# JESEH

VOLUME
9
ISSUE
2

YEAR
2023

## Journal of Education in Science, Environment and Health

e-ISSN 2149-214X

**Journal of Education in Science, Environment and Health**
Volume 9, Issue 2, 2023 e-ISSN:2149-214X

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## Contact Info

Journal of Education in Science, Environment and Health (JESEH)
Email: jesehoffice@gmail.com
Web : www.jeseh.net

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
e-ISSN:2149-214X

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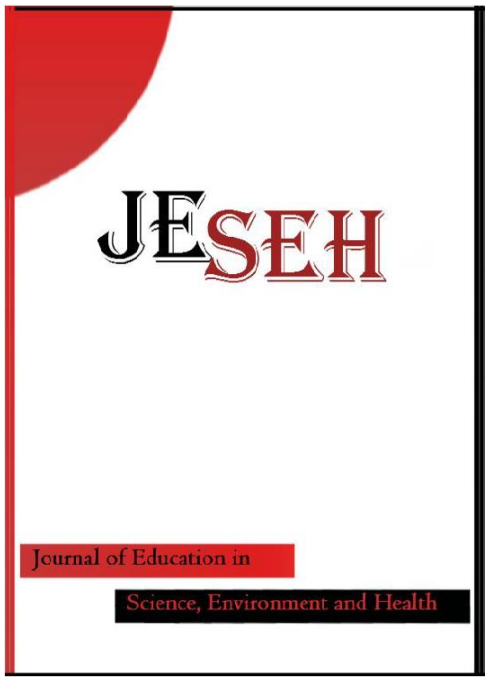


**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

**www.jeseh.net**

# The Design, Implementation, and Evaluation of a STEM Education Course for Pre-Service Science Teachers

**Kibar Sungur-Gul[1], Mehmet Fatih Tasar[2]**
[1]Nevşehir Hacı Bektaş Veli University
[2]Gazi University

**To cite this article:**

Sungur-Gul, K. & Tasar, M. F. (2023). The design, implementation, and evaluation of a STEM education course for pre-service science teachers. *Journal of Education in Science, Environment and Health (JESEH), 9*(2), 85-100. https://doi.org/10.55549/jeseh.1272793

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1272793

# The Design, Implementation, and Evaluation of a STEM Education Course for Pre-Service Science Teachers

**Kibar Sungur-Gul, Mehmet Fatih Tasar**

## Article Info

***Article History***

Published:
01 April 2023

Received:
10 June 2022

Accepted:
05 November 2022

***Keywords***

Educational design research
Pre-service teachers
STEM education
STEM course design

## Abstract

The purpose of this study was to design, implement, and evaluate a course according to a STEM education approach for pre-service science teachers. The study was conducted in three phases according to an educational design research method: preliminary research, development or prototyping, and assessment (Plomp & Nieveen, 2013). The STEM education pre-knowledge form, STEM lesson plans, the STEM lesson plan evaluation form, STEM self-evaluation, and peer-evaluation forms, and a semi-structured face-to-face interview form were used as qualitative data collection tools. Data were analyzed by methods of content analysis. The results suggest that pre-service science teachers need education in the dimensions of the theoretical structure of STEM education, STEM disciplines and integration, 21st-century skills, sample STEM activities, current science curriculum, STEM learning/teaching methods and techniques, measurement and assessment for STEM education, collaboration with peers, and planning-implementing a lesson according to STEM education. The findings showed that the STEM course design developed through this study was seen to be effective in responding pre-service teachers' needs. In STEM course design, six activities were prepared in the context of designing a 21st-century house and designing a vehicle according to the trans-disciplinary model and hands on-minds on method. According to the relevant literature, the findings were discussed and future studies should provide collaboration with pre-service teachers, students, and in-service teachers. Future studies should also focus on developing the knowledge and skills of pre-service teachers about engineering and technology discipline and show how to integrate these disciplines into their real-life problems.

## Introduction

STEM (Science, Technology, Engineering, Mathematics) is an educational approach that emerged in the 1990s to train 21st-century individuals (Sanders, 2009), and is defined as learning and teaching interdisciplinary knowledge practices involved in science and/or mathematics by integrating technologies related to engineering design/practices (Bryan et. al., 2016). To accomplish this vision, it is crucial to increase the number of well-educated teachers who will develop students' 21st-century skills (Partnership for 21st-century skills, 2009). Preparing efficient STEM teachers experienced in STEM instructional approaches is also main need to success this vision (Lynch et al., 2014; Outlier Research & Evaluation, 2014). The results of a preliminary study have also shown the need for effective pre-service STEM preparation programs in preparing quality STEM teachers (Bartels et al., 2019; Bell, 2016; English, 2017; Shernoff et al., 2017).

