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Acquiring Scientific Process and Innovative Thinking Skills for Secondary School Sixth Grade Students through Digital Activities: An Action Research

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ABSTRACT This research aims to develop students' scientific process and innovative thinking skills using digital activities in distance and face-to-face education. A total of 12 sixth-grade students in a primary school participated in the study. The research was action research. The analysis was carried out in the "Transmission of Electricity" unit within the scope of the sixth-grade Science Course in 5 weeks and 20-course hours. The quantitative data were collected with "The scientific Process Skills Scale" and "Innovative Thinking Scale". Semi-structured interview forms, researcher, and student diaries were used to acquire qualitative data. The study's findings revealed that students showed improvement in gaining scientific processes and innovative thinking skills. It was observed that there was a significant difference between the mean scores of the science process skills test applied before and after the application in favor of the post-test. It was determined that students' use of scientific thinking skills increased during the experiments and activities. Moreover, students identified themselves with the work of scientists and improved their skills in conducting scientific processes. This situation shows that students can gain a scientific approach and innovative thinking skills with the active use of digital activities, especially in Science.

Keywords Scientific process skills, Innovative thinking, Transmission of electricity, Action research, Digital activities

1. INTRODUCTION

Raising individuals who can play an active role in today's social and economic conditions is directly related to the competitiveness of countries in the international arena. This situation leads countries to seek an education model that will enable them to raise responsible individuals, solve problems, have advanced decision-making skills, and think critically and innovatively (MEB, 2018). This education model aims to make information meaningful for students, be active in communication, have innovative thoughts, and make them a part of their life, rather than assessing the level of students' knowledge. This perspective that emerged in educational paradigms causes the restructuring of education systems, updating, and developing curricula organized in thinking skills such as analytical, critical, innovative, or scientific process skills.

Curriculum putting students in the center and providing structuring knowledge seeks to train students with an environmental understanding supported by nature awareness. In addition, it considers an approach based on the idea that learning is not limited to school spaces or classrooms but covers the whole life and paves the way for the use of what is learned in daily life. This situation enables students to enter a scientific process to discover knowledge. Aktamış & Ergin (2007) stated that individuals are expected to recognize and define the individual and social problems they encounter in their environment and find solutions to a certain extent. For this reason, they emphasized that it is essential for them to acquire scientific process skills. People may suggest different answers to the same problem. It depends on how creative those people are. The ability to learn to solve problems can also contribute to scientific creativity. Individuals learn to solve problems gradually during the education process.

The American Commission for the Advancement of Science Education (ACASE) has adopted science process skills in many highly transferable science disciplines. They define it as a set of skills that are accepted as a reflection of the correct behavior of scientists (Tan & Temiz, 2003).

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Scientific process skills are used to carry out scientific activities, produce and use scientific knowledge, and solve problems (Zeidan & Jayosi, 2015). Process thinking skills are developed using scientific processes and approaches (Rezba, Sprague, McDonnough & Matkins, 2002). Since scientific process skills are frequently used in daily life, it is considered extremely important to acquire (Hirca, 2013). Rustaman (2006) stated that science process skills have three essential functions. The first function is a way of thinking that leads to an action (e.g., solving problems, setting goals, making plans). The second function is managing emotions (e.g., overcoming boredom). The third function is associated with transferring thoughts and feelings to others. Based on these three functions, scientific process skills can be defined as organizing thoughts and feelings for effective action and transfer between people. Managing here is an internal action and takes place in one's mind. On the other hand, the transfer is the transmission and reception of thoughts and feelings to other people. Scientific process skills shape the elements necessary for the emergence of scientific methods.

Individuals use the scientific process to figure out how to answer questions about the world by logically breaking down the steps in their thinking. This process is helpful in Science and any situation requiring critical thinking. Science process skills include observing attributes, measuring quantities, ordering/classifying, inferring, estimating, experimenting, and communicating (Vitti & Torres, 2006). Basic process skills are vital to developing appropriate scientific attitudes and values. For example, science education encourages students to think as scientists and emphasizes the development of good scientists' attitudes (Opulencia, 2011). One of the purposes of such teaching is to instill desired attitudes and values. These skills come together during a design and form a whole (Pacia, 2014; Yeany, Yap & Padilla, 1986; Rustaman, 2006). These skills occur naturally in the minds of individuals.

Individuals having scientific process skills and transferring these skills to their daily and academic lives are expected to be more innovative. In other words, they are expected to process information actively and produce new knowledge. Especially with the rapid introduction of 21st-century skills into our lives, the concepts of innovation and innovative thinking are frequently encountered in individuals' skills. Looking at the international level, the Partnership for 21st Century Skills (2008) report emphasized the concepts of creativity and innovation in the theme of learning skills, which are among the 21st-century skills (as cited in Deveci & Kavak, 2020). This importance given to innovative thinking skills at the international level has led to its rapid gaining at the national level. Innovative thinking skill, which quickly takes their place in the visions of curricula, has been defined by the Ministry of National Education (2008) as a way of thinking that leads to new insights, original approaches, new perspectives, and brand new ways to understand and comprehend something. The important thing in developing innovative thinking is to use techniques that will enable individuals to produce ideas, bring forward different ideas, and provide education based on idea generation, imagination, and the development of thinking skills. In addition, as of 2018, field-specific skills were included in the Science Curriculum under Engineering and Design Skills and Innovative Thinking (MEB, 2018).

Barak, Morad & Ragonis (2013) viewed innovative thinking as a cognitive process that leads to implementing new or significantly improved ideas. According to Drucker (2007), on the other hand, it is defined as the ability to put different products out of the ordinary and commercialization of this product to include its processes. Innovative thinking is to think outside of the patterns in mind, go beyond the standard thinking style, match the facts with the opposite of each other, come up with elastic ideas by going beyond rigid intellectual patterns, and develop original practical ideas with use-value (Çellek, 2002).

Scientific thinking and innovative thinking skills are not independent processes like other thinking skills. On the contrary, they complement each other and are intertwined, complex mental activities and unique cognitive processes accepted as the building blocks of thinking (Alkın-Şahin & Tunca, 2013). These thinking skills include skills such as obtaining, organizing, and analyzing information, drawing conclusions, brainstorming, problem-solving, determining cause and effect relationships, evaluating possibilities, establishing and planning goals, observing the process, making decisions, and applying them to one's own life (McGuinness, 2000). One of the aims of education is to raise individuals who know how to think and use what they learn in their lives. Therefore, education systems should train individuals with scientific thinking and seek cause-effect relationships outside of apparent reasons by providing the necessary tools to reach and develop information (Polat & Tümkaya, 2010). For this reason, learning environments should be equipped with various activities to enable them to gain these thinking skills.

Most countries have been transitioning their traditional education systems to modern ones. The contemporary education approach includes the 2018 Science Curriculum (Primary and Secondary Schools 3,4,5,6,7 and 8th Grades). This curriculum prioritized skills such as scientific process skills and innovative learning. It aims to raise students who research, question, criticize, observe, examine, solve problems, adapt, and apply what they learned at school to daily life (MEB, 2018). Recently, curricula have been prepared for exploration, experimentation, and cognitive thinking problems. It paves the way for the student to grow up as close to thinking and producing. Scientific processes and innovative thinking skills facilitate learning in Science, enable students to be active, develop a sense of responsibility, and take an important place in the program. These skills are essential skills that facilitate learning in Science, enable students to be active, develop a sense of responsibility in their learning, increase the permanence of knowledge, and provide the ways and methods of scientific research (Çepni, Ayas, Johnson & Turgut, 1997). The methods and techniques used in science education effectively teach students these skills. Scientific research methods, one of the methods used in science education, provide students with skills such as questioning, problem-solving, innovation, analytical, critical thinking, hypothesizing, and experimenting. The methods and techniques used in science education allow students to acquire these skills.

As the student becomes active in science, responsibility is given to the student, providing a more permanent grasp of the information. Anagün & Yaşar (2009) examined the development of scientific process skills in primary education's fifth-grade science and technology lessons. It has been observed that scientific process skills have improved with applications. In Can & Pekmez's (2010) study, the nature of science activities on the development of science process skills of primary school seventh-grade students was discussed. As a result, it is seen that students make a significant contribution to the development of scientific process skills. In another study by Özkan & Kargın (2017), the effect of the problem-solving method on middle school students' attitudes towards science, scientific process skills, and academic achievements was examined, and observed that they improved scientific process and critical and analytical thinking skills. In international studies (Rogers, 1995; Ha & Stoel, 2004; Şahin & Thompson, 2006; Tariq, 2007), individuals who gain scientific thinking and innovative thinking skills have been observed that they tend to be sociable and take action—analyzing, interpreting, finding solutions, having an objective point of view, adapting, coping with and researching problems, thinking critically, using imagination, being creative, questioning, communicating effectively, sharing information, being curious, energetic, lively. The ability of individuals to acquire these characteristics depends on their scientific process skills. Therefore, it is aimed that a child of the students who gain scientific process skills will be raised as individuals who can think innovatively.

