	5	3	0
25 October 2019	6	2	0
30 October 2019	7	1	0

As Table 7 suggests, the negative situations related to the students could not be completely eliminated, but at the end of the process, they were minimized. The items marked as partially were more related to the distribution of tasks and cooperation. This finding is similar to the researcher diaries. As a result of the content analysis of the focus group interviews, three main codes were reached in the student sub-factor of the implementation process. The frequency values of these codes are given in Table 8 on a weekly basis.

Table 8. Codes and frequency values regarding the student sub-factor obtained from focus group interviews

STUDENT Codes	Second Interview (f)	Third Interview (f)	Fourth Interview (f)
The importance given to the lesson	4	13	6
Interaction between students	4	2	1
Student's duties and responsibilities	0	8	3

Table 8 illustrates that the focus group students gave answers under the code of the importance given to the lesson the most. This situation was reflected in the researcher's diary as follows:

> *"We were in the exploration phase when the bell rang. When I asked the students if they wanted to go out for recess, the whole class shouted "No!" in unison. We continued the event without going to recess." (9.10.2019)*

Students worked in heterogeneous collaborative groups in science lessons taught with an inquiry approach supported by digital stories. It is thought that student interactions within the group affect middle school students' attitudes towards inquiry. It has been observed that students who are in harmony with each other enjoy inquiry-based studies, and this situation is reflected in the researcher's diary as follows:

> *"The group that worked best was the Whites. They have always progressed faster in events and completed all stages first. When I wanted to take their picture, they gave a positive message by hugging each other and raising their thumbs." (9.10.2019)*

Focus group students were asked to evaluate their group mates. Accordingly, students are willing to participate in the studies.

> *U2: "My friends were very good. They all participated in the experiment, so I did well. We all shared a job, one as a spokesperson, one as a printer, one as a researcher, one as a material officer, and one as the president. I will tell my friends about the topic we have just covered, and I will work to make it better."*

In the inquiry process, it was determined that the distribution of tasks within the group varied depending on the lower, middle and upper student groups. In this regard, the words of the focus group students and the researcher's diaries support each other:

> *L2: "G3 was the president, I was the writer. I was writing down what G3 and B11 said. They helped us a lot, and we respected them."*

Some of the answers given to the question "How did your friends in your group contribute to the work carried out this week, can you evaluate them?" which was asked during the third interview above, were shared. Communication and sharing of students within the group was coded as "interaction between students".

> *"G3 sometimes makes sentences like we do it because we are very smart, or my group friends listen to me and do what I say." (24.10.2019)*

Focus group students were asked about the importance of coping with difficulties in the inquiry process. Accordingly, attitudes towards coping with difficulties in the inquiry process vary depending on the lower, middle and upper student groups. Subgroup students see coping with difficulties as their duties and responsibilities:

> *L2: "It is important to make our parents happy, to congratulate us and to make our teachers happy."*

Middle group students consider that it is important to cope with difficulties as it enables them to be successful in the lessons.

> *M2: "I may encounter that question again in the future, it is important for us to be able to answer when the teacher asks. It affects our oral grade; it can also appear in the exam. It affects and elevates our lesson."*

Upper group students, on the other hand, think that if they do not cope with difficulties in the research-inquiry process, they will not be able to reach the right information.

> *U1: "We have to work hard to gain knowledge. Information that we do not question may turn out to be wrong. If we can't cope with difficulties, we are more likely to make mistakes."*

Findings regarding the Lecturing Sub-Factor in the Observation Form

In the observation form, there are 5 question sentences belonging to the lecturing sub-factor. Thanks to these questions, it will be brought under control in a way that can be controlled. When the observation form data is examined, which is summarized in Table 9, we understand that difficulties experienced regarding the lecturing have been minimized in recent weeks. In the researcher's diary, it was stated that the students started to follow the lecturing:

"When I was going to go to the stage of determining the research question without answering in the classroom, B10 warned me and asked, "Will you not write the questions we are curious about on the board?" I said you were right; I went back and answered the questions." (30.10.2019)

Table 9. Findings regarding the lecturing sub-factor in the observation form

LECTURING	Frequency (f)		
Observation Date	Yes	Partially	No
9 October 2019	2	1	2
11 October 2019	2	0	3
18 October 2019	2	1	2
23 October 2019	3	0	2
25 October 2019	5	0	0
30 October 2019	4	1	0

As a result of the content analysis of the focus group interviews, four main codes were reached in the sub-factor of the implementation lecturing. The frequency values of these codes are given in Table 10 on a weekly basis.

