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The Effect of Technology Integration in Education on Prospective Teachers' Critical and Creative Thinking, Multidimensional 21st Century Skills and Academic Achievements

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In this study, it was aimed to examine the critical and creative thinking, multidimensional 21st century skills and the change in academic achievements as a result of technology integration of prospective teachers who have science education in pedagogy fields. Research was carried out in Turkey's western Black Sea region in a state university. 144 prospective teachers, who were educated in the faculty of education and who were in science, classroom and pre-school education departments, participated in the research. The research was carried out in 3 stages. In the first stage, technology integration is not provided. In the second stage, basic and medium level technology integration is provided. In the third stage, advanced technology integration is provided. Quantitative and qualitative approaches were used together in the research. Academic success test, critical and creative thinking test developed by the researcher as a means of quantitative data collection, and three different scales with validity and reliability were used previously. In addition, project, exam, homework, presentation and group work scores are included in the process. Semi-structured interview, observation and field notes, document review, were used as qualitative data collection tools. The quantitative data obtained were subjected to descriptive and inferential statistics. While doing these operations, SPSS 23.0 and LISREL 9.2 package programs were used. Qualitative data were subjected to descriptive analysis and content analysis. The results of the research show that gradual integration of technology into the education process provides a positive change in prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievements.

1. Introduction

People are continually developing and changing. Accordingly, science and technology are progressing at an unbelievable speed. Especially in the 21st century, when we are at the

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beginning of technology development, we can see this. Many things that we could not even dream of have happened now, and they are happening rapidly. Changes in technology can cause people to experience both hope (digital convenience, access to all kinds of information, solution-oriented technological applications, medical developments) and worrying situations (technology addiction, internet abuse, virtual fraud) (Gunuc, 2017). This situation requires technology to be managed systematically and to be included in individuals' life processes in a planned and programmed way (Thomas & Brown, 2016). States made the most investment to people in all periods they existed. It made this investment through education systems (Durnali & Ayyildiz, 2019). The education system may differ from country to country. However, their goals are shared: "Qualified staff and well-educated individuals". At this point, technological changes play a significant role (Palak & Walls, 2009; Yilmaz & Aydin, 2019).

Today, the use of technology has become a necessity, not a privilege. Because technology is included in every area of our life, mobile phones, cars, apps, computers, smart homes, and many things we cannot here count constitute the abundance of examples. According to the "We Are Social - Digital 2020 April Global Statshot" report, 59% (4.54 billion) of the world population is internet users, 49% (3.80 billion) are social media users, and 67% (5.19 billion) are mobile users (Kemp, 2020). This shows how vital technology is in human life. Another area in which technology takes place is the education system. The education system is open to all kinds of changes in the society. Because the task of the education system is to prepare the individual for society and real-life (Ozan, 2013; Robin, 2008). Technology makes many direct and indirect contributions to the education system. Online learning, simulation environments, virtual laboratories, access to scientific information, instant access to technological developments, online learning applications and many other situations are solely some of these (Brito, Dias & Oliveira, 2018). The inclusion of science and technological developments in the educational process causes the emergence of several new skills and concepts. "Technology literacy, computer literacy, 21st century learners, internet generation, technological native, digital native" can be given as examples (Gunuc, 2017, p.2). In addition, these behaviours, expressed as 21st century skills, are expressed by NEA please provide the full form (2008) as follows (Tuzel-Iseri, 2018):

- Learning and innovation skills (creativity and innovation, critical thinking, critical thinking and problem solving, communication and collaboration)
- Information, media and technology skills (information literacy, technology literacy)
- Life and career skills (flexibility and compatibility, entrepreneurship, leadership and responsibility).

As can be seen, technological developments also change the expectations of educators. In addition to being academically successful, students are also expected to acquire many alternative skills (Trilling & Fadel, 2009). Because teacher-centred traditional education is replaced by student-centred education. Students are now as close to technology as a smartphone. They can instantly access the information they want with their mobile phones. Software, coding and digital applications have become an indispensable component of our daily life and education process (Area & Ribeiro, 2012; Yilmaz, Gulgun, Cetinkaya & Doganay, 2018). In the educational process, many branches of science come into play while preparing students for life. Mathematics education, social studies education, Turkish education and science education are some of them. However, the place of science education in science branches is slightly different. Because science plays a significant role in students' getting to know and make sense of the environment they live in (Jorde & Dillon, 2012). Science can be divided into sub-branches such as physics, chemistry and biology.

This branch of science is significant for students to acquire scientific process skills, gain systematic working habits, find solutions to problems encountered in daily life, analytical, critical, reflective and creative thinking, and especially gain the so-called 21st century skills (Lombardo, 2010). In addition, it is another essential feature to provide easy integration of technology and to have alternatives for adapting course content to technology. In the 21st century, knowledge is learned in a pile. Now, only information learned in schools is not enough for students. Therefore, continuous research, analysis, learning and teaching situations are essential parts of development (Lai & Viering, 2012). In this context, education types should be revised, and education should adopt various uses of technology. In our country, education types are divided into two as formal education and non-formal education. Formal education is education planned and programmed in schools. Non-formal education is the type of education carried out to meet the educational needs of individuals who cannot continue their formal education for any reason (Demirel; 2004; Sahin, 2015). However, education is not always carried out in schools. Natural disasters, global crises, wars, international conflicts and epidemics can prevent education from being fulfilled (Burgess & Sievertsen, 2020). One of the prominent factors within the scope of this research is the recent Covid-19 pandemic. Currently, there is a global virus epidemic known as Covid-19 in our world. This epidemic, which first emerged in China in December 2019, has spread to a large part of the world (Ozer, 2020). As of May 1, 2020, can be updated it is estimated that it infected approximately 4 million people and caused the death of 280 thousand people. All countries take precautions in the fight against this virus epidemic (OECD, 2020). Alternative education types, called "Emergency Remote Education", which enable the education process to continue using the technology infrastructure, play an essential role in this process. In the Emergency Remote Education process, technological infrastructures are strengthened and regulated by the education system (UNESCO, 2020).

In the literature, it is seen that many studies have been carried out for distance education and technology integration. When these studies are examined; technological pedagogical content knowledge (Angeli & Valanides, 2009; Chai, Koh, & Tsai, 2013; Koh, Chai & Tsai, 2010), the integration of technology into higher education (Ashrafzadeh & Sayadian, 2015; Georgina & Olson, 2008; Langenberg & Spicer, 2001), digital learning materials (Kreijns, Van Acker, Vermeulen & Buuren, 2013), technological applications in the educational process (Baek, Jung & Kim, 2008; Perkmen & Tezci, 2011; Pugh, Liu & Wang, 2018), children's internet usage (Shen, Liu & Wang, 2013), obstacles encountered in technology integration (Wachira & Keengwe, 2011), teacher training practices (Teo, 2009), individual education practices (Liu, Wu & Chen, 2013), distance education area knowledge (Anderson & Dron, 2010) and compilation studies for distance education (Zawacki-Richter, 2009) are amongst the studies found in the relevant literature. The work done so far included technology integration and distance education. However, today a new process has started due to the pandemic. This process is called the emergency remote education/learning process. In this process, some necessary measures are taken and a global effort is made. These studies concentrate on emergency remote education; adapting guided inquiry learning (Howley, 2020), priorities for mobile learning (Hall, et. al, 2020; Yuksel, Cetin & Berikan, 2019), rich dialogic interactions (Jung & Brady, 2020), perspectives on educational equity (Aguliera & Nightengale-Lee, 2020), a pedagogical toolkit to emergency remote education (Flynn, 2020), perspectives of technology education during COVID-19 (Code, Ralph & Forde, 2020), self-regulated learning environments: strategies for remote learning (Carter, Rice, Yang & Jackson, 2020), Covid-19 challenges and opportunities for teacher education (Kalloo, Mitchell & Kamalodeen, 2020), adapting quickly to emergency remote instruction (Kaiper-Marquez et al., 2020), China's education response to COVID-19 (Xue, Li, Li & Shang, 2020), construction and operation

method of remote class environment (Murata & Fujimoto, 2020), digital network education in times of pandemic (Moreira, Henriques & Barros, 2020), technology integration to distance learning (Peterson, Scharber, Thuesen & Baskin, 2020) issues have been discussed and analyzed. These studies mainly adopted the issues of moving education systems to a new platform, avoiding disruptions in distance education and taking measures.

These studies conducted during the pandemic process show that each individual's technology infrastructure and equal opportunity must be the same in the emergency remote education process. However, this is not the case in many countries around the world. Some students do not have technological infrastructure (computer, tablet). Some of them cannot even access the internet. Sometimes faculty members cannot adequately include technology in their courses. These situations led to a different perspective to the event. There appears a question in this regard: *If technology integration is included in the teaching process step by step, what will be the result?* Studies in which technology integration is included in the teaching process step by step have been examined in light of the literature. However, there are not many studies where technology integration is gradually included in the education system. From this point of view, it is thought that it would be appropriate to conduct a study in which technology integration is gradually included in the education process and thus it will contribute to the relevant field of science.

1.1. Theoretical Framework and Technology Integration Models

"Engagement and Technology Integration Theory" developed by Gunuc (2017, p.22) was used within the scope of the research. In this theory, technology integration is discussed at the micro level. In-class and out-of-class teaching and learning activities have been designed. The basis of this theory is not only the teacher. Both the teacher and the student are at the center. The basic idea of the theory is to explain that student engagement and technology integration are related to student success and effective learning.

Gunuc (2017, p.22) expresses student engagement as follows: "Student engagement is the quality and quantity of the student's psychological, cognitive, affective, behavioural responses and energies to participate in the learning process, academic and social activities inside/outside the classroom to achieve successful learning outcomes." Figure 1 shows the Engagement and Technology Integration Theory.

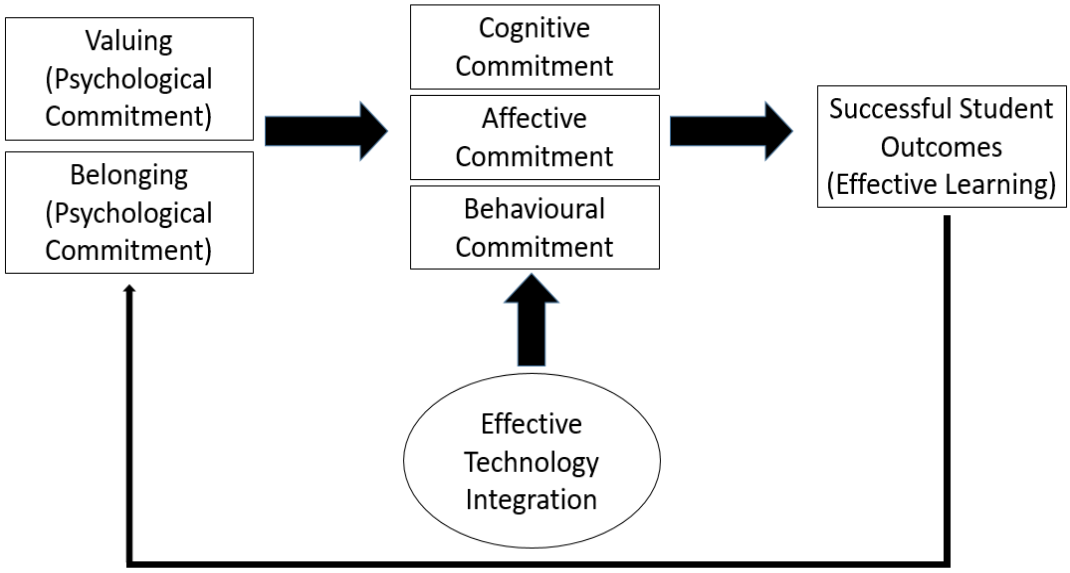


Figure 1. Engagement and Technology Integration Theory (Gunuc, 2017, p.23)

When Figure 1 is examined, first of all, it is necessary to emphasize the feelings of value and belonging of students. After these steps are fulfilled, activities should be done in order to create cognitive, affective and behavioral commitment. These should be accomplished by providing practical technology integration. As a result, feelings of commitment will be combined with technology integration, and effective learning outcomes will be created. This process can be used continuously in educational environments as a cycle.