Today, the rapid change of information, adaptation to change, and the problems encountered reveal the importance of problem-solving skills. In particular, the changing educational paradigms of the 21st century aim to raise individuals who can quickly adapt to the social and economic conditions of the age and contribute to the innovation process of countries. This situation has led to the emergence of teaching programs equipped with learning skills such as problem-solving, decision-making, critical thinking, creative thinking, and innovative thinking. During the implementation of the curricula, what is expected from the students is to transform these gains into real-life skills and move them beyond the level of knowledge. However, evaluation results such as PISA and TIMMS, which evaluate international maths and science literacy, and Central assessment exam results such as LGS and TEOG, conducted in our country, show that students have problems even in their knowledge. It is seen that students cannot internalize the information sufficiently in their learning environments, have difficulty in remembering, and therefore cannot pass to higher-level learning steps such as application, synthesis, and analysis. This indicates that science literacy remains at a low level. A learning environment with only traditional teaching methods and techniques, especially in a field such as science, prevents high-level thinking skills. Therefore, it seems unlikely that they will contribute to the development of societies where the speed of technology development is not caught. On the other hand, many innovative methods and techniques, such as digital story writing, will contribute to the development of thinking skills, stimulating the interests and curiosity of students and ensuring that they maintain the same excitement.

The curriculum is the most basic variable in developing the culture of thinking in science education. Since the programs developed by the Ministry of National Education are consistent with the philosophy, the dimensions of the culture of thinking can be integrated into the program only with the right interventions in the learning-teaching process. It is thought that it can contribute positively to the teaching of acquisitions, as it contributes to developing cognitive skills (Yüce & Yasemin, 2019). In this regard, students need to think like scientists during problem-solving. Students must acquire the skills that scientists use during their studies and develop innovative thinking skills.

For this reason, this research aims to provide students with these thinking skills through digital activities to be used in the 6th-grade science course. This study included practices that would develop students' scientific processes and innovative thinking skills in line with this goal. In addition, it is thought that using digital materials during the procedures carried out through action research will contribute to developing students' digital literacy skills. It can also be stated that these methods and practices are essential in reflecting on the dynamic process of the course in every aspect and contributing to the professional and academic knowledge of the researcher/teacher conducting the research. The fact that such applications are not widely used in the field, especially in the Science course, shows the importance of the study in this context.

There are lots of studies related to this topic. However, most of these studies were conducted with the relational screening method, and the relationship between thinking skills and academic achievement or another thinking skill was evaluated. For instance, the study by Atmatzidou &

Demetriadis (2016) examined the development of students' computational thinking skills in terms of different variables within the scope of learning activities in coding and robotics education. Barut, Tuğtekin & Kuzu (2016) aimed to reveal the importance of computational thinking skills in coding training given in their study. In their research, Batı, Çalışkan & Yetişir (2017) discussed computational thinking skills and examined the perspectives of educators in different countries by emphasizing the STEAM approach. Akkaya (2018) read the effects of educational games on students' basic conceptual knowledge of object-oriented programming and computational thinking skills in her master's thesis. Finally, Gülbahar, Kert & Kalelioğlu (2019) conducted a scale development study to determine self-efficacy perceptions for computational thinking skills. However, in this study, students are expected to produce a product (digital story) by activating scientific thinking and innovative thinking skills in learning environments.

This study was carried out in a total of 5 weeks in the middle school 6th-grade Science course through the action plans, some of which were distance education and some face-to-face education, on the subject of the transmission of electricity, Conductive and Insulating Materials, and Electrical Resistance and the Factors to which it is Connected. It is thought that the students sincerely answered the questions in group interviews and the applied interview form. In addition, questions asked to students in group interviews were suitable for research. The research is a study that covers 6th-grade students of Mehmet Sesli Secondary School and the second semester of the 2020-2021 academic year. Therefore, the applications carried out in research tried to support the students' scientific process and innovative thinking skills and determine their developmental status. In this context, the problem sentence of the study has been defined as "What are the effects of action plans realized in the Electricity Transmission unit of 6th-grade students on the development of scientific process and innovative thinking skills?". In addition, the sub-problems that are expected to be answered in this direction are as follows:

1. To what extent do activities aimed at developing scientific processes and innovative thinking skills improve students' skills such as observation, measurement, classification, recording data, forming hypotheses, using data, creating models, changing and controlling variables, and experimenting?
2. As a result of the activities carried out to develop scientific processes and innovative thinking skills, is there a difference in their views on Science, the nature of science, scientists, and their studies?
3. What are the positive aspects of developing scientific processes and innovative thinking skills?

2. METHOD

2.1 Research Pattern

The research was carried out through action research. Action research, one of the qualitative research designs, takes place in the company of expert researchers, with the participation of practitioners and the parties to the problem by making a critical evaluation of situations, determining measures to be taken to improve existing situations, and putting them into practice in a planned manner (Karasar, 2005). Action research follows a spiral pattern and can be detailed in roughly five stages, as shown in Figure 1 (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2020).

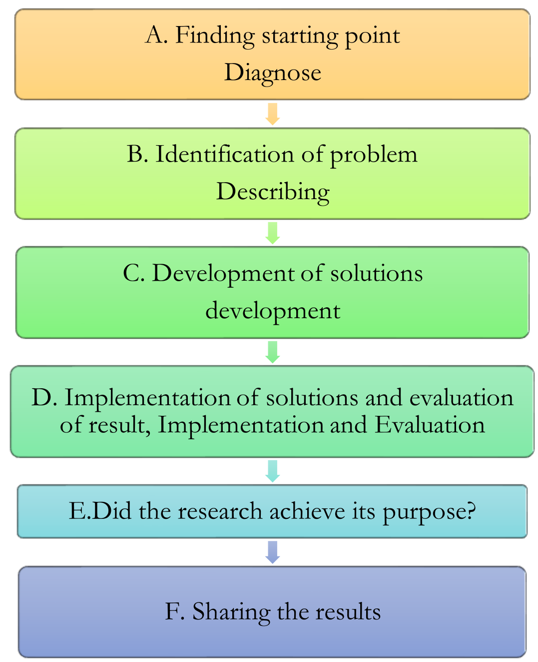

Figure 1 Stages of action research (Büyüköztürk et al, 2020)

Action research begins with awareness of a problem. After realizing the problem, the situation is defined with different analysis techniques. With the definition of the problem, the action phase begins. It is put to work with determined action stages, but the planned action stage is not expected to solve the problem immediately. On top of that, if an action plan fails, reasonable solutions are obtained by re-planning with different experiences.

2.2 Sample

The study group was determined by the typical case sampling method, one of the purposive sampling methods. The purpose of purposive sampling is to select situations with rich information that will illuminate the problems studied in the research. In this sense, purposive sampling methods help many cases discover and explain facts and events (Ayyildiz & Tarhan, 2015). On the other hand, typical case sampling is specific to many situations in the research universe. In this context, the study group was determined as 12 students, six girls and six boys, at the 6th-grade level, in a secondary school. The application class

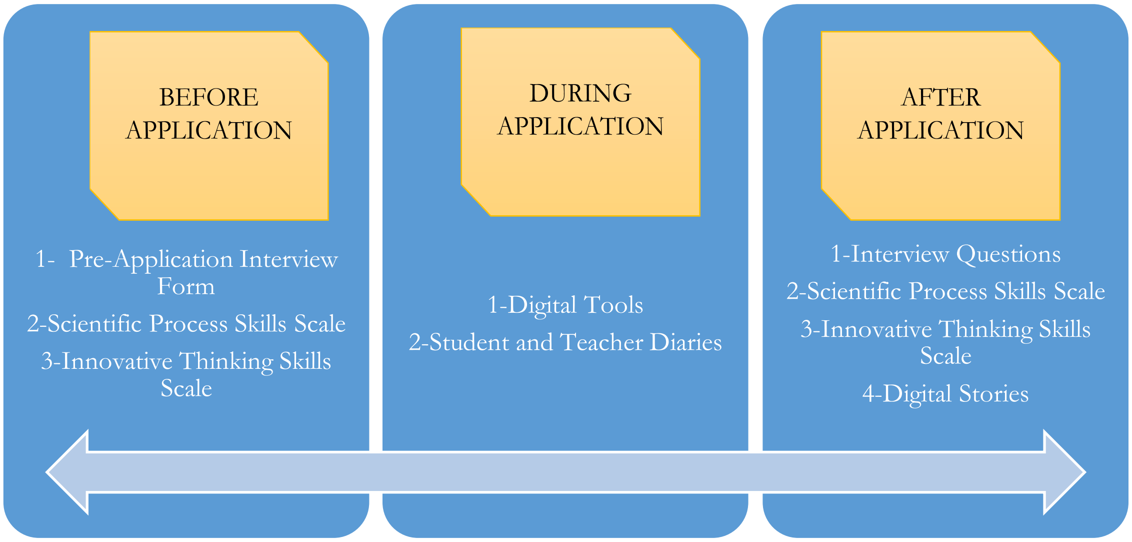

Figure 2 Collection of Research Data

consists of academically successful students, who are in contact with the school, and whose socio-economic status is at an average level.