The critical question is "How do teacher education programs prepare teachers for STEM teaching?" The reality is that teacher education in many countries is focused on discipline-based content and pedagogy courses which mainly provide mathematics and science disciplines, provide insufficient knowledge and experience in STEM (Epstein & Miller, 2011; Bartels et al. 2019). Consequently, science and mathematics teachers who try to implement STEM education in their courses will be experts only in their fields (Lederman & Lederman, 2013), and therefore they will focus on learning objectives specific to their subject areas (English, 2015; Williams, 2011).

A serious preparation process is required for teachers who are practitioners of the STEM curriculum. American National Science and Technology Council-NSTC (2013) has suggested pre-service education and continuous professional development to increase STEM education from pre-school to higher education. Hence, in-service and especially pre-service teachers who are new in the field must be equipped with the abilities to integrate

STEM into their education programs. Since, pre-service teachers have an important role in managing the trajectory of STEM education as future educational leaders (Atkinson & Mayo, 2010; Bybee, 2013). Consequently, STEM curriculums are needed in K-12 education and there is a lack of experienced STEM teachers to design and implement STEM lessons. Preservice teacher preparation programs are important for developing an understanding of STEM knowledge, integrated STEM, and pedagogical practices that support STEM integration (Radloff & Guzey, 2016; Shernoff et al., 2017). Therefore, it is urgently necessary to provide pre-service teachers professional development about STEM education. This study aims to design a STEM course for pre-service teachers and examine its effectiveness.

**STEM Education in Pre-Service Teacher Education**

STEM education is more progressive, student-centered, and experimental than traditional teacher-centered education approaches. STEM education encourages the teacher to create a learning environment based on the constructivist approach that students learn by doing and living (Fioriello, 2010). Therefore, it is extremely important how teachers successfully implement STEM education (Vescio et. al., 2008). In addition, teachers need to be educated about STEM and the content of the pre-service and continuing education should focus on the structure and functioning of STEM and its integration. This will raise awareness among in-service and pre-service teachers and to promote STEM education (Buyruk & Korkmaz, 2016; Ministry of Education, 2016).

The qualities of a competent and effective teacher in STEM education have been mentioned in many studies. For instance, Lee and Nason (2012) suggested that pre-service teacher education programs should ensure both disciplinary and interdisciplinary STEM knowledge as well as situational theoretical knowledge to form the basis of STEM education training, the development of positive attitudes and orientation towards STEM. In addition, teaching methods courses that prepare future STEM teachers should include advanced pedagogy lessons that are compatible with how scientists do science (National Research Council [NRC], 2012). In order to include engineering practices in science courses, teachers should have competencies such as designing scientific research processes, using various materials in the classroom, determining course content and linking it with real life situations, and combining engineering design and laboratory experiments (NRC, 2012). Furthermore, Williams (2011) reported that teachers' competencies should be defined according to the STEM education needs. Turk, Kalaycı, and Yamak (2018) conducted needs analysis for the curricular design of STEM education for pre-service science teachers.

The results of the research showed that STEM teachers should have features such as creative thinking, ability to use technology, cooperation, being open to learning and having knowledge in their content, being expert in their STEM disciplines, and following developments in education. It was also underlined that they should have the knowledge and skills to prepare and apply lesson plans suitable for STEM education. It was also stated that teachers should have sub-themes of integrated teaching knowledge such as educational technologies, content knowledge, other STEM disciplines, and interdisciplinary science. In sum, pre-service teachers should be equipped with necessary knowledge, skills, and beliefs to implement STEM education.

**Related Studies about STEM Education in Pre-Service Teacher Education**

Previously, there have been several studies examining STEM education in pre-service teacher education (e.g Aydeniz & Bilican, 2018; Karışan et. al., 2019; Lin & Williams, 2016). However, to the best of our knowledge, there were few studies that suggested and defined the efficiency of the STEM program, model, course, etc. for pre-service science teacher education. For example, Pimthong and Williams (2021) developed a STEM methods course at three phases as preparation, planning, and evaluation and revision for pre-service teachers. Thus, the researchers investigated the pre-service teachers' development of STEM understanding and pedagogical knowledge. The study was conducted with only seven pre-service teachers in the implementation phase and many of them were in science education. Similarly, Ryu, Mentzer, Knobloch (2019) also developed a STEM education methods course for secondary pre-service teachers in STEM disciplines utilizing principles and techniques of grounded theory and examined pre-service teachers' practices and experiences of STEM integration. Data were collected to investigate the methods course students' practices and experiences of STEM integration. According to the findings, students accomplishedly improved the STEM integration lessons and instructed them. Bartels, Rupe, and Lederman (2019) designed a STEM unit to bridge elementary pre-service math and science methods courses through the modeling of integrated STEM lessons and explored the pre-service elementary teachers' understandings of STEM and their ability to plan integrated STEM lessons.