Table 10. Codes and frequency values regarding the lecturing sub-factor obtained from focus group interviews

LECTURING Codes	Second Interview (f)	Third Interview (f)	Fourth Interview (f)
Research	0	7	0
Inquiry	1	0	4
Experiment	4	8	2
Sharing information	0	2	1

The stages of experimentation (f=14) and doing research (f=7) were the most influential on students' attitudes towards inquiry. Focus group students have a positive attitude about the experiments they perform in the lecturing.

U1: "We didn't do a lot of experiments in the past, now we do a lot of experiments, we didn't do research in the lessons before, now we do it, these are positive."

U2: "We all learned the subjects that we did not understand in my team in the experiment, we were happy and excited."

The answer of the mentioned example U1 was coded as both "experiment" and "research", whereas the answer of U2 was coded as "experiment". Focus group students stated that they were happy when they shared the information they learned through research. This situation was reflected in the researcher's diary as follows:

"In the afternoon, G4 came to me, and she said, "I learned a lot of things, my teacher, by researching here from where the solar eclipse can be seen, and that Jupiter has a ring here." (27.10.2019)

In the last meeting held with the focus groups, they were asked what the work that lasted for a month brought them. Accordingly, it positively affected attitudes towards inquiry in operation.

L2: "It gave us a lot of questions and made us think. For example, if the question is good and I know it, I will be happy and happy. I think of a difficult question."

Discussion

In science lessons which are planned in accordance with the inquiry-based learning approach, students are active throughout the process, they do research and question information and learn while having fun and using what they have learned in different situations. In this process, the roles of teachers and students are important in the realization of the process as desired. In addition to some difficulties that are not dependent on the teacher, such as student readiness, time and material supply, some difficulties such as guidance, subject selection, content knowledge, process knowledge, returning to a pedagogical understanding of research and inquiry from traditional ways have been reported (Bayram, 2015). Technology is used to facilitate inquiry-based learning in teaching subjects that are difficult to conduct science experiments. Technological tools like video, simulation, digital probe, interactive board, mobile device, etc. are used (Arabacioglu & Unver, 2016; de Jong, 2006;

Hwang et al., 2013; Koyunlu Ünlü, 2015). In the literature, using rich materials, visual technologies and activities in teaching astronomy and space sciences is recommended. These previous studies revealed that computer-assisted learning is frequently used and technological tools such as digital stories, augmented reality, and smart boards have a positive effect on learning. In the study of Francis (2018), 12th grade students prepared digital stories about the Solar System and Space Sciences. The process was supported by small group learning, discussion and argumentation. As a result of that study, the students think that the visual and auditory multimedia tools provide understanding, and the use of technology removes the limits of accessing information. According to Francis (2018), digital stories supported individual learning styles, learning strategies and self-directed learning.

Koyunlu Ünlü (2015) examined the effects of science lessons taught with technology supported inquiry activities on the views and perceptions of secondary school students towards inquiry and providing students with opportunities to conduct research in person enabled students to develop positive attitudes towards inquiry. Whereas, the current study suggests that the digital story technological course materials used in the introductory phase of the courses are effective in creating a positive difference in students' attitudes towards inquiry. This is because the attendee students asked questions using the digital story course materials and started their research on the situations described in the digital concept.

The current study revealed that technological devices have a positive effect on students' attitudes towards research and inquiry, since students use computers and mobile devices brought by the teacher in the classroom and after the lessons to conduct research. Similarly, there are many studies on supporting inquiry-based activities in science courses with technology (de Jong, 2010; Kachergis et al., 2017; Williams et al., 2017). Williams et al. (2017)'s 2-year study includes the processing of inquiry-based science courses with the support of educational technologies such as search engines, presentation tools, mobile tools and Moodle. The findings of mentioned study exposed that for an effective inquiry approach, the students should be supported with a set of networked technology tools, and they should be allowed to use their mobile phones during the practices. In this way, the students were able to record their work as videos and they stated that their research skills have improved thanks to technology, and they embraced their learning more by developing the ability to choose the tool that is best for them in reaching the goal.