2.3 Data Collection Tools and Data Collection

In action research, it is possible to collect data with qualitative or quantitative methods to define the problem better and obtain suggestions for solutions (Şimşek & Yıldırım, 2011). For example, qualitative data collection methods such as interview types, teacher and student diaries, and quantitative data collection tools such as questionnaires, scales, and multiple-choice exams can be used together or separately according to the research questions and data types to be collected (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2020). This study took place over five weeks in total. The applications were carried out in the distance and face-to-face education in the subjects of Conductive and Insulating Materials and Electrical Resistance and Dependent Factors in the Transmission of Electricity unit in the Science course of the 6th-grade students of secondary students school. Research data were collected before, during, and after applications. The process is summarised in Figure 2:

2.3.1 Pre-Application Interview Form

Before application, a semi-structured interview form prepared by researchers, including the following questions, was used to reveal students' views on the concepts of Science, scientific thinking, and innovation and to have an idea about their readiness (Table 1).

Table 1 Questions in the Pre-Application Interview Form

Questions in the Pre-Application Interview Form
1- What comes to mind when you think of science?
2- What do you think is the purpose of science?
3- What comes to mind when you think of a scientist?
4- What do you know about scientific studies?
5-Why do scientists conduct experiments?
6- Do you want to be a scientist, why?

2.3.2 Scientific Process Skills Scale

The Scientific Process Skills Scale for Primary School Students, developed by Aydoğdu, Tatar, Yıldız & Buldur (2012), was used both before (pre-test) and after application (post-test). During the scale development process, questions (34 items) regarding 12 primary and 22 high-level skills were prepared and presented for expert opinion. The opinions of five experts (two science and technology teachers and three lecturers with a Ph.D. degree in science teaching) were obtained to assess the scale's internal consistency. Six items that were difficult to understand were excluded from the scale in the light of experts' opinions and suggestions. As a result, the scale with 28 items was developed and administered to the study group. The ranking includes items related to basic skills such as observing, classifying, using space/time relations, estimating, and making inferences. In addition, it includes items related to high-level skills such as problem statements, generating hypotheses, variable determination and control, testing, and data interpretation. Then, the remaining 28-item scale was applied to 6th, 7th and 8th grade (n=345) students studying in five primary schools selected by an easily accessible sampling method. For statistical analysis, item analysis was performed using the Finesse Package Program, and item difficulty and discrimination indexes of each question were calculated. The reliability coefficient (KR-20) was 0.83, and the mean difficulty was 0.54. It was observed that the distinctiveness index of a question was below 0.20, and therefore, the question was removed. The reliability of the remaining 27-item scale (KR-20) was 0.84. As a result, it is seen as a valid and reliable tool that can be used to measure scientific process skills.

2.3.3 Innovative Thinking Skills Scale:

In research, the Innovative Thinking Skills Scale of Secondary School Students, developed by Aras (2020), was used both before (pre-test) and after application (post-test). The opinions of three experts from the educational sciences and science teacher education were sought by forming open-ended questions about innovative thinking. Then, a form consisting of open-ended questions was applied to 100 students. In line with the answers obtained, an item pool consisting of 58 items was created. As a result of the feedback from expert opinion, the scale, which was 58 items, was reduced to 55 items. The innovative Thinking Skills of Secondary School Students form was applied to 328 students. Explanatory Factor Analysis (EFA) was applied, and items found to be insufficient were removed. The structure received in the trial application was tested by Confirmatory Factor Analysis (CFA). Cronbach Alpha internal consistency and reliability coefficient was determined. After applying the trial scale, which initially consisted of 55 items, to 328 secondary school students, 28 items remained. When these four basic structures are transformed, they are reflected as grounded. To the items in factor I (23, 22, 15, 20, 13, 24, 14, 10, 11, 19, and 12), It has been determined that you measure “creativity”. II. The main items in the factor (18, 17, 16, 26, 27, 28, 21, and 25); I have detected that you have identified your “problem”. III. some explanations in the factor (8, 9, 5, 6, and 7): You have determined your level of “curiosity”. IV. The factors' explanations (2, 1, 3, and 4) are; It has been determined that you measure "entrepreneurship". The alpha coefficient of the first factor of scale, consisting of four elements, is 0.895, that of the second factor is 0.860, that of the third factor is 0.809, and that of the fourth factor is 0.755. The total alpha value of the scale is 0.936.

2.3.4 Digital Tools:

In research, the process of determining and introducing the WEB 2.0 tools will be used by students during and after the application and as a data collection tool before the application. The first is “the https://phet.colorado.edu/tr/s” website, where they will prepare animations. This page has software that will enable students to create animations using fundamental concepts and principles of the subject. The second is applications related to the realization of the slow-motion display.

2.3.5 Student and Teacher Diaries:

In research, both students and practitioner teachers were provided to keep a diary to reveal how action plans progressed during implementation, the student's achievements, the opportunities and threats encountered in practice, and the strengths and weaknesses of the approach. Thus, data were collected through student and teacher diaries while implementing action plans. Student diaries were designed in a semi-structured way, considering the grade levels of students. The questions in student diaries are listed in Table 2.

Table 2 The questions in student diaries

Questions to help keep a diary
1- I wonder why?
2- I was very surprised when this happened.
3- During the discussion I wondered.........
4- I know....
5-.....I think because....
6-.....causing........to happen?-........how is.......related?
7- What did you see/What did you hear/What did you feel?
8- How did it look?
9- What do you think its functions are?
10- How does this match up with what you've seen before?
11- How can we do it.?
12- Which factors can cause..............?
13- Where can we..............?
14- What 's going on here?
15- What changes did you notice compared to yesterday?
16- What predictions can you make?
17- What made you wonder today?
18- Create a question for yourself and your friends.

The diary of the researcher-practitioner was arranged in an unstructured way, and the practitioner was provided to share his experiences during the application. In addition, both student and teacher diaries were written online. Before application, students were introduced to padlet page they would write.

2.3.5 Digital Stories:

The website was also titled “https://www.storyjumper.com/go/wqmcedsvmufg”, where students can transform what they learned after application into a digital story used as a data collection tool. Students created digital stories using this website.

2.3.6 Post-Application Interview Form

After action plans were completed, a post-application interview form was developed and applied to evaluate the process's effectiveness. The questions in the interview form are listed in Table 3.

Table 3 Post-Aplication Interview Form

Questions in the Post-Application Interview Form
1- What has been the most difficult activity for you so far?
2- Did doing the activities help you understand the subject?
3- What are your thoughts on the activities we do?
4- Shall we continue such activities in the next lessons?
5- What are the positive and negative aspects of the activities held in the last month?

2.4 Analysis and Interpretation of Data

The data analysis was carried out in two stages and integrated into the findings section. Descriptive analysis, one of the qualitative data analysis methods, was used in the study of the "pre-application interview form, student and teacher diaries, post-application interview form" used before, during, and after implementing action plans. The themes and codes obtained were presented with the support of direct quotations from participants' views. The data obtained from the "Scientific Process Skills Scale" and "Innovative Thinking Skills Scale" were analyzed using descriptive statistics and presented in tables.

2.5 Application

Action plans were carried out in 20 lesson hours in 5 weeks. The weekly action plans followed during the implementation process, and the content of the action plans are given in Table 4.

2.5.1 1st-Action Plan/1st-Week

In the first week of the action plan, interviews were conducted to reveal students' readiness, thoughts, beliefs, and attitudes toward science and their expectations of science. Interviews were carried out in written form during one class hour with the "Pre-Application Interview Form" prepared by researchers. However, after discussions, pre-test applications were carried out in the first week to reveal students' scientific processes and innovative thinking skills. Pre-test applications were also completed in two hours. In the last hour of the first week, students were informed about diaries they would write during practices, the contents of journals, how they would be kept, and which application they would use. One of WEB 2.0 tools, the "https://tr.padlet.com/dashboard" site, has been introduced to record the logs and send them to the practitioner. Students will share their diaries through this webpage. Again, the "https://phet.colorado.edu/tr/s" website that students will use during the action plan implementation phase has been introduced. Students are expected to animate and design slow-motion videos with this website. Another tool introduced to students is the "story jumper" WEB 2.0 tool that students will use in writing digital stories. Students were asked to write digital stories on the topics covered throughout the process.