During the research process, two different models were used. "Technology Integration Planning Model" which was developed by Robyler (2006) and consists of six stages was used first. The purpose of this model is to provide teachers with a general planning approach in the process of integrating technology into their lessons. In this model, which has six different stages, all stages are followed, and teachers are guided step by step like a guide. In other words, teachers are presented with an extensive planning map. The second model is "Pedagogy, Social Interaction and Technology Generic Model" developed by Wang (2008). The purpose of this model is to guide teachers again and to provide the skills to plan and use pedagogy, social interaction and technology components together.

1.2. Purpose of the Research

In this study, it was aimed to investigate the effect of "Technology Integration in Education on Prospective Teachers (with science education in the field of Pedagogy) on Critical and Creative Thinking, Multidimensional 21st Century Skills and Academic Achievements".

1.3. Problem Statement and Subproblems

Within the scope of the research, the main problem seeks the answer to the question: "What is the Effect of Technology Integration in instruction (gradually) on Critical and Creative Thinking, Multidimensional 21st Century Skills and Academic Achievement of Prospective Teachers (who have science education in the field of Pedagogy)?" Within the framework of the fundamental problem situation, answers were sought for the following sub-problem situations:

(1) How does the instruction without technology integration affect the prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievements?
(2) How does the instruction provided by providing basic and intermediate level technology integration affect the prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievements?
(3) What are the effects of the instructions provided by advanced technology integration on prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievements?
(4) How do the different approaches applied at each stage affect the prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievements?
(5) What are the opinions of the prospective teachers regarding the application scales and sub-dimensions?

2. Methodology

2.1. The Research Model

In the research process, quantitative and qualitative research approaches were used together. The research model was created by using descriptive sequential pattern from mixed-method research. In descriptive sequential pattern applications, the process begins with quantitative applications first. Then quantitative applications are analyzed, and the results are reported (Creswell, 2014; Sozbilir, 2017). However, quantitative application results provide limited information about the overall results of the study by providing statistical significance, confidence interval and effect dimensions. This situation is not sufficient for how the results are formed and for establishing cause-effect relationships. In the second stage, qualitative practices come into play. With qualitative application results, problem situations are subjected to a more in-depth examination, and the results are interpreted (Goktas, 2017).

In the quantitative stage of the application, pretest - posttest semi-experimental pattern and survey method were used together. The study was designed in a semi-experimental design in general, and sub-applications (use of scale) were used from time to time. Technology integration has been implemented in 3 different stages. In the first stage, applications were made only by considering science education without technology integration. In the second stage, technology integration is included in the basic and intermediate level processes, and applications are realized. In the third stage, technology integration is included in the advanced process and applications are completed using fully emergency remote education procedures. In the qualitative phase of the application, a case study was used. In this context, the descriptive case study was preferred. Because descriptive case study is a frequently preferred method in cases where complex and cause-effect relationships need to be established. During the research, both superficial and in-depth information can be collected (Guclu, 2019).

2.2. The Study Group

In his research 144 teachers studying at a state university located in Turkey's western Black Sea region, participated. While determining the study group, criterion sampling was chosen from non-probabilistic sampling methods in order to increase the effect factor and reflective level of the application (Buyukozturk, Kilic-Cakmak, Akgun, Karadeniz & Demirel, 2016). As a determination criterion, departments with science education were chosen within the fields of pedagogy. In this context, prospective teachers who are studying in early childhood, science and classroom teaching departments are preferred. Both experimental and control groups were formed at all stages of the application.

Experimental and control groups are divided into three subgroups. Each subgroup consists of 8 prospective teachers. Prospective teachers who are early childhood, science and classroom teachers are both in the experimental group and the control group. During the research, prospective teachers were coded as Experiment 1 and Control 1 for science knowledge, Experiment 2 and Control 2 for classroom teaching, Experiment 3 and Control 3 for early childhood. Also, after all, quantitative applications, semi-structured interviews were made with two people from each group. Regardless of these sample groups, sampling was done using the appropriate sampling method in the validity and reliability analysis of the data collection tools to be used. However, the characteristics of prospective teachers participating in pilot applications are not included. The demographic characteristics of prospective teachers participating in the application are shown in Table 1.

Table 1. Demographic characteristics of prospective teachers participating in the application

Departments	Gender	f	%
Science Education	Female	28	19.45
	Male	20	13.89
Early Childhood Education	Female	34	23.62
	Male	14	9.75
Classroom Education	Female	29	20.15
	Male	19	13.14
Total		144	100

2.3. Data Collection Tools

Qualitative and quantitative data collection tools were used together in the research process. Therefore, the data collection tools used are specified separately. In the quantitative data collection phase, five different tools were used. Two of these data collection tools were developed by the researcher. The first data collection tool is "Academic Achievement Test-AAT" with 25 items, and the second data collection tool is "Critical and Creative Thinking Test-CCTT" with 25 items. Other data collection tools are, "Critical Thinking Standards Scale for the Teacher Candidates-CTSCTC", which was developed by Aybek, Aslan, Dincer & Coskun-Arisoy (2015), consisting of 3 factors and 41 items, "Multidimensional 21th Century Skills Scale-MSS" consisting of 5 factors and 41 items developed by Cevik & Senturk (2019) and "Student's Perception Scale About Instructors Technology Integration Competence-SPSITIC", consisting of 2 factors and 25 items developed by Artun & Gunuc (2016). For all data collection tools, necessary permissions were obtained from the relevant authors via e-mail. This situation is clearly stated in the ethical statement section. In addition, validity and reliability analyses were carried out at all stages by making pilot applications. The original of all scales was developed in the Turkish language. For this reason, it is recommended to use Turkish forms in applications.

At the qualitative data collection stage, firstly, two prospective teachers from each group were determined (the average score was the lowest and the average score was the highest). A semi-structured interview with three pre-determined prospective teachers and developed by the researcher was held at each stage. Then, during the applications, observations were made by the researcher, and field notes were taken. In addition to these practices, the assignments and projects prepared by prospective teachers as a result of the applications and exam grades were examined through document analysis. In the evaluation process of qualitative data, both teacher-oriented evaluation and peer evaluation were made. Validity and reliability information of data collection tools are presented in detail later in the article.

2.4. Application Process and Data Collection

In the research process, qualitative and quantitative applications were discussed separately. In Figure 2, the application process and the procedures performed at each stage are shown in detail.

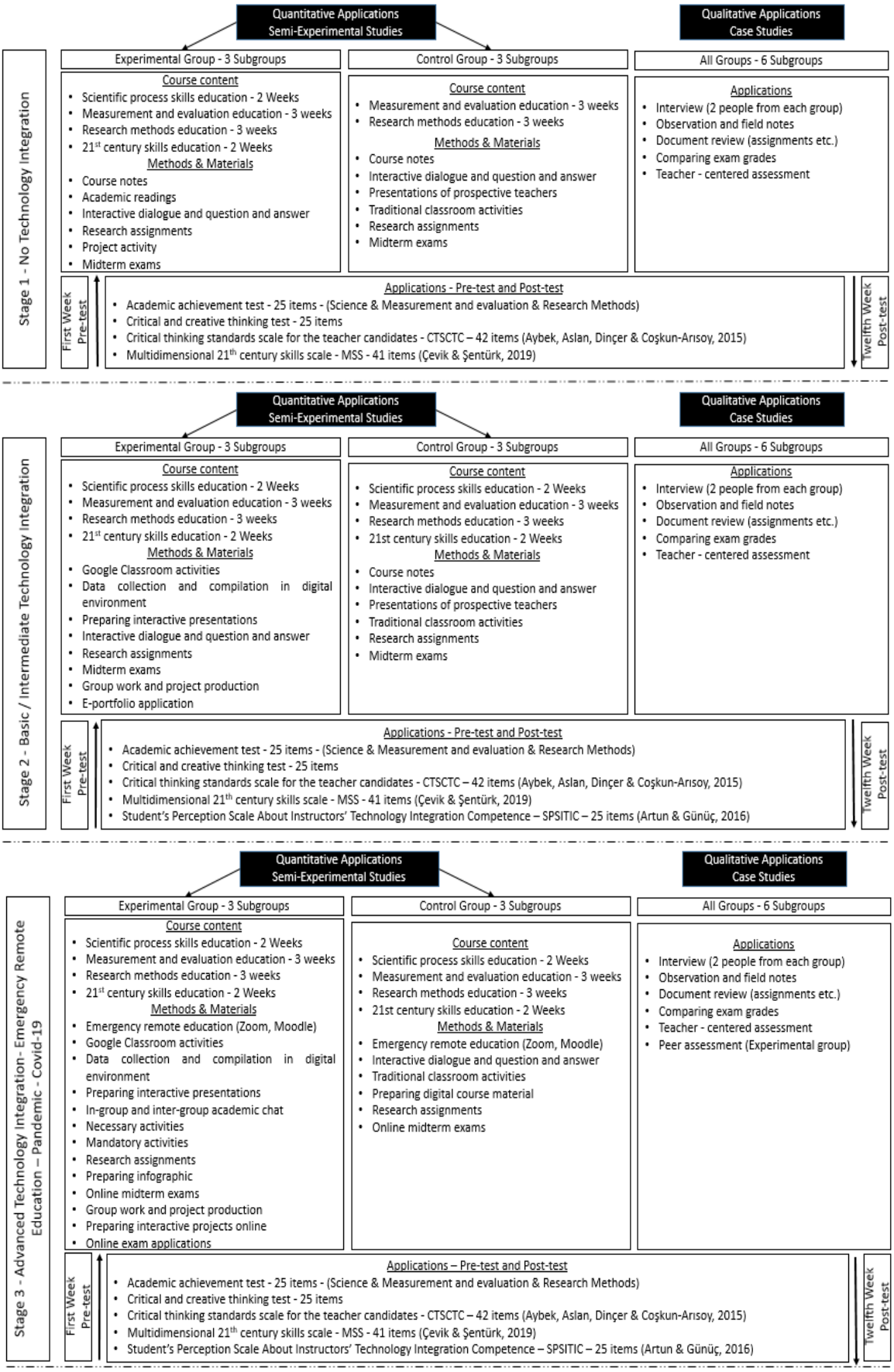


Figure 2. Application process and procedures

The research process consists of 3 stages in total. Quantitative and qualitative applications were carried out at each stage separately. However, some of the qualitative applications (observation, field notes and document review) were carried out in coordination with the quantitative applications. Quantitative applications have always been applied first, and then qualitative applications have been made. Each stage lasted 12 weeks. During the study, applications were made without technology integration. In the second stage, technology integration has been provided at basic and intermediate levels. In the third stage, advanced technology integration was provided.

All applications are structured considering the science course. While making quantitative applications, data collection tools were applied as a pre-test in the first week and as post-test in the 12th week. The data for the 1st stage were collected in the spring semester of the 2018-2019 academic year. Data for the 2nd stage were collected in the fall semester of the 2019-2020 academic year. Data for the 3rd stage were collected in the spring semester of 2019-2020 academic year and during the emergency remote education (pandemic). The faculty member factor, another component of technology integration, was also taken into account in the research. For this purpose, a data collection tool that measures the instructor's usage skills is also included in the process.