Eckman, Williams, and Silver-Thorn (2016) evaluated the effectiveness of the pre-service STEM teacher education model which incorporates science or mathematics content with pedagogical content knowledge, and defined its impact on pre-service teachers' understanding of STEM content and teaching skills. These studies provide general insights into the effects of a STEM methods course, a STEM teacher education model, or a STEM unit on pre-service teachers' STEM understanding, their pedagogical knowledge, their pedagogical content knowledge, and their experiences of STEM integration.

Considering the gap in the literature, this study aims to be the basis for current and future studies on pre-service teacher preparation by using a STEM course design developed in three phases with the Educational Design Research (EDR) method. EDR is a systematic but flexible methodology that seeks to improve educational practice through iterative analysis, design, development, and implementation, which is based on collaboration between researchers and participants in real-world settings, leading to contextually sensitive design principles and theories (Wang & Hannafin, 2005). Accordingly, activities focused on product design were conducted in the course of "Instructional Technology and Material Development". The course includes both technology as a discipline and the design of teaching materials, while providing the opportunity to integrate science and mathematics into this course we developed. Accordingly, the following research questions were formulated:

1. How can a course that aims to improve pre-service science teachers' knowledge and skills related to STEM education be designed, developed and evaluated?
2. How effective was the STEM course design in increasing pre-service science teachers' knowledge and skills in STEM education?

## Method

This study was conducted in three phases according to the Educational Design Research (EDR) method: preliminary research, development or prototyping, and assessment as mentioned by Plomp and Nieveen (2013). EDR method was used to design and evaluate a course to improve the pre-service science teachers' knowledge and skills about STEM education. As seen in Figure 1, the main outputs of the EDR are mentioned as follows: Design principles were determined as the STEM education knowledge and skills that pre-service science teachers should acquire. The curriculum products of the study are STEM course design which was developed to increase the knowledge and skills of pre-service science teachers about STEM education. Another output is professional development as training of the pre-service science teachers in the study and ensuring their active participation through cooperation.

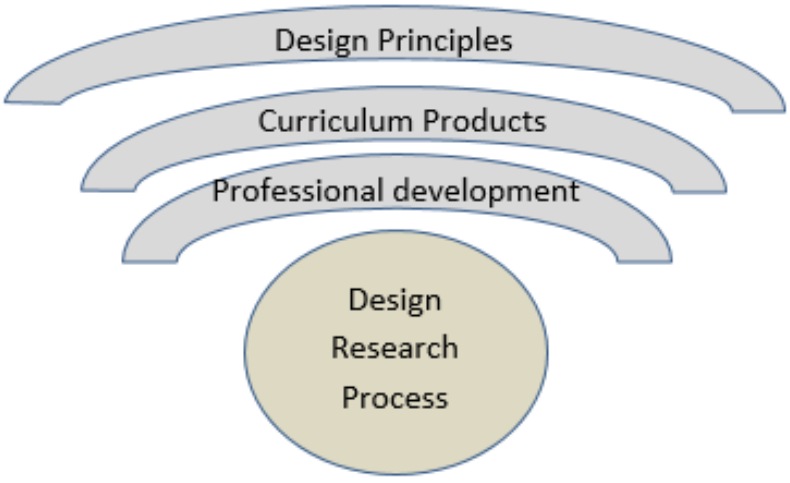


Figure 1. The three main outputs of design research. (McKenney et. al., 2006)

### The Three Phases of the EDR

The schematic representation of the STEM course design development processes was shown in Figure 2. The research was designed to consist of three phases in accordance with the EDR.