2.5.2 1st-Week Teacher's Diary

"In the first week, motivating speeches were made to ensure students adapted to the process. Students were informed about animation production and digital story writing. It was seen that the students were excited to do something new. They were asked to do freelance work on slow-motion animation techniques and digital story activities. When we look at the studies done in the same week, we have the impression that the students will adopt the process. However, some students' technology, etc. For some reason, it was seen that they couldn't. These students were interviewed one by one and briefed on correcting the deficiencies. They were asked to prepare their materials for the activities later this week." (Researcher-Practitioner Diary-1, 17.05.2021)

2.5.3 2nd-Action Plan/2nd-Week

In the first week, tools used during applications were introduced, pre-tests were applied, and activities were implemented. Within the scope of Activity 1, titled "Do all materials conduct electricity?", prepared for students to gain scientific process skills, students were expected to construct a simple electrical circuit. However, it was observed that students had difficulties establishing simple electrical circuits. It was seen that the readiness of students to do activities was not at a sufficient level. On top of that, what is in a simple electrical circuit and how to set it up has been studied. This study brought readiness levels to the desired level by reminding the subject of last year through animations (Activity 2) on the

Table 4 Weekly schedule of action plans

Time (Week)	Action Plans	Activities	Duration
1st	1st-Action Plan	Asking students interview questions Application of science process and innovative thinking scales (pre-test) Introduction of digital tools	160 minuntes
2nd	2nd-Action Plan	• Activity 1: Do all materials conduct electricity? • Activity 2: Animation production and presentations from the website https://phet.colorado.edu/tr/s	160 minuntes
3rd	3rd-Action Plan	Activity 3: Transmission of electricity, production and presentation of slow-motion display Study of checking variables	160 minuntes
4th	4th-Action Plan	• Activity 4: Let's make a lighthouse • Activity 5: What does electrical resistance depend on?	160 minuntes
5th	5th-Action Plan	Activity 6: Presentation of what we learned with digital stories Application of scientific process and innovative thinking scales (post-test)	160 minuntes

Activity 1

Activity name: Do all materials conduct electricity?

Materials: Power supply, light bulb, lamp holder, connecting cables, plastic clips, aluminum foil, nails, glass, salt water, sugar water, vinegar, candles, paper and materials they can reach at home

Making the Activity:

- Let's set up a simple electrical circuit using circuit elements
- Let's check if the bulb lights up.
- Let's turn our circuit into a test circuit by separating the two connecting cables in the circuit.
- Let's guess whether the bulb lights up when we bring these test leads into contact with different solid materials or when we immerse them in different liquids that we put in a beaker.
- Let's record our estimates in the chart below.
- In order to test our predictions, let's observe whether the bulb gives light by contacting the test leads with the solid materials mentioned above.
- Let's repeat the same operations with liquid substances and observe whether the bulb gives light.
- Let's record the observations on the chart.

Item	Guessing	The bulb gave light	The bulb did not light	It transmits electrical energy
Plastic clip Aluminium foil Nail				
Glass				
Water with salt Water with sugar Materials available at home				

- What substances did the bulb light up when we contacted the test leads?
- When we compared our predictions with the experimental results, how many of these results were we able to predict correctly?
- When we touch the test leads with some substances, the light bulb gives light, and when we touch some substances, it does not light up, which properties of the substances can be related to?

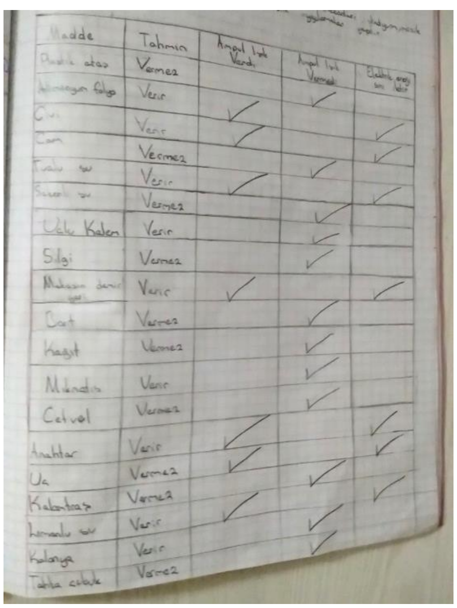

Figure 3 Estimation and classification

https://tr.padlet.com/dashboard page. After students gained their prior knowledge, Activity 1 was started.

Thanks to Activity 2, students remembered their previous knowledge about what elements are in a simple electrical circuit and how they are connected. After this event, the first Activity 1 was held.

Students did their experiments by asking their friends which materials would transmit electricity between test leads through a simple electrical circuit prepared by each student. Then, all students tried both materials on the list and all materials they provided at home. Finally, they recorded their observation results as electrically conductive and non-conducting in Figure 3 and Figure 4. This way, students' scientific process skills such as estimation, observation, data recording, and classification have been contributed.

2.5.4 2nd-Week Teacher's Diary

"We started this lesson by remembering last year's topics. It was observed that students carefully followed the

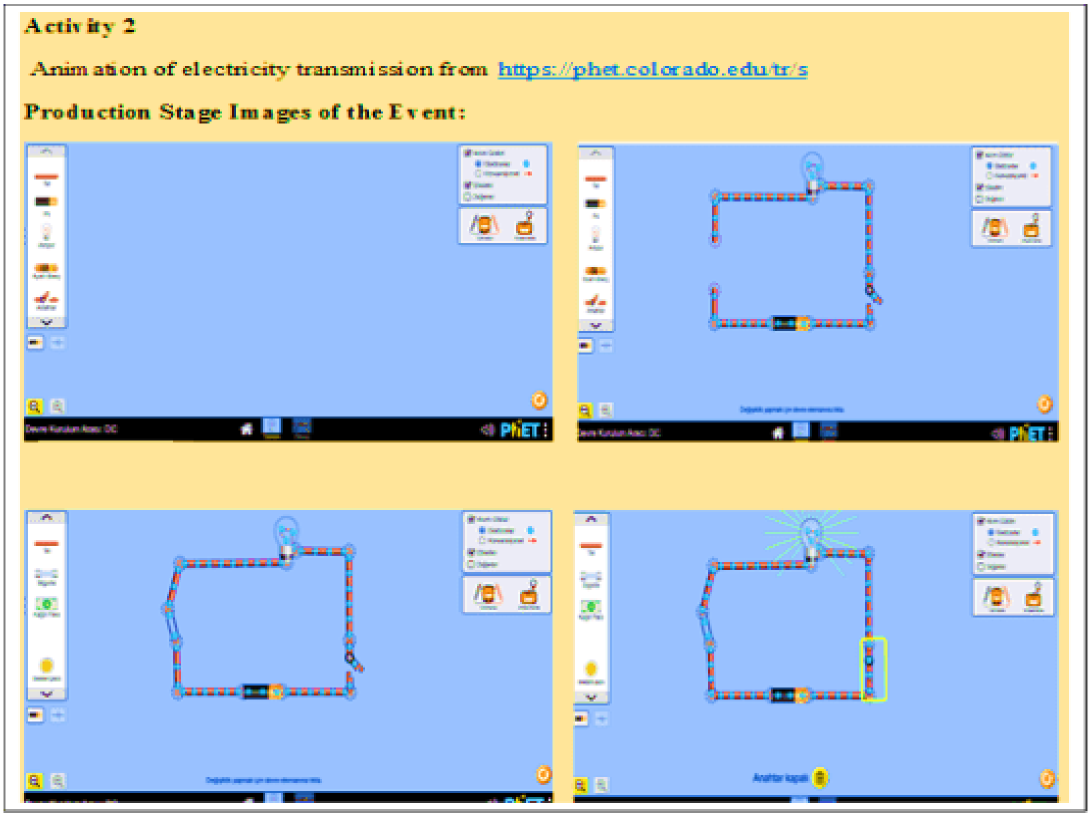

Figure 4 Estimation and classification

lesson since the subject of electricity had initially been the subject that some students eagerly awaited and wanted. However, having a distance class brought many problems. Every student wanted to do an activity, but we faced many issues such as internet connection problems and students' cameras not turning on. In addition, the failure of the teacher to help problems such as circuit connection problems experienced by students caused malfunctions in the process. Despite all these setbacks, the event was tried to be completed. While some students were experimenting with liquid materials in circuit assembly, saltwater, which should conduct el ectricity, did not transmit, causing wrong observations and classifications. Discussions were held on this, and misunderstanding was prevented with necessary explanations. In general, the activity seemed to be beneficial with the willing participation of students." (Research-Practitioner Diary-2, 24.05.2021)

2.5.5 3rd-Action Plan/3rd-Week

A similar study of the same activity in Table 5 was carried out on activities carried out last week for students to learn to change and control variables. First, students