Different procedures were carried out for the experimental and control groups in all applications performed during the research. Traditional teaching methods were used for prospective teachers in the control group at all stages, and technology integration was carried out only at stage 3 (mandatory). However, the technology integration realized at this stage is presented in a similar way to traditional teaching. Technology integration was presented to the prospective teachers in the experimental group gradually, and the changes in this group were examined in detail. Detailed information regarding the applications made in Table 2 is given.

Table 2. Detailed information table for applications

		Quantitative Applications		**Qualitative Applications**	
Stage 1 - No Technology Integration		**Application Groups**		**Interview**	**Observation and field notes**
	Pre-Test & Post-Test	**Experiment 1, Experiment 2, Experiment 3**	**Control 1, Control 2, Control 3**	- Conductedwith two people from each group. - It was carried out on the 12th week.	- All groups are observed every week. - Field notes were taken regularly.
		Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS	Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS		
	Applications	Course notes of the researcher are given. For academic readings, articles etc. documents have been distributed. The course process was conducted in the form of interactive dialogue and question-answer. They were asked to do their research assignments without digital resources. They were asked to produce a project that could be used in science education.	Course notes of the researcher are given. The course process was conducted in the form of interactive dialogue and question-answer. Prospective teachers gave presentations without using digital materials. They were asked to do their research assignments without digital resources. Midterm exams were held.	**Evaluation Procedures** - Examining and scoring of research assignments. - Examining and scoring of the projects produced. - Examining and scoring midterm exams. - Examining and scoring presentations. - Examining of observation and field notes, transcript and analysis of interviews.	
Stage 2 - Basic / Intermediate Technology Integration		**Application Groups**		**Interview**	**Observation and field notes**
	Pre-Test & Post-Test	**Experiment 1, Experiment 2, Experiment 3**	**Control 1, Control 2, Control 3**	- Made with two people from each group. - It was carried out on the 12th week.	- All groups are observed every week. - Field notes were taken regularly.
		Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS Scale 3 - SPSITIC	Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS Scale 3 - SPSITIC		
	Applications	Google Classroom activities Data collection and compilation in the digital environment Group work and project production Preparing interactive presentations E-portfolio application	Course notes of the researcher are given. The course process was conducted in the form of interactive dialogue and question-answer. Prospective teachers gave presentations without using digital materials. They were asked to do their research assignments without digital resources. Midterm exams were held.	**Evaluation Procedures** - Examining and scoring of research assignments. - Examining and scoring of the projects produced. - Examining and scoring midterm exams. - Examining and scoring presentations. - Examining of observation and field notes, transcript and analysis of interviews. - Examining and scoring of e-portfolio files	

Continuation of Table 2

Stage 3 - Advanced Technology Integration – Emergency Remote Education – Pandemic - Covid-19		**Application Groups**		**Interview**	**Observation and field notes**
	Pre Test & Post-Test	**Experiment 1, Experiment 2, Experiment 3** Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS Scale 3 - SPSITIC	**Control 1, Control 2, Control 3** Academic achievement test Critical and creative thinking test Scale 1 - CTSCTC Scale 2 - MSS Scale 3 - SPSITIC	- Conducted with two people from each group. - It was carried out on the 12th week.	- All groups are observed every week. - Field notes were taken regularly.
	Applications	**Experiment 1 - Early Childhood Edu.** Online emergency remote education (Zoom) Assignment, presentation preparation and online midterm exam applications in the digital environment Group work and online project production Google Classroom activities **Experiment 2 – Classroom Education** Online emergency remote education (Zoom) Assignment, presentation preparation and online midterm exam applications in the digital environment Group work and online project production Google Classroom activities Necessary activities (problem-solving applications, Quizizz, Testmoz, Kubbu, word matching, Learningapps, Mentimeter. **Experiment 3 – Science Education** Online emergency remote education (Zoom) Assignment, presentation preparation and online midterm exam applications in the digital environment Group work and online project production Google Classroom activities Mandatory activities (problem-solving practices, Quizizz, Testmoz, Kubbu, word matching, Learningapps, Mentimeter) Preparing infographic Establishment of Whatsapp groups and constant communication in problem-solving (with researcher participation)	**Control 1, Control 2, Control 3** - Online emergency remote education (Zoom/Moodle etc.) - Course notes of the researcher are given. - The course process was conducted in the form of interactive dialogue and question-answer. - Prospective teachers were asked to prepare digital course material. - They were asked to do their research assignments in the digital environment. - Online midterm exams were held.	**Evaluation Procedures** - Examining and scoring of research assignments. - Examining and scoring of the projects produced. - Examining and scoring midterm exams. - Examining and scoring presentations. - Examining and scoring digital course materials. - Examining and scoring of infographics. - Examining of observation and field notes, transcript and analysis of interviews. - Peer assessment (Experimental group) - Analysis of necessary activities. - Analysis of mandatory activities. - Analysis of conversations in Whatsapp groups. - Determining rates of participation in emergency remote education.	

2.5. Data Analysis, Validity and Reliability Applications

While analyzing the data, as in all stages, quantitative and qualitative findings were analyzed separately. Quantitative data has been subjected to descriptive and inferential statistics. While doing these operations, SPSS 23.0 and LISREL 9.2 package programs were used. Qualitative data were subjected to descriptive analysis and content analysis. The results obtained are presented in the findings section with the help of tables and figures. In this study, which aims to determine the effects of technology integration in education, three successive and supportive practices were implemented. These applications were mainly carried out using quantitative approaches. Although there are differences between the applications, it includes similar processes in terms of analysis, validity and reliability (Yilmaz & Yanarates, 2020). Reliability and validity applications are discussed separately.

2.5.1. Reliability Applications

Within the scope of the application, reliability measures were taken considering the quantitative and qualitative data. During quantitative applications, five different data collection tools were used together. Of these, the academic achievement test and the critical and creative thinking test were developed by the researcher. At this stage, firstly, the literature review was done, and a draft item pool was created by using the indicator table. Then, expert opinion was taken from 10 different academicians who worked as science specialists in science education by using Lawshe (1975) technique. As a result of expert opinions, the draft pool of articles was revised, and a pilot application was made (McMillan & Schumacher, 2009).

Item difficulty, item discrimination, 27% subgroup and upper group mean values and Cronbach Alpha coefficients were determined after the pilot and final application. Finally, both data collection tools were given their latest form, and final applications were made. The other three scales used in the quantitative data collection phase are the previously valid and reliable scales. However, in order to be compatible with the application sample, all scales were piloted, and internal consistency Cronbach Alpha values and 27% subgroup and upper group averages were calculated (Fraenkel, Wallen & Hyun, 2011).

In the qualitative data collection phase, semi-structured interview and observation were used. Opinions of the field experts were received during the preparation of the interview questions. As a result of the pilot implementation, some of the interview questions were rearranged (in terms of language and content) and finalized. Then, participant selection criteria were created, and a systematic selection was made. Transcripts recorded as a result of the interviews were subjected to content analysis. At this stage, transactions were carried out by adhering to the criteria of content analysis (Yilmaz & Yanarates, 2020).

Before starting the coding and sorting process, several preliminary preparations were made in order to perform high-quality coding. These preparations can be expressed as creating coding guide, giving detailed training to coders, pretesting and improving management procedures in order to check the applicability of the coding system and whether it is working (Krippendorff, 2004; Ozkan, 2019). Analyzer triangulation was used for coding and extracting the obtained interviews. With this application, it is aimed to prevent the occurrence of similar and controversial situations while coding. In addition, the consensus and divergence levels of three different encoders were calculated with the help of the formula determined by Miles & Huberman (1994), and this rate was determined as 92%. Because of the consensus levels of the coders are in ideal ranges, the Cohen Kappa Coefficient was finally determined, and the coordination and interoperability ratio was determined as .84. All statistical results calculated in this context are presented in Table 3.

Table 3. Results for reliability applications

AAT	Item Difficulty	Item Discrimination	27% Lower Group-Upper Group Average			Cronbach Alpha		
			r	t	p	Stage 1	Stage 2	Stage 3
	Between .30-.60	Between .40-.70	.685	8.142	.002	.91	.88	.90
CCTT	Between .24-.57	Between .50-.80	.543	6.754	.000	.86	.82	.89

Stage 1 - No Technology Integration

Scale 1 CTSCTC	Cronbach Alpha Total = .83												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3						P.A.			F.A				
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A				r	t	p	r	t	p		
	.89	.85	.87	.78	.76	.74	.63	.69	.77				.426	4.863	.001	.742	7.364	.000		
Scale 2 MSS	Cronbach Alpha Total = .88												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3			Factor 4			Factor 5			P.A.			F.A		
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	r	t	p	r	t	p
	.84	.86	.89	.79	.82	.85	.76	.87	.88	.73	.70	.74	.75	.71	.73	.523	6.421	.000	.473	5.021	.001

Stage 2 - Basic / Intermediate Technology Integration

Scale 1 CTSCTC	Cronbach Alpha Total = .87												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3						P.A.			F.A				
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A				r	t	p	r	t	p		
	.89	.92	.89	.78	.82	.85	.63	.84	.79				.630	7.753	.000	.325	5.512	.000		
Scale 2 MSS	Cronbach Alpha Total = .90												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3			Factor 4			Factor 5			P.A.			F.A		
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	r	t	p	r	t	p
	.84	.82	.83	.79	.77	.78	.76	.80	.82	.73	.75	.76	.75	.80	.77	.541	6.452	.002	.412	6.854	.003
Scale 3 SPSITIC	Cronbach Alpha Total = .84												27% Lower Group-Upper Group Average							
	Factor 1						Factor 2						P.A.			F.A				
	O.S		P.A		F.A		O.S		P.A		F.A		r	t	p	r	t	p		
	.90		.88		.92		.90		.87		.91		.354	4.129	.001	.436	6.742	.000		

Stage 3 - Advanced Technology Integration – Emergency Remote Education – Pandemic - Covid-19

Scale 1 CTSCTC	Cronbach Alpha Total = .89												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3						P.A.			F.A				
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A				r	t	p	r	t	p		
	.89	.93	.91	.78	.84	.87	.63	.85	.88				.465	5.742	.001	.443	.6.012	.003		
Scale 2 MSS	Cronbach Alpha Total = .92												27% Lower Group-Upper Group Average							
	Factor 1			Factor 2			Factor 3			Factor 4			Factor 5			P.A.			F.A		
	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	O.S	P.A	F.A	r	t	p	r	t	p
	.84	.85	.88	.79	.89	.85	.76	.80	.84	.73	.79	.83	.75	.78	.86	.325	.4.495	.000	.493	5.982	.000
Scale 3 SPSITIC	Cronbach Alpha Total = .95												27% Lower Group-Upper Group Average							
	Factor 1						Factor 2						P.A.			F.A				
	O.S		P.A		F.A		O.S		P.A		F.A		r	t	p	r	t	p		
	.90		.86		.92		.90		.85		.93		.523	7.823	.001	.506	8.452	.000		

p<.05 Correlation .05 Signifiance level O.S= Original scale, P.A= Pilot Application, F.A= Final Application.