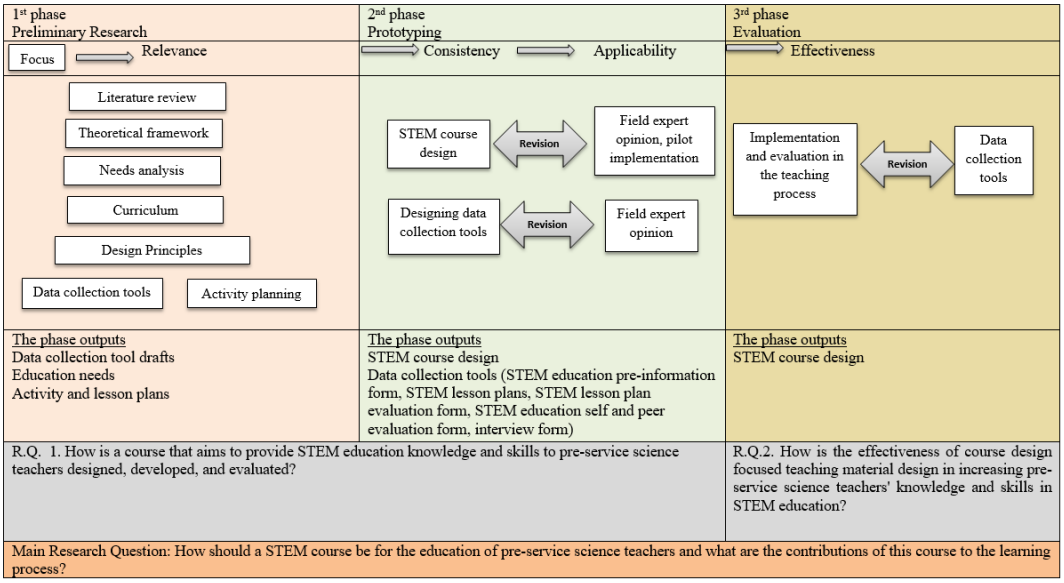


Figure 2. Schematic representation of the STEM course design development process

### *1. Preliminary Research Phase*

In this phase, needs analysis was conducted to create a detailed scientific framework required to ensure the STEM professional development of pre-service science teachers. All contents specified in the STEM education needs analysis form were stated to be necessary by the experts. However, robotics-coding was not stated to be necessary at the first stage. In addition, it is thought that pedagogical content knowledge and teaching profession competencies should be included. Similarly, the pre-service teacher education literature supported the opinions of experts (Sanders, 2009; Eckman et. al., 2016; Hacıoğlu, et. al., 2016; Pimthong & Williams 2018). When the curriculum as "Science Trainings" and the "Science" is also examined, it can be said that they do not fully include STEM education and they take into account science, engineering, and entrepreneurship practices.

Thus, several activities have been designed to increase the knowledge and skills of pre-service teachers regarding STEM education. The activities were prepared according to the transdisciplinary model expressed by Vasquez et al. (2013). Science concepts were associated with mathematical thinking and data collection, engineering was used as a context and activities were engineering centered. The ending engineering product and materials used were associated with the technology discipline. Six activities were designed according to hands on-minds on method with simple materials and the participants were asked to design a 21st century house as a common theme. In this way, "Prototype 1-STEM Course Design" was created.

### *2. Prototyping Phase*

The prototyping phase of the research reflects the process of developing STEM course design through formative assessments as a result of collaboration between pre-service teachers, experts, and researchers. In the sub-phases of the prototyping phase shown in Figure 3, the necessary arrangements (seen in the Pilot study and Expert Opinions) were made and thus, the consistency and applicability of the STEM course design were determined.

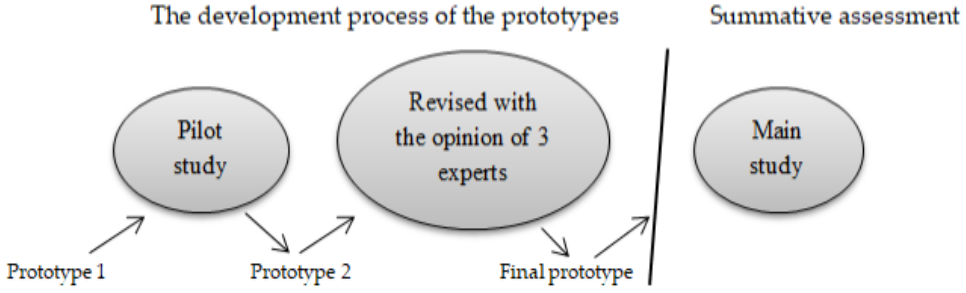


Figure 3. Prototyping phases of STEM course development

### *2.1. Pilot Study*

Prototype 1 which was developed in the preliminary research phase was evaluated in the Special Teaching Methods-I course. The participants of the study were 20 pre-service 3rd year science teachers who participated voluntarily in the spring semester of 2017-2018 in Turkey. Prototype 1 was revised by taking into account the researcher's experience and observations in the pre-service teachers' trainings performed every week and the reflections written by the pre-service teachers. In this initial phase, theoretical framework of STEM education in the STEM course design was revised by enriching with teaching methods and techniques without reducing its content. In addition, instant (online applications such as Kahoot, plickers) and alternative assessment methods (examine-prepare PISA questions) were included in STEM course design. As a result, the course design was reviewed in terms of understandability, applicability, and suitability.