Table 5 Chart for controlling variables

Research question	What happens when we use different substances between test leads in an electrical circuit?
Hypothesis	When we use plastic paper clips, the bulb is light … When we use nails, the bulb is …
Independent variable	
Dependent variable	
Control variable	
What was done?	
Observations	
Conclusion	

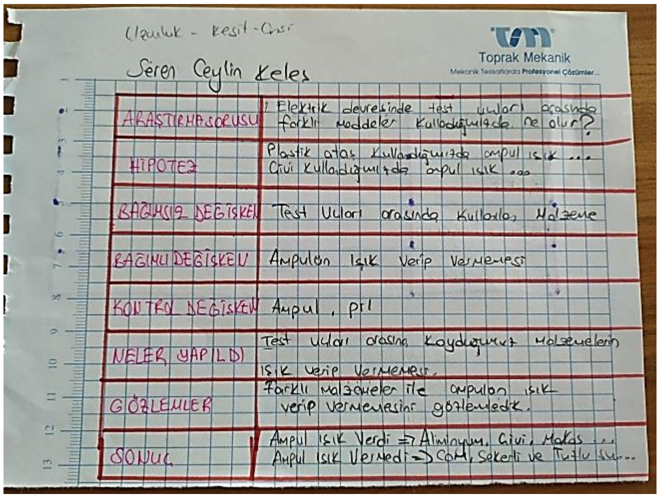

Figure 5 Variable control chart

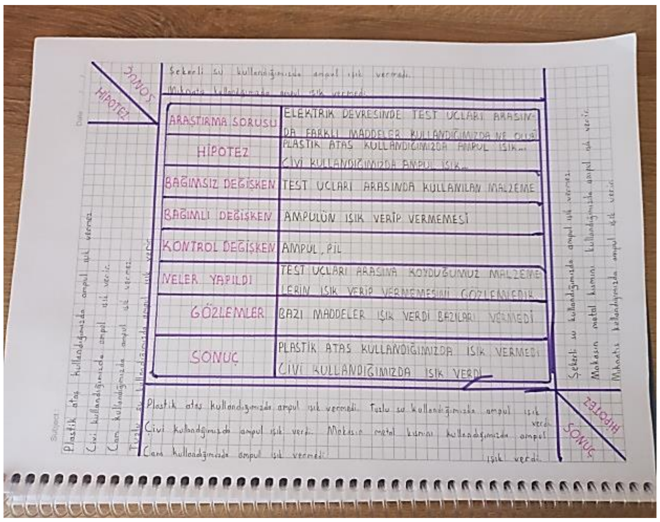

Figure 6 Variable control chart

were asked to define research questions. Next, discussions were held on the variables of these research questions. Then, the experimental phase of the problem, whose variables were determined, was started. Finally, each student controlled their variables with their experiments.

They shared what was done as a result of the experiment, their observations, and results with their friends and recorded tables as in Figures 5 and 6.

Variables were determined and controlled by preparing different experimental setups. This study was carried out several times to understand the process better. This way, it was ensured that the steps of forming hypotheses, creating models, and changing and controlling variables from scientific process skills were realized. However, it was noticed that some students had difficulties in changing variables. To make up for this shortcoming, the subject was repeated with a slow-motion animation technique in Activity 3. Slow-motion animation was realized by taking photographs and then throwing photos into an animation program on the phone. Animations were prepared until the next lesson was evaluated. This activity enabled students to learn by doing-experiencing their scientific process skills by drawing their attention to digital material. In this way, in addition to scientific process skills, students' innovative thinking skills were also developed (Figure 7).

2.5.6 3rd-Week Teacher's Diary

"This week, the subject of variables that students find the most difficult was discussed. According to my previous experience, variables that first appear in the 5th grade and controlling variables is a skills that students cannot understand until they set up an experiment. At first, I asked if they remembered from last year, but I saw that almost all of them did not remember. Upon this, we set up an experiment, prepared research questions, and made observations by determining variables. I noticed that students have a challenging time in this regard. In particular, the problem arose as students confused independent variables with dependent variables. It seemed that the solution to this problem would be complicated with distance education. Therefore, I had my students repeat this topic with slow-motion animation. I saw that students liked slow-motion activities a lot. In the next lesson, I realized that some of my students still could not reinforce the subject. Interviews with subject experts were held in the 3rd week of the action plan. In this meeting, it was concluded that a new action plan was prepared. With partial opening of schools, action plans have equipped activities that can be done remotely and at school." (Research-Practitioner Diary-3, 31.05.2021)

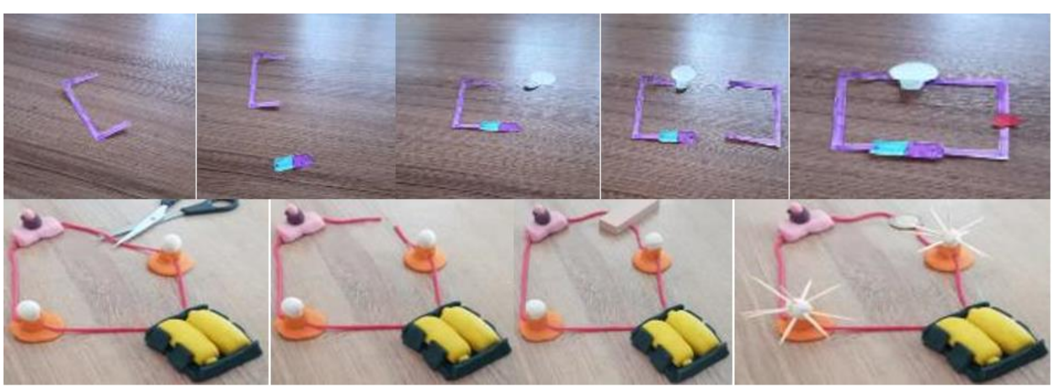

Figure 7 Example of slow motion animation

Activity 3:

Demonstrating transmission of electricity with slow motion technique

Materials: simple electrical circuit elements, electrically conductive and non-conductive parts, telephone, paper, pencil, cardboard, play dough, colored paper

Making the event:

- The design of activity to be held before slow motion production is drawn on paper in stages.
- Animation created for storyboards is turned into 2D or 3D models. In this way, abstract concepts are made concrete.
- The prepared models are animated according to content of subject to be explained and photographed with phone camera.
- Every movement of models is photographed.
- The resulting photos are animated with animation program on phone.

2.5.7 4th-Action Plan/4th-Week

A new action plan was prepared as a solution to problems determined due to observations. In contrast, the first action plan was implemented according to what was written in the teacher's diary. This action plan's activities are planned to gain skills such as determining variables, controlling them, and forming hypotheses. Our first activity was about electrical resistance, and students were allowed to discover factors that electrical resistance depends on by dedicating the action to be done. Initially, Activity 4 was prep ared by students.

Questions were directed to the students for both events in Activity 4. Considering the experiments, we designed above;

-What did you observe in the setup?-Why did this happen?
-What did you observe in the setup?-Why did this happen?

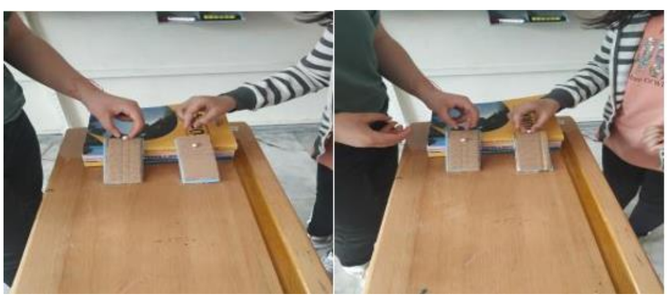

Figure 8 Images of the 5th activity held in class

-What did you observe in the setup?-Why did this happen?

Figure 8 shows images of the 5th activity held in class On the other hand, let's explore factors on which electrical resistance depends on a simple electrical circuit; its effectiveness was prepared by the acquisition of "estimates dependent variables of the brightness of the light bulb in an electrical circuit and tests their predictions" (MEB, 2018). The activity, carried out in stages, allowed students to make predictions, observations, and explanations in three different mechanisms and to take notes about what students observed. First, it was questioned why the experiment results were like this, and students were asked to make inferences about the outcome. Then, students answered the chart of controlling variables in Table 5 (above) and discussed it.

Figure 9 depics the effect of properties of the conductor on the brightness of the bulb in a simple electrical circuit. Moreover, with "Let's make a lighthouse

activity (Activity 4)", it was sought answers to these questions: "How do you think we can make a light bulb flash at certain intervals?, How should we set up an electrical circuit to obtain a flashing course like a lighthouse?. Students were expected to form hypothetical sentences for the solution of the problem. Mechanisms were designed in line with established hypotheses (Figure 10).