In addition to these studies within the scope of reliability measures, other measures mentioned in the relevant literature and included in this application are as follows (Batdi, 2019; Flick, 2009; Patton, 2014; Yilmaz & Yanarates, 2020):

(1) First of all, clear, simple and detailed information was provided at each stage.
(2) As it is mainly a quantitative study, triangulation has been made with qualitative applications. The subject has been deeply studied with multiple applications and data collection tools.
(3) In the context of credibility and transferability, direct quotations were made from time to time. By providing examples over raw data, the reliability of the study was increased.
(4) Due to the use of content analysis in the analysis of qualitative data analysis units, codes to be used (preparation of coding guide, pilot application, training of coders), categories, data processing and interpretation steps are also included in the process.
(5) Other measures included in the process involve the choice of well-known research methods, continuous observation, long-term and systematic reviews, detailed presentation of information, implementation of audit trail (detailed description of the data collection and data analysis process), and comparison with findings in the literature.

2.5.2. Validity Applications

Validity measures were taken in the research considering the quantitative and qualitative data. Validity applications, as in reliability applications, require standard processes for some applications and different processes for some applications. Firstly, the content and appearance validity of the academic achievement test, critical and creative thinking test and interview questions were examined (Mor-Dirlik, 2020). Lawshe (1975) technique, which is a statistical application, was used for content and appearance validity. Content validity rates and content validity indices were calculated for each question individually. Confirmatory factor analyzes (CFA) were then performed to ensure structure validity.

CFA analyses were performed for all quantitative data collection tools. LISREL software was used while performing these operations. Despite its validity in the literature, confirmatory factor analyses were carried out both before and after the final implementation in order to determine the status of the scales serving the purpose and to support the construct validity (Ozdamar, 2002; Mor-Dirlik, 2014). In addition, convergent validity and combined reliability values were calculated as a result of these analyzes. Results for the analyzes are presented in Table 4. In addition to these studies carried out within the scope of validity measures, the other measures mentioned in the relevant literature and included in this application are as follows (Batdi, 2019; Ozkan, 2019):

(6) In order to ensure descriptive and interpretive validity, the data in the research process are presented randomly, objectively and without exaggeration.
(7) In order to provide theoretical/internal validity, necessary care has been taken to eschew overlap of the concepts and categories created by the researcher with the results achieved and to support the different practices used.
(8) Comparison of research data on generalizable/external validity and findings in the related literature has been made, results obtained are generalizable, and they are expressed consistently.

Attention has been paid to ensure criterion validity in the process of determining the prospective teachers to be interviewed, cross-referencing during the examination of qualitative data and creating the coding guide during the coding phase and attention has been paid to each stage in this regard.

Table 4. Results for validity applications

Applications	Data Collection Tools	Stages	X^2/Df	RMSEA	NFI	CFI	GFI	RMR	P	AVE	CR
Pilot Application	AAT	Stage 1	3.45	.07	.86	.89	.81	.09	.000	.64	.82
		Stage 2	2.96	.05	.90	.92	.84	.07	.000	.69	.86
		Stage 3	2.65	.04	.93	.94	.86	.07	.000	.75	.90
	CCTT	Stage 1	3.96	.09	.88	.90	.84	.10	.000	.71	.76
		Stage 2	3.42	.06	.91	.91	.85	.09	.000	.74	.82
		Stage 3	2.89	.05	.93	.94	.88	.07	.000	.81	.88
	Scale 1 CTSCTC	Original	3.81	.08	.90	.92	.85	.06	.000	-	-
		Stage 1	4.26	.13	.86	.89	.80	.11	.000	.65	.79
		Stage 2	3.89	.10	.88	.90	.79	.08	.000	.73	.85
		Stage 3	3.92	.08	.90	.90	.84	.08	.000	.77	.87
	Scale 2 MSS	Original	2.60	.05	.91	.95	.90	.05	.000	-	-
		Stage 1	3.86	.09	.88	.92	.86	.09	.000	.72	.83
		Stage 2	3.26	.08	.90	.92	.84	.08	.000	.75	.90
		Stage 3	2.94	.06	.90	.94	.89	.06	.000	.81	.92
	Scale 3 SPSITIC	Original	2.00	.07	.94	.97	.80	.07	.000	-	-
		Stage 2	3.01	.10	.92	.93	.76	.11	.000	.66	.90
		Stage 3	2.75	.08	.91	.94	.78	.08	.000	.75	.93
Final Application	AAT	Stage 1	3.33	.06	.88	.90	.84	.08	.000	.71	.84
		Stage 2	2.88	.04	.91	.93	.89	.06	.000	.76	.88
		Stage 3	2.47	.04	.94	.96	.92	.05	.000	.86	.93
	CCTT	Stage 1	3.59	.08	.90	.92	.83	.11	.000	.75	.79
		Stage 2	2.86	.06	.94	.95	.88	.07	.000	.79	.85
		Stage 3	2.64	.04	.94	.98	.91	.04	.000	.82	.90
	Scale 1 CTSCTC	Original	3.81	.08	.90	.92	.85	.06	.000	-	-
		Stage 1	4.09	.11	.88	.88	.86	.10	.000	.70	.84
		Stage 2	3.95	.08	.90	.94	.89	.07	.000	.77	.89
		Stage 3	3.88	.08	.90	.92	.88	.07	.000	.83	.91
	Scale 2 MSS	Original	2.60	.05	.91	.95	.90	.05	.000	-	-
		Stage 1	3.07	.09	.90	.90	.90	.12	.000	.78	.86
		Stage 2	2.79	.07	.90	.89	.94	.08	.000	.84	.89
		Stage 3	2.66	.05	.92	.92	.92	.07	.000	.87	.94
	Scale 3 SPSITIC	Original	2.00	.07	.94	.97	.80	.07	.000	-	-
		Stage 2	2.74	.13	.90	.90	.76	.10	.000	.78	.91
		Stage 3	2.41	.08	.91	.93	.82	.07	.000	.84	.94

p<.05 Correlation .05 Signifiance level.

3. Findings

Research findings are handled separately for each problem case. Firstly, the applications made in the first stage were examined. At this stage, technology integration is not included in any process. There are quantitative analyzes made in Table 5.

Table 5. Quantitative findings for the first stage

Tests		D.C.T.	Group	N	$\overline{X}$	Sd	Df	t	p	Sig.
Pre-Test - General	Independent Groups T-Test	AAT	Experiment	24	64.50	7.01	46	1.545	.129	-
			Control	24	61.01	8.60				
		CCTT	Experiment	24	65.52	7.71	46	.951	.346	-
			Control	24	63.33	8.05				
		CTSCTC	Experiment	24	123.16	23.36	46	1.296	.202	-
			Control	24	115.20	18.95				
		MSS	Experiment	24	127.91	22.90	46	1.398	.170	-
			Control	24	118.87	22.01				
Post-Test-General	Independent Groups T-Test	AAT	Experiment	24	77.66	7.45	46	4.005	.000	1>2
			Control	24	69.66	6.34				
		CCTT	Experiment	24	73.01	7.57	46	2.143	.037	1>2
			Control	24	68.16	8.04				
		CTSCTC	Experiment	24	143.45	16.37	46	3.450	.001	1>2
			Control	24	127.01	16.67				
		MSS	Experiment	24	144.63	16.33	46	2.758	.008	1>2
			Control	24	130.16	19.81				
Experimental Group	Dependent Groups T-Test	AAT	Experiment	24	64.50	7.01	23	7.277	.000	4>3
			Control	24	77.66	7.45				
		CCTT	Experiment	24	65.52	7.71	23	6.747	.000	4>3
			Control	24	73.01	7.57				
		CTSCTC	Experiment	24	123.16	23.36	23	3.892	.001	4>3
			Control	24	143.45	16.37				
		MSS	Experiment	24	127.91	22.90	23	4.092	.000	4>3
			Control	24	144.63	16.33				
					Df	Mean Square		F	p	Sig.
Experimental Group	One Factor ANOVA Test	AAT	Between Groups		2	284.66		8.444	.002	S>C
			Within Groups		21	33.71				
		CCTT	Between Groups		2	326.01		10.249	.001	S>C S>E.C
			Within Groups		21	31.81				
		CTSCTC	Between Groups		2	246.54		.913	.417	-
			Within Groups		21	270.04				
		MSS	Between Groups		2	281.62		1.061	.364	-
			Within Groups		21	265.54				

D.C.T= Data Collection Tools, Experiment Group=1, Control Group=2, Pre-test=3, Post-test=4, S=Science, C=Classroom, E.C=Early Childhood

In the first stage of the research, instructions were provided without technology integration. However, changes have been made to the methods and materials used. Materials covering 21st century skills were mainly used in the experimental group. In the analysis process, the pre-test and post-test results of all quantitative data collection tools were examined by independent groups t-test. Accordingly, when the pre-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=1.545, p>.05], CCTT test [$t_{(46)}$=.951, p>.05], CTSCTC scale [$t_{(46)}$=1.296, p>.05] and for the MSS scale [$t_{(46)}$=1.398, p>.05] results were reached and no significant differences were found. This shows that experiment and control groups have similar cognitive characteristics.

When the post-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=4.005, p<.05], CCTT test [$t_{(46)}$=2.143, p<.05], CTSCTC scale [$t_{(46)}$=3.450, p<.05] and for the MSS scale [$t_{(46)}$=2.758, p<.05] results were reached and significant differences were found. Significant differences were found significant for the experimental and control groups. However, significance levels are higher in the experimental group. Therefore, the results of the experimental group were emphasized more. The experimental group is divided into three different subgroups. For this reason, in order to test whether the difference exists between the groups, one factor ANOVA test was performed.

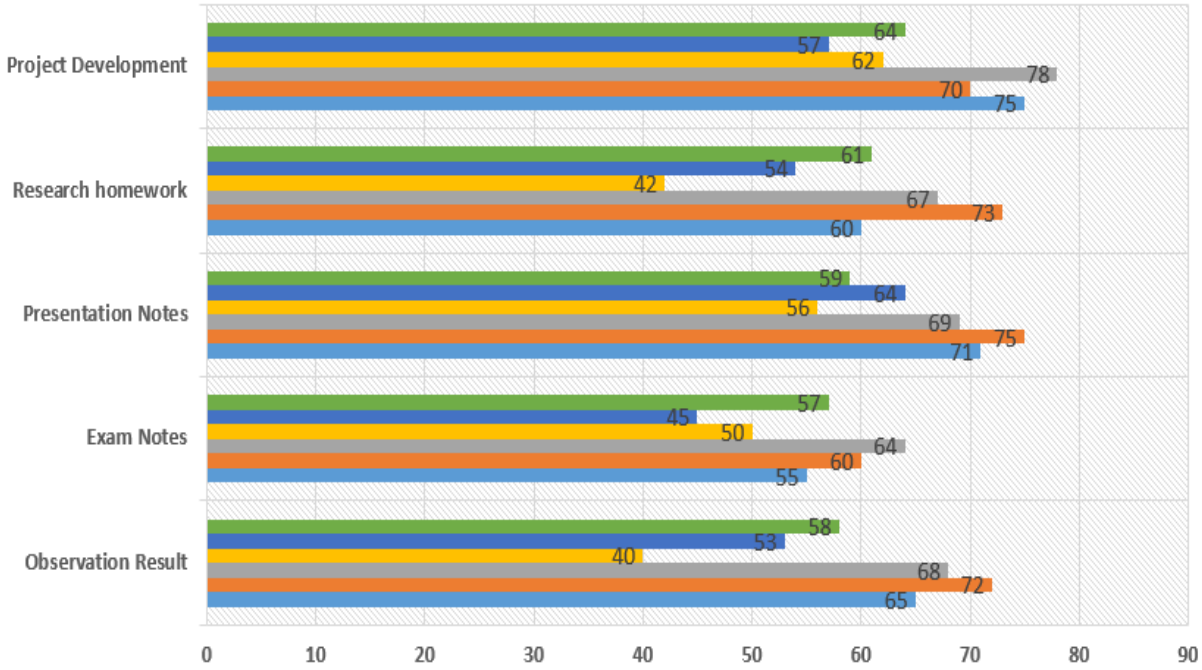
According to this; The results of ABT test; AAT test [$F_{(2-21)}$=8.444, p<.05] ve CCTT test [$F_{(2-21)}$=10.249, p<.05] are significant in favor of prospective teachers studying in science education, CTSCTC scale [$F_{(2-21)}$=.913, p>.05] and for the MSS scale [$F_{(2-21)}$=1.061, p>.05], there were no significant differences between groups. To summarize, each subgroup of the experimental group makes a significant difference with each subgroup of the control group. However, the experimental group differed only for two tests, while similar results were achieved in other tests. Within the scope of the qualitative findings of the research, interviews are presented in the form of themes and codings, observation results as items and exam notes and homework readings are presented in Table 6 and Figure 3.