According to Liu et al. (2021), although many studies conducted between 2007-2019 reveal that the positive aspects of inquiry-based applications supported by mobile technologies in science lessons are more than the negative aspects, technology overloads students with cognitive information, misconceptions in students while visualizing the real world in environments where inquiry is supported by mobile technologies. The teacher's role as a guide is needed to support it with epistemological information. However, in the current study the findings obtained from the observation form, teacher diaries and focus group interviews explained the teacher's effect on student attitudes towards inquiry, with the sub-factors of duties and responsibilities, feedback correction and reinforcer use. Teacher guidance is very important for students to display positive attitudes towards inquiry. Lessons taught through inquiry make students realize that the teacher is not the source of all knowledge. However, some students need more teacher guidance as finding something from search engines is a waste of time. The task of the teacher is a facilitator who monitors and guides the groups during questioning (Williams et al., 2017).

In their study, Vácha and Rokos (2017) found that university students found the methods in which students take an active role, such as research and inquiry, to be effective. However, student participation and teacher-related inadequacies show that classical oral teaching methods continue to be a form of non-formal education. Kurtén and Henriksson (2021) designed inquiry-based science courses for students aged 7-12 with four different teacher groups, each lasting one year, between 2014 and 2017. The study clearly reveals that the inquiry approach imposes more responsibility on students, unlike traditional methods. Even if the teacher does not present everything to them, they should have the courage to believe in what the students have learned, allowing them to make mistakes and learn from their mistakes. In this type of approach, where students are independent of the teacher but feel teacher support, they are interested in learning for themselves and not for others. In this way, students work with emotional joy and enthusiasm, their motivation is high in the lessons, and they have fun. Accordingly, in the current study, the effect of the student sub-factor on the attitude towards inquiry was explained by the importance given to the lesson, the interaction between students, and the students' duties and responsibilities.

During the implementation process, the students continued to experience the activities they carried out in the classroom outside of school, to share their experiences with their friends from different classes, and to research the questions they encountered in the classroom at home. Similarly, in the study of Williams et al. (2017),

students stated that they shared the information they learned in the lessons they taught through inquiry with their parents and that they felt extremely smart at that time. Accordingly, the findings obtained in the current study are similar to the results of other studies in the literature.

Murphy et al. (2021), using qualitative research methods, examined the knowledge and opinions of teachers and students about inquiry. According to their study, inquiry-based lessons are enjoyable and gratifying as they give responsibility to the students in accessing information. The shyness feelings of the students working in groups were broken, and they felt safe by checking the accuracy of their information thanks to their friends. In addition, during the interviews, the students stated that self-discovery increased their self-confidence and that they wanted to be a scientist in the future. Similarly, the qualitative findings of the current study revealed that the interaction of the students with their group mates and the entire class positively affected students' attitudes towards inquiry.

Conclusion

The applications revealed that the lower and middle group students' attitude scores towards inquiry converged to each other, but the students in the upper group diverged from the lower and middle group students. Qualitative data also support this situation. While the lower and middle group students are doing research and questioning in order to obtain information and keep the information in mind, the upper group students think that it is important to research and question in order to reach the correct information. Coping with difficulties in the research-interrogation process is considered important for lower group students in terms of fulfilling their duties and responsibilities, being successful in lessons for middle group students, and reliability of information for upper group students.

With the participation of an outside observer, an observation form was filled in order to evaluate the effects of learning environment, teacher, student, and lecturing factors on student attitudes. The positive changes observed in the process are explained with the data obtained as a result of the analysis of the focus group interviews through content analysis. Accordingly, it was determined that there were 6 variables for the learning environment factor, 3 for the teacher factor, 3 for the student factor, and 4 for the lecturing factor. We conclude that student attitudes towards inquiry were most affected by the "activity papers" in the learning environment sub-factor, and the "teacher's duties and responsibilities" in the teacher sub-factor. Attitudes were most affected by the "caring about the course" in the student sub-factor and the "experiments" in the lecturing sub-factor.

Recommendations

- In this study, we observed that the attitudes of the lower group and middle group students towards inquiry converged to each other. Since it takes time to change the attitudes, longer-term studies can be designed that enable the lower and middle group students' attitudes towards inquiry to approach the upper group students.
- Unlike this study, sub-factors in the fields of knowledge, skills and affect can be determined and their effects on students' attitudes towards inquiry can be investigated in depth.
- By choosing different methods and techniques from the digital story, studies can be carried out on which sub-factors affect students' attitudes towards inquiry.
- By ensuring that the digital stories are prepared by students themselves, it can be investigated how students' attitudes towards inquiry are affected.
- Control group studies can be designed to see the effect of the applied method more clearly.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

Note

This study is produced from the Master's thesis in which the first author is the student and the second one is the supervisor.

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