Figure 9 The effect of properties of conductor on brightness of bulb in a simple electrical circuit

Activity 4:
Goal: Let's discover the factors that electrical resistance depends on by designing an experiment.
Materials: Thick cardboard, 3 pieces of A4 size, 40 nails, 2 balls, 2 funnels, water
Making the Activity:
Step 1: Let's drive nails into our cardboard boxes at regular intervals as indicated in the figure below. Let's name a cardboard as A and put nails on this cardboard A at frequent intervals, and put nails on the other cardboard we call C with less frequent intervals. Let's be careful that the pointed part of the nail does not stick to our hands.
Step 2: Let's release the ball from the top points of the ball from both of our mechanisms at the same time. Let's see which one goes down faster.
Step 3: Let's take another piece of cardboard and nail it with the same frequency as cardboard A, but up to half the cardboard. Let's call this cardboard cardboard C.
Step 4: Let's release the ball from the tops of cardboards A and B at the same time. Let's observe which marble reaches the lower part in a shorter time.

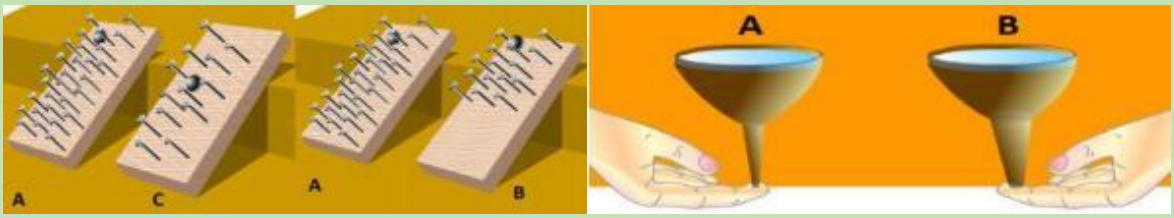

Figure 10 Examples of lighthouse activities

At the end of the designed mechanisms, the questions below were asked to students:
-Which object is your circuit key in this activity?
-What structure makes the light bulb blink in an event, and how does it work?
-Can you give examples of other circuit switches from your environment?

At the end of the study, the questions below were asked:
-What was the role of the cylinder used in your activity?

Which materials can we use instead of aluminum foil in your event? Why?. Last week, its effectiveness was evaluated with a performance evaluation scale.

2.5.8 4th-Week Teacher's Diary

"With the reopening of schools, I have observed that some students are not attending distance classes. Due to the epidemic, some students could not participate in face-to-face classes. They carried out the activity at school with deficiencies. I observed that the skills of constructing a problem statement and identifying and changing variables could be achieved with activities. Our face-to-face class this week may have affected this. Students' teaching of last unit topics by adding scientific process skills enabled students to be more disciplined than in previous lessons. Subjects' processing with different media methods enabled them to express themselves. For example, I observed that some students continued with original works outside animation production and digital story writing. I realized that teaching lessons in different ways to students contributed greatly to the understanding subject throughout the class. I can say that action research has added something to myself in this case." (Research-Practitioner Diary-4, 07.06.2021)

2.5.9 5th-Action Plan/5th-Week

This week, students' works were evaluated and scales made before the study were applied again. Digital stories

Figure 11 Examples of digital stories

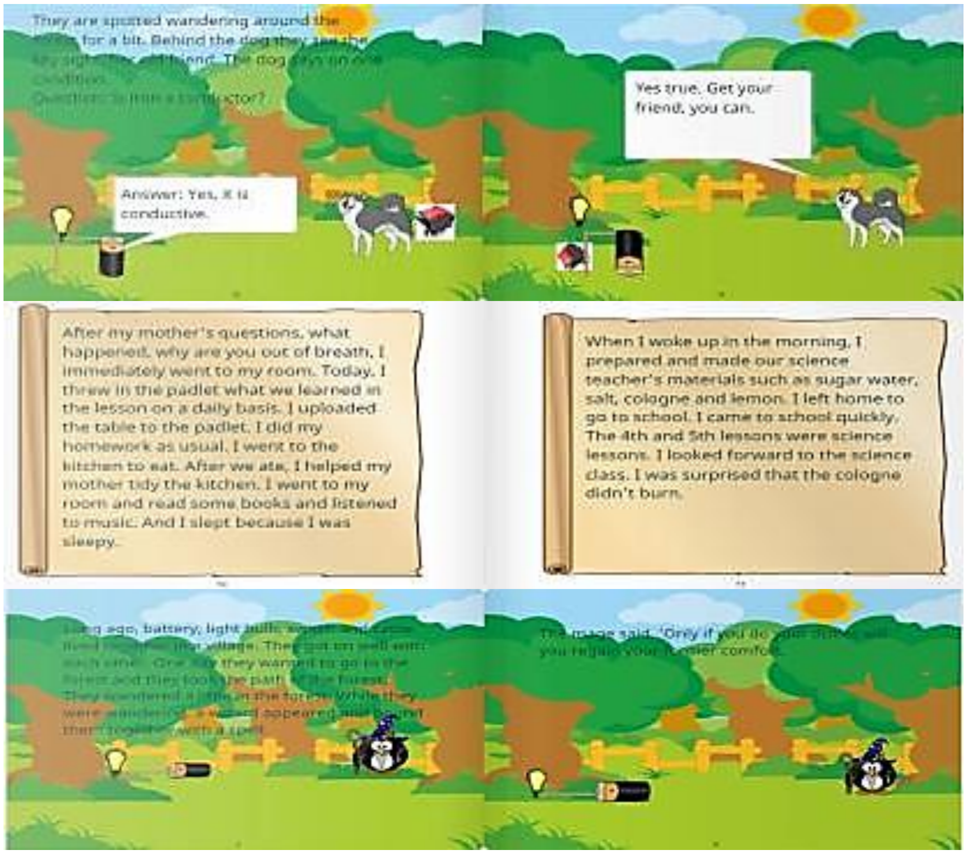

Figure 12 Examples of digital stories

prepared by students (Figure 11, Figure 12) were assessed. The lighthouse activity they did was evaluated with rubrics. Feedback was provided on their work, wrong places were corrected, and missing parts were completed. Process evaluation was made in groups, and assessments were recorded.

3. RESULTS

The pre-test and post-test results and findings obtained from interviews are included in this section.

3.1 1st-Week-Findings Regarding Pre-Application Interview Form

In the first week, students were provided to complete a pre-application interview form to determine what they knew about scientists and scientific processes. The questions and the answers of students are given in Table 6.

When the first question is examined in Table 6, the most repeated statement is experimenting and doing research. It is seen that the concepts of experiment and research come to mind when most students say “Science”. It is also noteworthy that some students think of new information and inventions. The most repeated statement regarding the second question is learning new information. This statement shows some of the students believe that the goal of Science is to know further details. Some of the students also stated that the purpose of Science is "to make life easier". The most recurring statement about the third question is that students look at life and think differently. It is seen that some of them use the expression "researcher

Table 6 Expressions mostly used in answering interview questions

Items	Questions/Most Used Phrases	Frequency(f)
1st-Question	What comes to mind when you think of science?	
	* Experiment, doing research	5
	* Finding new information, inventions	3
2nd-Question	What do you think is the purpose of science?	
	* learning new information	5
	* Make life easier	3
3rd-Question	What comes to mind when you think of a scientist?	
	* Looking at life differently, thinking differently	6
	* researcher, inventor, inventor	4

Table 6 Expressions mostly used in answering interview questions (*Continued*)

Items	Questions/Most Used Phrases	Frequency(f)
4th-Question	What do you know about scientific studies?	
	* Conducting the experiments	3
	* work on a topic	1
5th-Question	Why do scientists experiment?	
	* to explore	6
6th-Question	Do you want to be a scientist, why?	
	* I would like	4
	* I do not want	3

and inventor". The most repetitive statement about the fourth question is that the experiments are done. One of the students used the word "working on a subject". The most recurring phrase about the fifth question is to explore. Finally, in the sixth question, some students expressed "I would like" and some "I don't want".

3.2 2nd-Week-Findings for Activities 1 and 2

In the first week of the preliminary interviews, it was tried to reveal what the students knew and understood about concepts such as science, scientific thinking, and innovative thinking. From this point of view, activities covering the scientific and creative process skills of students in science activities were designed and implemented. In these activities (Activity 1, Activity 2), they were asked to discover materials that conduct and insulate electricity in a simple electrical circuit they built and classify them as conductor-insulator materials. It was observed that students did not have much difficulty in this activity. Some examples from student diaries are as follows:

"Today, in science class, we tested whether electrical circuits can transmit electricity and light bulbs by putting different substances between cables. We tried both solid and liquid materials. I was most surprised that saltwater conducts electricity. Still, I did not think that any salty liquid without salt would conduct electricity." (K3)

".. we put different materials between electrical circuits and tested whether they were conductors or insulators. I was surprised that the pen tip conducts electricity and tap water. We tried other materials like this; some are conductive, and some are insulating." (K6)

"… we unplugged one end of a simple electrical circuit and put some items in it. Our friend asked whether it would light up or not, and we answered it. It was my turn. I tried scissors and tape. The bulb on the tape did not light. But scissors also gave bulb light. When I made a plastic end, it did not light up; when I touched the metal part, the bulb gave light." (K5)

"…. we added different substances to a simple electric circuit. We determined whether these different substances conduct electricity. We guessed first and then checked the result of our guess. Many of our predictions were correct, as we learned about conductive and insulator materials before." (K2)

The explanations above show that students used skills of estimating, observing, and classifying in science process skills on the "transmission of electricity".