Table 6. Qualitative findings for the first stage

	Theme	Code	Participants	(f)
Semi-Structured Interview	Can critical and creative thinking be developed without technology integration?	It's very difficult without technology.	E1, E2, E4, E6, C1, C3	6
		Without technology, you cannot be creative.	E3, C2, C4	3
		Technology only makes our job easier.	E5, C5	2
		Sure, but it may take too long.	C6	1
	Can 21st century skills be developed without technology integration?	21st century cannot be technology independent. Because technology is a must.	E1, E2, E3, E4, E6, C2, C4, C5, C6	9
		Technology has compelled new skills.	E5, C1	2
		Skills are not dependent on technology.	C3	1
	Can academic success be improved without technology integration?	Access to scientific information is not possible without technology.	E2, E4, E5, E6, C5	5
		All information is now available on the Internet.	E1, E3, C1, C3, C4	5
		Technology affects success to some extent.	C2	1
		Success is possible with the effort of the individual.	C6	1

	Determinations Regarding the Research Process	Group (f)
Observation and Field Notes	Prospective teachers produce more systematic solutions when they do academic readings.	3
	Scientific process skills education works very effectively in project production.	4
	Scientific projects affect prospective teachers' sense of taking responsibility.	2
	Traditional teaching approach affects the diversity of thoughts of prospective teachers.	3
	Conducting research assignments without using technology challenges prospective teachers.	3
	21st century skill education is very effective in generating alternative thoughts and ideas.	3
	Researching in groups and providing the division of labor are included in the process as a source of motivation.	5
	Traditional applications cannot adequately meet the needs of students.	2
	The quality of projects and assignments cannot go too far without technology.	3

E= Experiment Group, C= Control Group



	Observation Result	Exam Notes	Presentation Notes	Research homework	Project Development
Control 3	58	57	59	61	64
Control 2	53	45	64	54	57
Control 1	40	50	56	42	62
Experiment 3	68	64	69	67	78
Experiment 2	72	60	75	73	70
Experiment 1	65	55	71	60	75

Figure 3. Detailed examination results for the first stage

After the first stage was completed, the second stage was started. At this stage, technology integration is included in the process at a basic and intermediate level. There are quantitative analyzes made in Table 7.

Table 7. Quantitative findings for the second stage

		Experiment Group – Pre-Test							Control Group – Pre-Test						
Tests	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
Independent Groups T-Test	AAT	24	68.33	7.07	46	1.863	.069	-	24	64.50	8.92	46	1.863	.069	-
	CCTT	24	69.83	7.73	46	1.267	.211	-	24	67.01	7.75	46	1.267	.211	-
	CTSCTC	24	128.16	23.18	46	1.049	.301	-	24	121.83	18.36	46	1.049	.301	-
	MSS	24	132.95	22.81	46	1.245	.219	-	24	125.08	20.96	46	1.245	.219	-
	SPSITIC	24	68.62	5.28	46	.341	.735	-	24	68.12	4.85	46	.341	.735	-
		Experiment Group – Post-Test							Control Group – Post-Test						
	AAT	24	75.75	5.63	46	2.291	.027	1>2	24	71.41	7.35	46	2.291	.027	1>2
	CCTT	24	78.25	7.01	46	3.887	.000	1>2	24	70.83	6.18	46	3.887	.000	1>2
	CTSCTC	24	135.20	21.53	46	2.498	.016	1>2	24	122.02	14.39	46	2.498	.016	1>2
	MSS	24	138.92	22.13	46	3.304	.002	1>2	24	129.91	13.05	46	3.304	.002	1>2
	SPSITIC	24	76.21	5.23	46	2.554	.014	1>2	24	72.58	4.57	46	2.554	.014	1>2
		Control Group – Within Groups- Pre-Test – Post-Test													
		Pre-Test							Post-Test						
Tests	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
Dependent Groups T-Test	AAT	24	64.50	8.92	23	3.909	.001	4>3	24	71.41	7.35	23	3.909	.001	4>3
	CCTT	24	67.01	7.75	23	2.014	.056	-	24	70.83	6.18	23	2.014	.056	-
	CTSCTC	24	121.83	18.36	23	.049	.961	-	24	122.02	14.39	23	.049	.961	-
	MSS	24	125.08	20.96	23	1.031	.313	-	24	129.91	13.05	23	1.031	.313	-
	SPSITIC	24	68.12	4.85	23	7.371	.000	4>3	24	72.58	4.57	23	7.371	.000	4>3
		Experiment Group – Within Groups- Pre-Test – Post-Test													
		Pre-Test							Post-Test						
	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
	AAT	24	68.33	7.07	23	13.550	.000	4>3	24	75.75	5.63	23	13.550	.000	4>3
	CCTT	24	69.83	7.73	23	6.437	.000	4>3	24	78.25	7.01	23	6.437	.000	4>3
	CTSCTC	24	128.16	23.18	23	12.881	.000	4>3	24	135.20	21.53	23	12.881	.000	4>3
	MSS	24	132.95	22.81	23	13.796	.000	4>3	24	138.92	22.13	23	13.796	.000	4>3
	SPSITIC	24	68.62	5.28	23	12.864	.000	4>3	24	76.21	5.23	23	12.864	.000	4>3
		Experiment Group – Within Groups - Post-Test													
		Between Groups							Within Groups						
One Factor ANOVA Test	D.C.T	Mean Square		Df	p	F	Sig.		Mean Square		Df	p	F	Sig.	
	AAT	87.50		2	.056	3.308	-		26.45		21	.056	3.308	-	
	CCTT	186.50		2	.015	5.170	S>C, S>E.C.		36.07		21	.015	5.170	S>C, S>E.C.	
	CTSCTC	1723.16		2	.017	5.015	S>C		343.60		21	.017	5.015	S>C	
	MSS	584.29		2	.317	1.214	-		481.10		21	.317	1.214	-	
	SPSITIC	111.79		2	.010	5.777	S>E.C.		19.35		21	.010	5.777	S>E.C.	

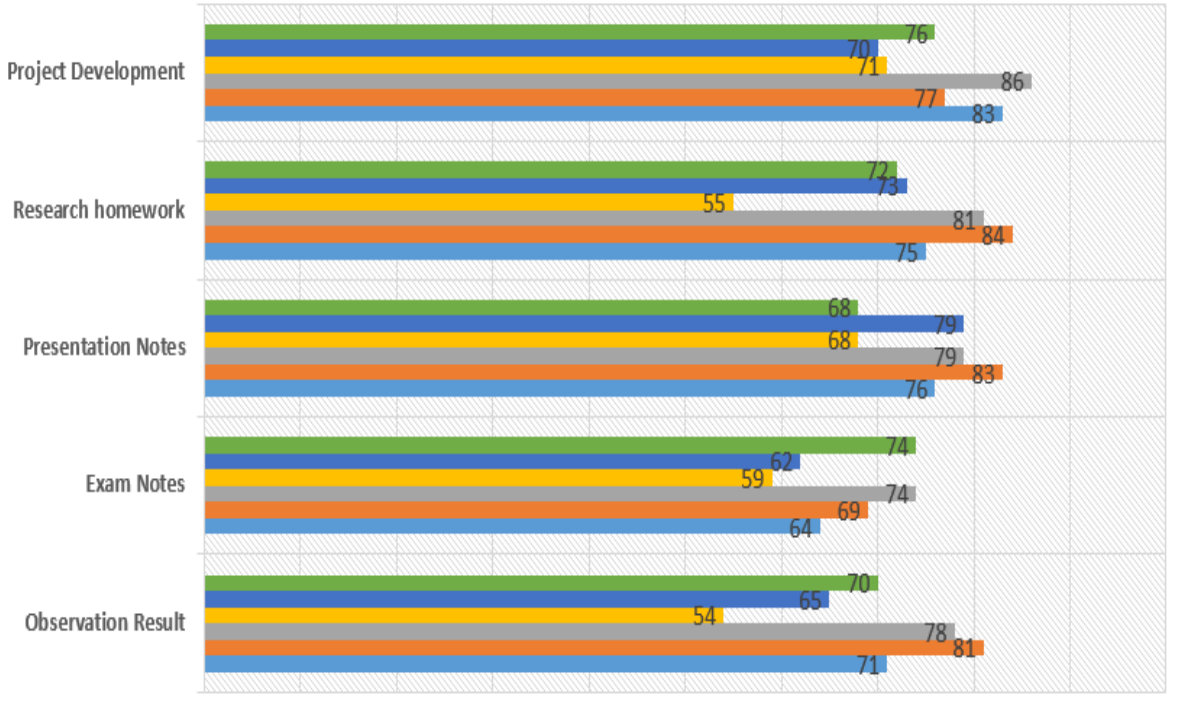
D.C.T= Data Collection Tools, Experiment Group=1, Control Group=2, Pre-Test=3, Post-Testt=4,S=Science, C=Classroom, E.C=Early Childhood.

In the second stage of the research, technology integration is included in the process, at the basic and intermediate level. Unlike the first stage, all methods are used in the same way. Activities were carried out only in the experimental group by providing technology integration. The pre-test post-test results of the experimental and control groups were examined by independent groups t-test, and intra-group tests were examined by dependent groups t-test. Accordingly, when the pre-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=1.863, p>.05], CCTT test [$t_{(46)}$=1.267, p>.05], CTSCTC scale [$t_{(46)}$=1.049, p>.05], MSS scale [$t_{(46)}$=1.245, p>.05] and for the SPSITIC scale [$t_{(46)}$=.341, p>.05] results were reached and no significant differences were found. This shows that experiment and control groups have similar cognitive characteristics. When the post-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=2.291, p<.05], CCTT test [$t_{(46)}$=3.887, p<.05], CTSCTC scale [$t_{(46)}$=2.498, p<.05], MSS scale [$t_{(46)}$=3.304, p<.05] and for the SPSITIC scale [$t_{(46)}$=2.554, p<.05] results were reached and significant differences were found. differences were found significant for the experimental and control groups. However, significance levels are higher in the experimental group. Therefore, the results of the experimental group were emphasized more. The experimental group is divided into three different subgroups. For this reason, in order to test whether the difference exists between the groups, one factor ANOVA test was performed. According to this; CCTT test [$F_{(2-21)}$=5.170, p<.05], CTSCTC scale [$F_{(2-21)}$=5.015, p<.05] and for the SPSITIC scale [$F_{(2-21)}$=5.777, p<.05] results are significant in favor of prospective teachers studying in science education, AAT test [$F_{(2-21)}$=3.308, p>.05] and for the MSS scale [$F_{(2-21)}$=1.214, p>.05], there was no significant difference between the groups. To summarize, each subgroup of the experimental group makes a significant difference with each subgroup of the control group. However, the experimental group differed only for three data collection tools, while other tests yielded similar results. Qualitative findings for the second stage are presented in Table 8 and Figure 4.

Table 8. Qualitative findings for the second stage

	Theme	Code	Participants	(f)
Semi-Structured Interview	Can critical and creative thinking be developed when basic and intermediate technology integration is achieved?	The current level of technology is quite sufficient.	E2, E3, E4, E5, C2, C4	8
		If we become technology literate, it can improve.	E1, E6, C1	2
		Technology supports creativity.	C5, C6	1
		Technology may not always work.	C3	1
	Can 21st century skills be improved when basic and intermediate technology integration is achieved?	Technology always positively affects my skills.	E2, E3, E4, E6, C1, C3, C5, C6	8
		Technology- related skillscan improve up to a point.	E1, C2, C4	3
		Technology susceptibility can develop if it happens.	E5	1
	Can academic success be improved when basic and intermediate technology integration is achieved?	If academic success is supported by technology, good results will be obtained.	E1, E2, E3, E4, E5, C1	6
		Technology increases people's reading rate. Even just following social media is enough.	C2, C3, C4, C6	4
		Technology alone will not be enough.	E6, C5	2
	Determinations Regarding the Research Process			**Group (f)**
Observation and Field Notes	The use of technology enables prospective teachers to submit their assignment on time.			3
	Assignments and materials prepared with the use of technology are more qualified.			3
	The rate of communication has increased considerably with the use of technology.			3
	More practical and useful solutions can be produced.			2
	21st century skill education enabled prospective teachers to have a questioning personality.			4
	Traditional applications are not very effective against technological applications.			6
	Technology integration makes it very easy to control, discipline leraners and communicate with them.			3

E= Experiment Group, C= Control Group



	Observation Result	Exam Notes	Presentation Notes	Research homework	Project Development
Control 3	70	74	68	72	76
Control 2	65	62	79	73	70
Control 1	54	59	68	55	71
Experiment 3	78	74	79	81	86
Experiment 2	81	69	83	84	77
Experiment 1	71	64	76	75	83

Figure 4. Detailed examination results for the second stage

After the second stage was completed, the third stage was started. At this stage, technology integration is included in the process in an advanced manner. There are quantitative analyzes made in Table 9.

Table 9. Quantitative findings for the third stage

		Experiment Group – Pre-Test							Control Group – Pre-Test						
Tests	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
Independent Groups T-Test	AAT	24	76.91	6.61	46	1.331	.190	-	24	74.45	6.17	46	1.331	.190	-
	CCTT	24	74.65	7.87	46	1.811	.077	-	24	70.16	9.13	46	1.811	.077	-
	CTSCTC	24	139.70	28.84	46	1.743	.088	-	24	127.51	18.59	46	1.743	.088	-
	MSS	24	144.91	19.75	46	1.412	.165	-	24	136.04	23.61	46	1.412	.165	-
	SPSITIC	24	83.70	6.16	46	1.820	.075	-	24	79.25	10.01	46	1.820	.075	-
		Experiment Group – Post-Test							Control Group – Post-Test						
	AAT	24	84.83	4.74	46	4.489	.000	1>2	24	78.29	5.33	46	4.489	.000	1>2
	CCTT	24	83.12	7.91	46	2.655	.011	1>2	24	77.02	8.07	46	2.655	.011	1>2
	CTSCTC	24	157.91	23.77	46	3.368	.002	1>2	24	136.12	20.97	46	3.368	.002	1>2
	MSS	24	162.37	19.46	46	3.280	.001	1>2	24	144.03	19.35	46	3.280	.001	1>2
	SPSITIC	24	94.87	9.79	46	2.640	.014	1>2	24	88.75	5.75	46	2.640	.014	1>2
		Control Group – Within Groups- Pre-Test – Post-Test													
		Pre-Test							Post-Test						
Tests	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
Dependent Groups T-Test	AAT	24	74.45	6.17	23	70.039	.000	4>3	24	78.29	5.33	23	70.039	.000	4>3
	CCTT	24	70.16	9.13	23	.987	.334	-	24	77.02	8.07	23	.987	.334	-
	CTSCTC	24	127.51	18.59	23	14.131	.000	4>3	24	136.12	20.97	23	14.131	.000	4>3
	MSS	24	136.04	23.61	23	4.683	.000	4>3	24	144.03	19.35	23	4.683	.000	4>3
	SPSITIC	24	79.25	10.01	23	9.905	.000	4>3	24	88.75	5.75	23	9.905	.000	4>3
		Experiment Group – Within Groups- Pre-Test – Post-Test													
		Pre-Test							Post-Test						
	D.C.T	N	$\overline{X}$	Sd	Df	t	p	Sig.	N	$\overline{X}$	Sd	Df	t	p	Sig.
	AAT	24	76.91	6.61	23	10.031	.000	4>3	24	84.83	4.74	23	10.031	.000	4>3
	CCTT	24	74.65	7.87	23	7.235	.000	4>3	24	83.12	7.91	23	7.235	.000	4>3
	CTSCTC	24	139.70	28.84	23	4.760	.000	4>3	24	157.91	23.77	23	4.760	.000	4>3
	MSS	24	144.91	19.75	23	6.894	.000	4>3	24	162.37	19.46	23	6.894	.000	4>3
	SPSITIC	24	83.70	6.16	23	5.284	.000	4>3	24	94.87	9.79	23	5.284	.000	4>3
		Experiment Group – Within Groups - Post-Test													
		Between Groups							Within Groups						
One Factor ANOVA Test	D.C.T	Mean Square		Df	p	F	Sig.		Mean Square			Df	p	F	Sig.
	AAT	189.54		2	.000	28.791	S>C, S>E.C		6.58			21	.000	28.791	S>C, S>E.C
	CCTT	403.12		2	.000	13.345	S>C, S>E.C		30.21			21	.000	13.345	S>C, S>E.C
	CTSCTC	3482.29		2	.000	12.125	S>C, S>E.C		287.20			21	.000	12.125	S>C, S>E.C
	MSS	2784.12		2	.000	18.588	S>C, S>E.C		149.78			21	.000	18.588	S>C, S>E.C
	SPSITIC	372.87		2	.013	5.353	S>C, S>E.C		69.66			21	.013	5.353	S>C, S>E.C

D.C.T= Data Collection Tools, Experiment Group=1, Control Group=2, Pre-Test=3, Post-Test=4,S=Science, C=Classroom, E.C=Early Childhood

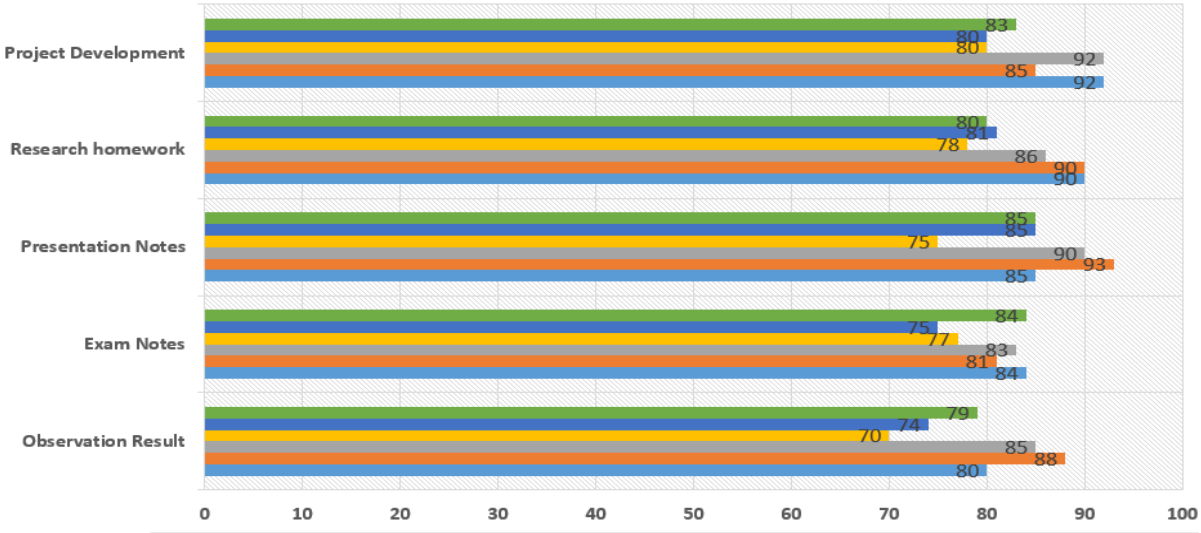
In the third stage of the research, technology integration is included in the process, with advanced level. Here, unlike the second stage, all methods were applied in the same way as emergency remote education. Only in the experimental group activities were gradually increased within the scope of technology integration. The pre-test post-test results of the experimental and control groups were examined by independent groups t-test, and within group tests were examined by dependent groups t-test. Accordingly, when the pre-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=1.331, p>.05], CCTT test [$t_{(46)}$=1.811, p>.05], CTSCTC scale [$t_{(46)}$=1.743, p>.05], MSS scale [$t_{(46)}$=1.412, p>.05] and for the SPSITIC scale [$t_{(46)}$=1.820, p>.05] results were reached and no significant differences were found. This shows that experiment and control groups have similar cognitive characteristics.

When the post-test results of the experimental and control groups are examined; AAT test [$t_{(46)}$=4.489, p<.05], CCTT test [$t_{(46)}$=2.655, p<.05], CTSCTC scale [$t_{(46)}$=3.368, p<.05], MSS scale [$t_{(46)}$=3.280, p<.05] and for the SPSITIC scale [$t_{(46)}$=2.640, p<.05] results were reached and significant differences were found. Significant differences were found significant for the experimental and control groups. However, significance levels are higher in the experimental group. Therefore, the results of the experimental group were emphasized more. The experimental group is divided into three different subgroups. For this reason, in order to test whether the difference exists between the groups, one factor ANOVA test was performed. According to this; AAT test [$F_{(2-21)}$=28.791, p<.05], CCTT test [$F_{(2-21)}$=13.345, p<.05], CTSCTC scale [$F_{(2-21)}$=12.125, p<.05], MSS scale [$F_{(2-21)}$=18.588, p<.05] and for the SPSITIC scale [$F_{(2-21)}$=5.353, p<.05] in favor of prospective teachers studying in science education, there were significant differences between the groups. To summarize, as the level of technology increases, both between-group and within-group significant differences increase positively. Qualitative findings for the third stage are presented in Table 10 and Figure 5.

Table 10. Qualitative findings for the third stage

	Theme	**Code**	**Participants**	**(f)**
Semi-Structured Interview	Can critical and creative thinking be developed when advanced technology integration is achieved?	As the level of technology increases, it is necessary to work more systematically.	E1, E2, E5 C1, C3	5
		Technology takes people's limits and creativity to the next level.	E3, E6, C2	2
		As the level of technology increases, we are more curious. In this case, it causes us to question and criticize more.	E4, C3, C4, C5, C6	5
	Can 21st century skills be improved when advanced technology integration is achieved?	As the level of using technology increases, new skills emerge. This situation is directly proportional to the use of technology.	E1, E2, E3, E5, C1, C2, C3	7
		Technology brings new generation skills.	E4, C4	2
		Technology and artificial intelligence know no boundaries.	E6, C5, C6	3
	Can academic success be improved when advanced technology integration is achieved?	The use of advanced technology brings systematic and disciplined work habits.	E3, E5, E6, C1, C3, C4	6
		Advanced technology integration enables many alternative learning environments.	E1, E2, C2, C5	4
		Technology integration directly affects success.	E4, C6	2
	Determinations Regarding the Research Process			**Group (f)**
Observation and Field Notes	Advanced technology integration allows students to focus longer.			3
	As the use of technology increases, the rates of communication increase.			3
	Digital messaging environments and constant online status affect group success.			3
	The use of technology ensures that the educational process continues actively outside of school.			6
	Some skills, such as working with a group and problem solving, can be acquired directly without the need for additional effort as communication increases with the use of technology.			3
	As the level of technology integration increases, prospective teachers can work deeper.			4

E= Experiment Group, C= Control Group



	Observation Result	Exam Notes	Presentation Notes	Research homework	Project Development
Control 3	79	84	85	80	83
Control 2	74	75	85	81	80
Control 1	70	77	75	78	80
Experiment 3	85	83	90	86	92
Experiment 2	88	81	93	90	85
Experiment 1	80	84	85	90	92

Figure 5. Detailed examination results for the third stage

The fourth problem situation of the research was: "How do the different approaches applied at each stage affect the prospective teachers' critical and creative thinking, multi-dimensional 21st century skills and academic achievement?" In this context, in order to determine the effects of the applications performed at each stage, multi-dimensional regression analyses were conducted on the post-test results of the prospective teachers in the experimental group. Regression analysis for the first stage is presented in Table 11.