3.3. 3rd-Week-Findings for Activity 3

The second week's activity determined that the students used their estimation, observation, and classification skills and made inferences in this process. The third week's action was held to analyze better whether the students exhibited these skills accidentally or on purpose and to reinforce these skills. In this event, the materials used between test leads in a simple electrical circuit were tested, and it was checked whether the bulb would light or not. This process aims to provide students with skills of observing, classifying, scientific communication, estimating, making inferences, forming hypotheses, and determining and controlling variables. At the end of the process, the following are reflected in students' diaries:

"We took a look at what we did today and told what independent, dependent, and constant variables are. Thus, we recalled our topic last year." (K2)

"We did experiments with our friends; we tried many examples to see if it would light or not. We tried examples such as magnet, scissors, ruler ... and the teacher had another table drawn, and we filled it out." (E5)

"Disconnect the cable of a simple electrical circuit and use scissors, paper, iron, pencil eraser, etc. We put tools and observed whether the light bulb would turn on, then we wrote observation papers. Our teacher told us about dependent and independent variables". (E6)

When the student and teacher diaries above were examined, it was observed that some skills students should gain were not acquired. The process was supported by performing a slow-motion activity.

"Our teacher gave us an animation homework. I took figures one by one and checked whether bulb was lit by putting a conductive and insulating material on the ends of cables." (K5)

When the student's diary is analyzed, it is seen that the activity strengthened skills but was insufficient.

3.4. 4th-Week-Findings for Activities 4 and 5

It is seen that the activity in the third-week activity reinforced the skills but was not sufficient. For this reason, the fourth-week event was held. In this action plan, students' scientific process skills were discussed under "electrical resistance and the factors it depends on". In the activity, answers given to questions about the mechanism in which the ball is thrown from the upper part will reach the lower part faster by pins attached tightly to one cardboard and sparsely to the other cardboard as follows:

Table 7 Rating scale for digital stories

Considerations	Group 1	Group 2	Group 3	Group 4	Group 5
Dramatic question(6)	2	3	2	2	2
The purpose of the story(6)	3	3	3	3	2
Creating a storyboard(6)	3	2	3	3	2
Originality(6)	3	1	3	3	1
Length of story(6)	3	3	3	3	3
Affordability(6)	3	3	3	3	3
Grammar usage(6)	3	3	3	3	3
Sound(6)	3	3	3	3	3
Music(6)	3	3	3	3	3
Multimedia quality(6)	3	3	3	3	3
Multimedia sync(6)	3	3	3	3	3
Sharing for feedback(6)	3	3	3	3	3
Total(36)	35	33	35	35	31

Question-1. What did we observe in the setup?

"I observed that it descends faster in the sparse one"(E3)

"I've observed that it descends slowly on the frequent. (K3)"

Question 2. Why did this happen?

"It was difficult for the ball to go in common setup."(E2)

"In the sparse setup, the ball reached the bottom easily."(K3)

When we look at the answers to questions of the first activity, it is seen that students observed the movement of marble and could reach correct inferences. When we look at other activities, it has been observed that water-filled into two funnels with different cross-sections emptied faster. Sample expressions from answers given by students to questions as a result of their observations are given below:

Question 1. What did we observe in the setup?

"The one with thicker tip, the water drained faster"(E2)

"The water emptied later in the one with the thinner tip"(E4)

Question 2. Why did this happen?

"The water with thick tip was easier to flow"(K5)

"It was difficult for water to flow with thin tip"(K1)

When we look at answers given to questions of activity, it is seen that students observed the discharge process in detail. Their responses at the end of the action show that they understand what resistance might depend on. In addition, the students carried out new experiments on the subject of "Electrical resistance and its related factors", and students answered questions they asked. Some answers to questions asked about the investigation are given below:

Question 1. What could the research question be?

"How does the cable cross-section affect the brightness of the bulb in an electrical circuit?"(K4)

Question 2. What could the hypothesis be?

"If we change cable cross-section, bulb brightness will change."(E2)

Question 3. What could be the independent variable?

"Cable cross-section."(E6)

Question 4. What could be the dependent variable?

"Brightness of the bulb."(K1)

Question 5. What could be the result?

"If we use different thickness wire, the bulb brightness will change."(K4)

3.5. 5th-Week-Findings for Digital Story

In the fourth week's activity, it was observed that the students acquired many scientific and innovative thinking skills. Therefore, a fifth action plan was designed to see if students reflected on these skills in an activity and to combine these skills with digital stories. It was ensured that the students dealt with subjects in the light of their scientific process skills and created digital stories. Students did this work in groups. As a result, the students adopted and liked to write digital stories in their diaries and the teacher's diaries. Findings related to this are given in Table 7.

According to Table 7, students wrote digital stories in groups (5 groups, n=6) during the five-week application. Especially in the first week, students used a question at the beginning of a story that would impress listeners and attract their attention. Still, the level was insufficient to create an answer. Again, it is seen that students can predetermine the purpose of the story and focus on the purpose throughout the story. According to Table 7, it is seen that students are sufficient in using digital stories and writing new digital stories.

In Table 8, it is seen that students included frequently used expressions in the interviews after the application. In the first question, the students stated that they had difficulties in the activity of building a lighthouse to a large extent. Students emphasized that activities were mainly enjoyable, and they learned different things.

3.6. Findings Regarding the Innovative Thinking Scale

The 28-question scale, presented to the students as a pre-test before action research, was repeated after the study, and the change in innovative thinking skills of students was examined. The reliability coefficient of scale applied was Cronbach α, 0.941. Cronbach's alpha is expressed as follows: $0 < R2 < 0.40$ unreliable $0.40 < R2 < 0.60$ low reliability $0.60 < R2 < 0.80$ highly reliable $0.80 < R2 < 1.00$ high reliability (Özdamar, 1999).

Table 8 Findings regarding the post-application interview form

Questions	Questions/Most Used Phrases	Frequency(f)
1st-Question	What has been the most difficult activity for you so far?	
	*animation production	1
	*make a lighthouse	4
2nd-Question	Did doing the activities help you understand the subject?	
	*Yes it's okay	5
	*I understand better	1
3rd-Question	What are your thoughts on the activities we do?	
	*Enjoyable	4
	*We learned to do different things (animation, digital story)	2
4th-Question	Shall we continue such activities in the next lessons?	
	*Yes	5
5th-Question	What are the positive and negative aspects of our activities?	
	*learning different things	2
	*Insufficient time for activities	4

Table 9 T-test results of pre-test and post-test scores

Tests	N	$\bar{X}$	Ss	t	p
Pre-Test	12	3,47	,737	-1,083	0,302
Post-Test	12	3,61	,582		

Table 10 T-test results of pre-test and post-test scores

Tests	N	$\bar{X}$	Ss	t	p
Pre-Test	12	16,58	7,692	-2,483	0,030*
Post-Test	12	20,16	5,219		

*p<,05

As seen in Table 9, there was no statistically significant difference between students' pre-test mean score ($\bar{X}$=3.47) and post-test mean score ($\bar{X}$=3.61). However, when we look at pre-test and post-test averages, an increase is observed in favor of the post-test. Although it is not statistically significant, it can be said that the averages of students have increased. If the P-value is more significant than 0.05, a judgment is made that the hypothesis is valid. In other words, a P-value greater than 0.05 means that the hypothesis cannot be rejected (Frick, 1996).

3.7. Findings Regarding the Scientific Process Skills Scale

The 27-question scale, presented to students as a pre-test before action research, was repeated after the study, and the change in students' scientific process skills was examined. The reliability coefficient of the scale was found to be Cronbach α, 0.912.

As seen in Table 10, a statistically significant difference was found between students' pre-test mean score ($\bar{X}$=16.58) and post-test mean score ($\bar{X}$=20.16). The related samples t-test provides information about the difference between pre-test and post-test mean scores.