Table 11. Regression analysis findings for the first stage

Dependent variable		Independent variable	B	SE	β	t	p
Stage 1 - No Technology Integration	AAT	Constant	3.75	.05	-	39.45	.000*
		Scientific Process Skills Education	.57	.05	.42	6.21	.002*
		21st Century Skill Education	.48	.07	.31	5.19	.001*
		Academic Readings	.32	.14	.34	4.41	.000*
		Project Activity	.21	.17	.26	3.24	.000*
			F = 44.16, R = .74, R^2 = .55, *p<.05				
	CCTT	Constant	2.46	.09	-	28.74	.000*
		Scientific Process Skills Education	.44	.011	.33	5.79	.000*
		21st Century Skill Education	.36	.08	.32	4.68	.002*
		Academic Readings	.25	.12	.28	4.03	.004*
		Project Activity	.29	.10	.21	4.46	.001*
			F = 33.89, R = .62, R^2 = .38, *p<.05				
	Scale 1 CTSCTC	Constant	4.14	.08	-	48.59	.000*
		Scientific Process Skills Education	.68	.03	.54	9.24	.000*
		21st Century Skill Education	.70	.08	.49	10.11	.003*
		Academic Readings	.65	.10	.56	8.26	.000*
		Project Activity	.46	.06	.32	5.98	.004*
			F = 50.18, R = .79, R^2 = .62, *p<.05				
	Scale 2 MSS	Constant	5.16	.03	-	60.42	.000*
		Scientific Process Skills Education	.79	.04	.63	11.19	.000*
		21st Century Skill Education	.64	.08	.57	9.14	.002*
		Academic Readings	.45	.11	.42	6.29	.000*
		Project Activity	.33	.10	.24	5.07	.000*
			F = 56.74, R = .82, R^2 = .67, *p<.05				

When the regression analysis results of the experimental group are examined; AAT test [$F_{(4-19)}$=44.16, p<.05], CCTT test [$F_{(4-19)}$=33.89, p<.05], CTSCTC scale [$F_{(4-19)}$=50.18, p<.05] and for the MSS scale [$F_{(4-19)}$=56.74, p<.05] results were reached and significant differences were found. Here, each dependent variable showed a positive change depending on the sub-parameters. In addition, dependent variables are determined by sub-parameters; AAT test (R=.74, R^2=.55), CCTT test (R=.62, R^2=.38), CTSCTC scale (R=.79, R^2=.62) and for the MSS scale (R=.74, R^2=.55) affect levels. Regression analysis for the second stage is presented in Table 12.

Table 12. Regression analysis findings for the second stage

	Dependent variable	Independent variable	B	SE	β	t	p
Stage 2 - Basic / Intermediate Technology Integration	AAT	Google Classroom Activities	5.83	.06	-	57.86	.000*
		Data Collection in Digital Media	.63	.08	.57	9.75	.000*
		Preparing Interactive Presentations	.56	.11	.45	8.01	.003*
		Group Work and Project Production	.48	.09	.42	7.46	.002*
		E-portfolio Application	.45	.12	.40	6.98	.005*
			F = 64.79, R = .82, R^2 = .67, *p<.05				
	CCTT	Google Classroom Activities	4.19	.09	-	48.73	.000*
		Data Collection in Digital Media	.56	.08	.51	8.06	.000*
		Preparing Interactive Presentations	.39	.06	.38	5.98	.000*
		Group Work and Project Production	.47	.08	.40	7.18	.003*
		E-portfolio Application	.53	.07	.49	7.64	.005*
			F = 66.87, R = .85, R^2 = .72, *p<.05				
	Scale 1 CTSCTC	Google Classroom Activities	6.29	.05	-	48.59	.001*
		Data Collection in Digital Media	.78	.06	.67	11.67	.000*
		Preparing Interactive Presentations	.69	.08	.62	10.74	.001*
		Group Work and Project Production	.82	.04	.75	13.56	.004*
		E-portfolio Application	.72	.06	.71	10.97	.002*
			F = 70.83, R = .89, R^2 = .79, *p<.05				
	Scale 2 MSS	Google Classroom Activities	5.80	.10	-	59.42	.005*
		Data Collection in Digital Media	.66	.08	.57	10.81	.003*
		Preparing Interactive Presentations	.69	.05	.62	11.32	.004*
		Group Work and Project Production	.72	.03	.65	12.86	.000*
		E-portfolio Application	.78	.04	.71	12.93	.001*
			F = 66.75, R = .75, R^2 = .56, *p<.05				
	Scale 3 SPSITIC	Google Classroom Activities	4.32	.13	-	53.24	.005*
		Data Collection in Digital Media	.58	.10	.43	8.06	.009*
		Preparing Interactive Presentations	.64	.16	.54	8.89	.000*
		Group Work and Project Production	.48	.09	.37	7.04	.002*
		E-portfolio Application	.43	.14	.29	6.08	.000*
			F = 60.18, R = .65, R^2 = .42, *p<.05				

At this stage, basic and intermediate technology integration has been provided. When the regression analysis results of the experimental group are examined; AAT test [$F_{(4-19)}$=64.79, p<.05], CCTT test [$F_{(4-19)}$=66.87, p<.05], CTSCTC scale [$F_{(4-19)}$=70.83, p<.05], MSS scale [$F_{(4-19)}$= 66.75, p<.05] and for the SPSITIC scale [$F_{(4-19)}$=60.18, p<.05] results were found and significant differences were detected. Here, each dependent variable has positively changed sub-parameters at various levels. In addition, dependent variables are determined by sub-parameters; AAT test (R=.82, R^2=.67), CCTT test (R=.85, R^2=.72), CTSCTC scale (R=.89, R^2=.79), MSS scale (R=.75, R^2=.56) and for the SPSITIC scale (R=.65, R^2=.42) affect levels. Technology integration has affected the opinions of prospective teachers towards the first scale and at least the views towards the third scale. Regression analysis for the third stage is presented in Table 13.

Table 13. Regression analysis findings for the third stage

Dependent variable		Independent variable	B	SE	β	t	p
Stage 3 - Advanced Technology Integration – Emergency Remote Education – Pandemic - Covid-19	AAT	Online emergency remote education	8.52	.13	-	75.68	.000*
		Preparing Presentations in Digital Media	.79	.08	.67	12.84	.000*
		Online Exam Applications	.68	.12	.60	10.84	.005*
		Group Work and Online Project	.76	.08	.71	11.76	.000*
		Infographic Preparation	.85	.02	.80	14.65	.001*
		Necessary Activities	.64	.09	.53	10.45	.000*
		Mandatory Activities	.89	.04	.76	15.63	.004*
		Peer Assessment	.80	.07	.74	13.74	.000*
		Whatsapp Groups and Problem Solving	.92	.03	.85	18.73	.000*
			F = 74.68, R = .91, R^2 = .82, *p<.05				
	CCTT	Online emergency remote education	7.85	.18	-	72.49	.001*
		Preparing Presentations in Digital Media	.80	.09	.69	13.56	.005*
		Online Exam Applications	.66	.15	.62	10.98	.000*
		Group Work and Online Project	.71	.10	.64	12.78	.004*
		Infographic Preparation	.75	.09	.59	13.08	.006*
		Necessary Activities	.73	.13	.32	12.99	.002*
		Mandatory Activities	.81	.04	.72	13.94	.000*
		Peer Assessment	.76	.11	.66	13.74	.000*
		Whatsapp Groups and Problem Solving	.84	.05	.73	15.12	.003*
			F = 71.73, R = .95, R^2 = .90, *p<.05				
	Scale 1 CTSCTC	Online emergency remote education	6.75	.11	-	63.75	.002*
		Preparing Presentations in Digital Media	.75	.09	.66	13.08	.000*
		Online Exam Applications	.72	.13	.58	12.41	.001*
		Group Work and Online Project	.66	.15	.49	11.43	.000*
		Infographic Preparation	.80	.05	.71	15.13	.004*
		Necessary Activities	.56	.16	.48	8.73	.001*
		Mandatory Activities	.79	.12	.67	14.12	.000*
		Peer Assessment	.72	.13	.63	13.05	.000*
		Whatsapp Groups and Problem Solving	.85	.03	.73	17.15	.003*
			F = 64.76, R = .81, R^2 = .65, *p<.05				
	Scale 2 MSS	Online emergency remote education	9.64	.13	-	75.68	.002*
		Preparing Presentations in Digital Media	.79	.12	.73	13.24	.000*
		Online Exam Applications	.82	.10	.75	14.32	.000*
		Group Work and Online Project	.86	.07	.74	15.64	.003*
		Infographic Preparation	.80	.08	.67	13.48	.005*
		Necessary Activities	.69	.14	.49	9.76	.005*
		Mandatory Activities	.92	.04	.81	16.73	.002*
		Peer Assessment	.95	.03	.88	18.93	.002*
		Whatsapp Groups and Problem Solving	.87	.07	.74	16.42	.000*
			F = 86.74, R = .90, R^2 = .81, *p<.05				
	Scale 3 SPSITIC	Online emergency remote education	6.12	.15	-	59.76	.005*
		Preparing Presentations in Digital Media	.66	.13	.53	8.96	.001*
		Online Exam Applications	.71	.08	.57	10.41	.000*
		Group Work and Online Project	.68	.11	.62	9.32	.000*
		Infographic Preparation	.80	.04	.73	15.33	.003*
		Necessary Activities	.59	.16	.44	6.42	.000*
		Mandatory Activities	.86	.02	.75	16.79	.002*
		Peer Assessment	.80	.04	.69	15.33	.001*
		Whatsapp Groups and Problem Solving	.84	.03	.74	16.42	.001*
			F = 60.78, R = .76, R^2 = .57, *p<.05				

At this stage, advanced technology integration has been achieved. When the regression analysis results of the experimental group are examined; AAT test [$F_{(4-19)}$=74.68, p<.05], CCTT test [$F_{(4-19)}$=71.73, p<.05], CTSCTC scale [$F_{(4-19)}$=64.76, p<.05], MSS scale [$F_{(4-19)}$= 86.74, p<.05] and for the SPSITIC scale [$F_{(4-19)}$=60.78, p<.05] results were reached and

significant differences were found. Here, each dependent variable has positively changed sub-parameters at various levels. Also, dependent variables are determined by sub-parameters; AAT test (R=.91, R^2=.82), CCTT test (R=.95, R^2=.90), CTSCTC scale (R=.81, R^2=.65), MSS scale (R=.90, R^2=.81) and for the SPSITIC scale (R=.76, R^2=.57) affect levels. Technology integration has mostly affected the opinions of prospective teachers for CCTT test, and at least the views for the third scale. For he fifth problem of the research; "What are the opinions of the prospective teachers regarding their application scales and sub-dimensions?". the average results are presented in Table 14.

Table 14. Averages of prospective teachers' opinions about application scales

Experimental Group	Stage 1	CTSCTC	Factor 1	Factor 2	Factor 3		
			3.45	3.80	3.76		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.14	3.52	2.89	4.12	3.34
	Stage 2	CTSCTC	Factor 1	Factor 2	Factor 3		
			3.69	4.02	4.06		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.36	3.89	3.47	4.42	4.35
		SPSITIC	Factor 1		Factor 2		
			3.75		3.90		
	Stage 3	CTSCTC	Factor 1	Factor 2	Factor 3		
			4.23	4.45	4.76		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.88	4.36	4.09	4.68	4.71
		SPSITIC	Factor 1		Factor 2		
			4.29		4.57		
Control Group	Stage 1	CTSCTC	Factor 1	Factor 2	Factor 3		
			3.38	3.55	3.64		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.22	3.48	3.17	3.85	3.62
	Stage 2	CTSCTC	Factor 1	Factor 2	Factor 3		
			3.51	4.10	4.19		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.28	3.77	3.55	4.17	4.20
		SPSITIC	Factor 1		Factor 2		
			3.63		3.81		
	Stage 3	CTSCTC	Factor 1	Factor 2	Factor 3		
			4.05	4.18	4.09		
		MSS	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
			3.71	4.12	3.96	4.37	4.18
		SPSITIC	Factor 1		Factor 2		
			4.08		4.36		

4. Conclusion, Discussion and Suggestions

This study, in which technology integration in instruction was examined within the scope of science education, was carried out in 3 different stages. Technology integration has never been achieved in the first stage, at the basic and intermediate levels in the second stage and the advanced level in the third stage. Within the scope of the study, critical and creative thinking, multidimensional 21st century skills and changes in academic achievements of

prospective teachers were examined. Experiment and control groups are divided into three subgroups at each stage. In all stages and sub-steps of the research, measurement, evaluation and research methods training has been kept constant. Firstly, as there was no technology integration in the first stage, the experimental group was given scientific process skills education and 21st century skills education, unlike traditional education. Traditional education was given to the control group. Besides, academic readings and project activities were made to the experimental group. While all activities were being held, prospective teachers were informed about not including technology in the process and explicitly stating the resources they use. In this context, when table 5 was examined, it was determined that there was no significant difference between the pre-test results of the experimental and control groups. This is a situation that should be in experimental studies. Because groups with similar characteristics should be included in the process. When the post-test results of the experimental and control groups are examined, it is seen that there is a significant difference, and this difference is in favour of the experimental group. Besides, the pre-test and post-test results of both groups were compared, and significant differences were found.

Since the prospective teachers in the experimental group had a higher significance level, the analyses of this group were deepened. As a result of the one factor ANOVA test, it was determined that the scores of prospective science teachers differed significantly from prospective early childhood and classroom teachers. This difference occurred in AAT and CCTT tests, and there was no significant difference in scale applications. When the literature is analyzed, it is seen that prospective science teachers show scientific process skills and the so-called 21st century skills more frequently than the prospective teachers studying in other departments and they have a high tendency towards these skills (Beaumont-Walters & Soyibo, 2001; Cetin & Solmaz, 2020; Downing & Filer, 1999; Duran & Ozdemir, 2010; Farsakoglu, Sahin, Karsli, Akpinar & Ultay, 2008). Reasons for this include the fact that critical and analytical thinking is the basis of science education, frequent use of scientific processes (experiment, application, etc.) and areas require sub-branches of science such as physics, chemistry and biology to actively use 21st century skills (Demir, 2007; Tifi, Natale & Lombardi, 2006). It can be interpreted that there is no significant difference in prospective teachers' thoughts about application scales, when technology integration is not provided, these processes are not actively used, and technology should be considered as a factor that supports these behaviours (ChanLin, 2005; Hussain & Safdar, 2008). Hsu & Kuan (2013) stated that there are many factors affecting technology integration in their study. Among these factors, it has been stated that individuals need to interact with technology for a long time in order to develop technology integration. These results support the current research results.

In Table 6, it is seen that prospective teachers have different views about technology integration. It is especially emphasized that some skills are directly related to technology integration. It is a natural result that prospective teachers think in this way. Because the individuals who participated in this study were born in the 21st century and started their education life after 2000. From the first stage of their educational life to the present, they have incorporated technology into their educational processes at various levels and have benefited from it. These opinions also support the results of the scale study conducted within the scope of quantitative applications (Gunuc, Odabasi & Kuzu, 2012; Kolikant, 2010). Because when there is no technology integration, all prospective teachers advocate similar thoughts. When Figure 3 is examined, it has been determined that project development, research assignments, presentation grades, exam grades and observation results for prospective teachers in the experimental group differ significantly from the prospective teachers in the control group. This supports the interview results, AAT test and CCTT test results. In the second stage of the

research, technology integration is included in the basic and intermediate level process. In the first stage, only scientific process skills education and 21st century skills education given to the experimental group were given to all groups equally after this stage. However, technology integration in the control group was not achieved. Technology integration was provided only to the experimental group. At this stage, a new one was added to the quantitative applications, and the technology usage of the instructors was also questioned. Within the scope of the applications, technology-based applications such as Google Classroom activities in the experimental group, data collection in the digital environment, preparation of interactive presentations, e-portfolio application were included in the process. When Table 7 is examined, it is seen that there is no significant difference between the pre-test results of the experimental and control groups as in the first stage. When the post-test results of the experimental and control groups are examined, it is seen that there is a significant difference in favour of the experimental group. The pre-test and post-test results of the experimental and control groups also differ significantly among themselves. While there was a significant difference in the AAT test and SPSITIC scale application in the control group, it was seen that there was a significant difference in all applications in the experimental group. Since the level of significance was higher in the experimental group, the analyses were deepened. As a result of the one factor ANOVA test, it was determined that there was no difference for AAT and MSS scale, and that there was a significant difference for CCTT, CTSCTC and MSS scale. Here, prospective teachers studying in the science department achieved higher results than prospective teachers in both the classroom and early childhood department. The reason for this can be said to arise from the content and technology suitability of science education as in the first stage (Bybee, 2010; Gibson, 2012).

Also, as a result of the interviews and observations done with prospective teachers, they think that the technology level used in the instruction process is sufficient and that technological applications will contribute to a certain point. When the reasons of this view are examined, it can be shown that the use of advanced technology in schools and higher education has not been established yet, the technological infrastructure is not equal in every university, and prospective teachers do not use technology for specific purposes (Bittman, Rutherford, Brown & Unsworth, 2011; Cetin, 2021). At this stage, where technology integration is applied more than the first stage; it was determined that the project development, research assignments, presentation grades, exam grades and observation results differed significantly and increased positively for prospective teachers in the experimental group compared to the prospective teachers in the control group. Also, it was stated in the interviews with prospective teachers that after the technology was included in the process, they needed to ask more questions, had to communicate more with the instructor, and creative ideas arose as the level of access to information increased (Gray, 2008; Naish, 2008).

Asadi, Abdekhoda & Nadrian (2019) stated in their study that the willingness levels of the teachers in the process of adapting to technology integration positively affects their success levels. It has been observed that as the relationship with technology increases, the behaviors of using technology and including it more actively in lessons improve. Technology integration from the third and final stage of the research was mandatorily applied to both groups. Because during this period, owing to the global epidemic (Covid-19) and the announcement of the pandemic period, all education processes had to be carried out as emergency remote education. However, technology integration was implemented at the advanced level in the experimental group, and the basic and intermediate level in the control group. At this stage, traditional education in the control group was tried to be given as emergency remote education. In the experimental group, technology applications were

gradually increased. These applications are; Google Classroom activities that include online project preparation, necessary activities, mandatory activities, infographic preparation and the establishment of WhatsApp groups in solving problem situations. These processes are presented in detail in Table 2. When the quantitative results for the third stage are examined, no significant difference was found between the pretest results of the experimental and control groups as in the other stages. When the posttest applications of the experimental and control groups are examined, it is seen that there is a significant difference in favour of the experimental group. Also, all groups create differences in terms of pre-test and post-test results. The control group created significant differences in itself in all applications except for the CCTT test. The experimental group showed a significant difference in all sub-applications. Since the results in the experimental group yield higher results than the control group, the analyses for this group have been deepened. As a result of the one factor ANOVA test, prospective teachers in science teaching department made a positive difference in all applications compared to other branches. Providing advanced technology integration has also changed prospective teachers' thought structures and approaches to technology (Dewitt & Siraj, 2010). When the technology integration is made at lower levels, the prospective teachers who find the process sufficient show more interest in this process and as the technology level increases and express that new needs and skills emerge (Cakiroglu, 2016).

Advanced technology integration encourages prospective teachers to focus longer, increases technology usage times and enables them to continue their educational work outside of school (Jung & Ottenbreit-Leftwich, 2020; Turac, Caliskan & Gulnar, 2017). Besides, it has been determined that project development, research assignments, presentation grades, exam grades and observation results differ significantly and increase positively for prospective teachers compared to all other stages. Technology integration was realized in a group with the necessary activities before starting the lesson. In this process, most of the prospective teachers did not participate because the activities were not compulsory. In another group, some activities were mandatory before starting the lesson. Later, lessons were taught. When the results of the study were examined, it was determined that the group's mandatory activities had higher grade averages and differed in all applications compared to other groups (Anderson & Putman, 2020; Conejar & Kim, 2014; Kirschner & Karpinski, 2010). In another experimental group, in addition to these activities, an infographic was prepared, and a WhatsApp group was established in which the researcher participated in this process. The researcher acted as a guide and a team member in this group and meticulously followed up correspondence for the whole process.

As a result of the application, it was determined that the establishment of WhatsApp group and continuous discussion about problem situations, sharing information and increasing the interaction caused the students to increase their academic success depends on many 21st century skills, critical and creative thinking skills and the result of these. There are many studies supporting this situation in the related literature (Ebersole, 2019; Jones, Blackey, Fitzgibbon & Chew, 2010; Korkmaz & Ozturk, 2020; Sebetci, Topal, Hanayli & Gurel-Donuk, 2018). As a result of the third stage, it was determined that the prospective teachers' opinions, project development, research assignments, presentation grades, exam grades and observation results increased in all groups. Regression analysis results that are carried out for the level of the applications applied at each stage can be examined. As the technology integration and use of technology increases in all processes, the skills desired to be acquired increase systematically. The important point here is; increasing the interaction is the necessity for the technology to be well-structured in the education process and to be integrated in a harmonious way. Prospective teachers showed a regular upward trend in their thoughts

regarding their application scales. As the level of technology integration increased, their attitudes towards the application scales and the mean of thought increased. Within the scope of this research, the following suggestions can be made;

- Technology integration should be made gradually to the education process and presented with well-prepared educational contents. In the use of technology, emphasis should be placed on practices that can involve participants. This situation increases participants' cognitive, affective and behavioural loyalty and affects their success levels positively.
- Technology integration is a labour-intensive process that requires advanced computer and technology literacy. In this context, it has become a necessity rather than a need for educators to improve themselves and keep up with the needs of the age. While providing technology integration, participants should be taken to the centre of the applications, and the process should be structured together so that they can both enjoy it and contribute fully to the very process.

Ethical Declaration

Ethical rules conducted this study. During the research, all details were kept under control and carried out within the framework of scientific ethics.

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