4. DISCUSSION

This research aims to develop the scientific process and innovative thinking skills of middle school 6th-grade students through digital activities used in Science courses. For this purpose, action plans prepared by researchers were applied by the researcher-practitioner teacher. Due to pandemic conditions, three weeks were spent in distance education, and two weeks were spent distance and face-to-face. The "Transmission of Electricity" unit in the Science Curriculum at the sixth-grade secondary school level was selected. Action research of 20 lesson hours in 5 weeks was carried out during the research process. Of these 20 course hours, 12-course hours are devoted to "Conductive and Insulating Materials", and 8-course hours are dedicated to "Electrical Resistance and Its Dependent Factors". In preparation of action plans, the course objectives in the curriculum were considered, but researchers created lesson plans. One of the researchers is a science teacher and a researcher-practitioner. The activity plans prepared by researchers were implemented after the approval of the validity committee. The programs were designed by the united annual plan and lesson plan. During implementation, necessary changes were made to action plans in line with the suggestions made by the validity committee.

The study data were collected from different data collection tools such as semi-structured interviews, scientific process skills scale, innovative thinking scale, researcher's diary, and student diaries. The data obtained from the quantitative measurement tools were analyzed and interpreted using the SPSS (Statistical Package for Social Sciences) program. The qualitative data of the research were analyzed by descriptive analysis, and the findings were interpreted by adhering to research questions. Findings obtained after data analysis show students' interest in digital materials used in science courses is exceptionally high. Thanks to these materials, it is seen that students' scientific thinking skills are improved, and they have a more innovative perspective in the face of new situations they encounter.

It is seen that various studies have been carried out, especially on scientific process thinking and innovative thinking skills. For example, in a study conducted by Yiğit, Muradoğlu & Mazlum-Güven (2019), a measurement tool was developed to determine secondary school students' perceptions of innovative thinking. Another study conducted by Sevinç & Uyangör (2020) aimed to prepare a reliable and valid measurement tool to determine the creative thinking skills of vocational high school students. Another study by Deveci & Kavak (2020) aimed to determine the perceptions of secondary school students about the concept of "innovation" and develop a measurement tool depending on determined perceptions. As seen in these studies, most studies conducted, especially in national literature, are studies to develop measurement tools to reveal students' scientific process thinking or innovative thinking skills. Such measurement tools can be used as a needs assessment step for applied research such as this study.

In this study, it was observed in digital activities that students' scientific thinking and innovative thinking skills improved thanks to the activities carried out through action research. Charyton & Merrill (2009) express that creativity and innovation skills can be enhanced if students are given opportunities such as doing experimental activities. Students who receive creative and innovative education show more creative and innovative characteristics than students who do not receive such education (Ayob, Hussain, Mustafa & Shaarani, 2011). These supported the findings of this research.

Anagün (2008) stated in her study that the dev Gonzalez elopement observed in students' scientific process skills did not occur at the same level for all skills. The development could be faster or slower at some stages of the scientific process than in other states. This may be related to how much students are exposed to activities to improve their scientific process skills. For this reason, such students' skills can be developed much more effectively through applied studies, especially in this study. Arslan's (1995) research revealed that "fifth-grade students' scientific process skills developed more than fourth-grade students". In addition, the research findings showed that the skills that are suitable for the development levels of the students developed and that there were difficulties in developing the skills that showed a higher level of proficiency. In this study, the study group consists of sixth-grade students. In the first week of the application, it was observed that the students had difficulty remembering the information they had learned in past years. In this sense, the results of both studies show that the process of developing both scientific process skills and innovative thinking skills is closely related to students' maturation and readiness.

However, González, Martín, Bruno & Prado (2016) stated in their study that as the grade levels of the students increase, their computational thinking skills increase. This study was conducted with sixth-grade students. The action plans improve the thinking skills of students. If these skills are taught in the next grades, they can be improved gradually. The sooner innovative thinking is developed, the more successful and future-oriented students will be raised (Sokolov & Sokolova, 2020). Aydoğdu (2006) found in her research that "the development of students' scientific process skills is also affected by the parent's education level and the variables of having a computer at home". This finding supports the idea that the socio-economic and educational status of families may be related to the study; therefore, not all skills are at the same level in their development. In addition, this situation shows that the development of scientific process skills and innovative thinking skills are affected by various variables.

In her study, Büyüktaşkapu (2010) conducted her research with a different study group than the study groups mentioned above. The study carried out with children attending pre-school education institutions aimed to reveal the effect of the "Constructivist Approach-Based Science Education Program for Developing Scientific Process Skills," prepared by the researcher so that children can acquire scientific process skills effectively and permanently. In the study group in which the Pretest-Posttest control group trial model was used, 40 of them were in the experimental group (18 girls, 22 boys) and 40 in the control group (16 girls) attending the kindergartens of Ayah Kindergarten and Necip Fazıl Kısakürek Primary School in Konya in the 2009-2010 academic year. A total of 80 children (24 men) participated in the study. In the prepared science curriculum, magnet, water, pendulum, ramp, cylinder, and shadow activities related to physical events support children's scientific process skills. The data were collected with the "Preschool Scientific Process Skills Scale" prepared by the researcher. According to the results of the research, a statistically significant difference at the level of 0.05 was observed between the Preschool Scientific Process Skills Scale mean scores of the experimental group of children who participated in the "Science Teaching Program Based on the Constructivist Approach to Develop Scientific Process Skills" and the mean scores of the control group children who participated in the current science teaching program.

The scores of the experimental group were higher than the scores of the control group. These results reveal that the Constructivist Approach-Based Science Curriculum for Improving Science Process Skills, applied to children attending pre-school education institutions, is effective in providing children with scientific process skills. This situation shows that scientific processes and innovative thinking skills are gained much more effectively in applied learning environments, just like in this study. Technology can perform several vital functions in the change process, including opening up new opportunities that improve teaching and learning—particularly with the affordance of customization of learning to individual learner needs, which is highly supported by the learning sciences (OECD, 2010). Web 2.0 technologies embody the perspective of many educational technologists and theorists that learning best takes place within technology-supported environments where learners individually and collaboratively consume and create content (Selwyn, 2010). Kartal (2020) aimed to examine innovative thinking skills according to the views of social studies teacher candidates in her study. In this direction, the definitions of innovation, innovative features, categories, reasons for teaching innovativeness, factors affecting innovation, environmental factors, roles in the social group, problem-solving methods, referenced resources and new methods, thoughts, and searches were discussed. As a result of this research, it has been determined that teacher candidates define innovation, is necessary for education, is open to innovations, and adopt innovation. According to the innovation categories, pre-service teachers have innovative features. They use different perspectives, alternative approaches, and creative thinking skills in problem-solving. This shows that age is an effective variable in acquiring scientific process skills and innovative thinking skills.

Ongowo & Indoshi (2013) state that every science teacher aims to support the development of science process skills. These skills enable students to explore critical global issues and their immediate environment. One of the main aims of science education is to develop scientific thinking and research skills. Scientific process skills are generally considered an approach that should be applied in the laboratory, so it is a laboratory approach (Çepni, Ayas, Johnson & Turgut, 1997). A "learning to learn" activity determines how learning is shaped by using scientific process skills, critical thinking, and creative knowledge (Rauf, Rasul, Mansor, Othman & Lyndon, 2013). Scientific process thinking skills can be expressed as creative and critical thinking models. They connect thought planes and generate ideas that will be tested later using the "if/and/then" reasoning model. Data suggests that such thinking skills develop in familiar and observable contexts before being used in less familiar and unobservable contexts (Lawson, 2001).

5. CONCLUSION

The results obtained from the qualitative and quantitative findings of the research are given below. It has been observed that there is a significant difference in favor of the post-test between the mean scores of the science process skills test applied before and after application to determine the development of students' scientific process skills. The research results showed that activities were effective in developing scientific process skills. After the activities and the digital stories were created, it was determined that the students used their estimation, observation, and classification skills and made inferences. Applied digital activities carried out during the action research process contributed to students' scientific process skills. It was determined that students' scientific thinking skills increased during experiments and activities.

When the results obtained from the qualitative and quantitative findings regarding the development of innovative thinking skills of the research students are examined, it is observed that there is no significant difference. Still, it increases in favor of the post-test. Therefore, it can be said that the activities carried out throughout the process effectively develop students' innovative thinking skills. As a result, when the study's findings are examined, it is seen that there is a significant difference in the development of scientific process skills, and it can be said that this study contributed to the student's scientific thinking skills. In the activities carried out in the action plans, it was observed that the students used some features of scientific thinking and innovative thinking skills. However, after these activities, the students were asked to perform a different activity, and they were provided to create a digital story. In these stories, it was seen that the students were able to use the features related to their thinking skills together. Therefore, learning the students' thinking skills and applying them in the activities enabled them to become a habit. In other words, there has been permanence in learning. Therefore, it can be said that a study can be a source for similar studies.

In future studies, activities can be carried out for students to develop their thinking skills to increase the level of innovative and scientific process thinking. Considering the renewed curricula, students can be offered different teaching methods and techniques. Furthermore, it can be ensured that laboratories are used as extracurricular activities in schools so that students can apply their innovative ideas.

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