### *2.2. Expert Opinions*

The opinions of the three experts (two from science education, one from curriculum and instruction) were received in terms of suitability and applicability of the STEM course design for pre-service science teachers, and the suitability of STEM activity-lesson plans. According to expert opinions, the theoretical parts in the 1-4th weeks of Prototype 2 was not changed and consequently, structured STEM lesson plans prepared according to the 5E instructional model, problem and project-based learning methods were planned to be examined and discussed by the pre-service science teachers between 5-7th weeks. These methods were preferred because they are among the models and methods frequently used in STEM education (e.g. Han, Capraro & Capraro, 2014; Yıldırım & Selvi, 2017). Moreover, problem/project-based strategies provide a deeper and more relevant learning experience in the process of solving real-world problems with open-ended and multiple solutions (Vasquez, Sneider & Comer, 2013). In the 8th and 9th weeks, the pre-service teachers actively participated in determining outcomes, selecting materials, designing products, and preparing lesson plans according to the 5E instructional model and problem-based learning method. Between the 10-14th weeks, pre-service teachers designed a STEM activity as the final task, prepared a lesson plan according to the project-based learning method in STEM, and presented them. The researcher and other pre-service teachers gave feedback to the presenter group. Thus, the final prototype was created by making the necessary improvements suggested by the experts in the STEM course design.

### *3. Evaluation Phase*

In this phase, to determine the effectiveness of the STEM course developed in this cyclical process, it was applied in the course titled "Instructional Technologies and Material Design" to 21 volunteer pre-service science teachers (3rd year) in the fall semester of the 2018/2019 academic year. The whole study group consisted of female students who have not received any STEM education.

## Data Collection Instruments

*STEM Education Needs Analysis Form*

STEM education needs analysis form was developed to determine the knowledge and skills that pre-service teachers should have about STEM education. In the process of developing the form, national (Turkish Ministry of Education [TMoNE], 2016) and international research reports (e.g. National Academy of Engineering [NAE] & NRC, 2014) about STEM education in pre-service teacher education (Stohlmann et. al., 2012; Teo & Ke, 2014) and science curriculum were taken into consideration. Two experts in STEM studies and an expert from curriculum and instruction were consulted to establish the content validity of the items. After expert opinions, the final version consisted of 15 items answered as 3-point Likert type (disagree, undecided and, agree). An example of which is: *"There are educational needs for the application of the project-based learning method in the STEM education." After the form was prepared, it was sent to five experts from STEM education and the opinions of pre-service science teachers regarding STEM education needs were defined.*

*STEM Education Pre-Information Form*

STEM education pre-information form was developed to determine the current knowledge and skills of pre-service teachers regarding STEM education. In this form, the subject was "Connecting Light Bulbs" which is included in the science curriculum was topic chosen and three different scenarios included the teaching performances of teachers according these different methods (1st scenario: STEM education approach, 2nd scenario: Prediction-Observation-Explanation (POE) method, 3rd scenario: Experimentation technique based on demonstration). In this form, pre-service teachers were asked to evaluate three different scenarios comparatively and to fill in the table containing the unit outcomes by associating the outcomes with the scenarios.

*STEM Lesson Plan and STEM Lesson Plan Evaluation Form*

Firstly, the STEM lesson plans in the literature (Walton & Caruthers, 2016; Konuk, 2014) were examined. The STEM lesson plan evaluation form was developed in line with the STEM lesson plan. Two experts from both science and STEM education were consulted to finalize the STEM lesson plan and the STEM Lesson Plan Evaluation Form. The STEM Lesson Plan Evaluation Form consists of three parts: Pre-lesson (Preparation and Planning), Course Process (using 5E Instructional Model) and Course Outcome (Design Evaluation). The pre-lesson section consists of 8 items that aim to measure the knowledge and skills of pre-service teachers regarding the preparation and planning process for the STEM education course. The course process consists of 5 items that aim to measure the knowledge and skills of pre-service teachers to use the stages of the 5E teaching model in the STEM lesson plan. The lesson result consists of 1 item that aim to measure the knowledge and skills of pre-service teachers to design a product as a result of STEM activity. Summarily, 14 items and a 3-point Likert type form was constructed. In addition, a column was supplied to write the justification for the score obtained for each item. The minimum score to be given from the STEM lesson plan evaluation form is 0, the maximum score is 42.

*STEM Education Self and Peer Evaluation Form*

In the self-evaluation form, pre-service teachers were asked to evaluate whether STEM activity and lesson plans were effective and they were asked where to change if they had to re-present the STEM activity in their future practices.

In the peer evaluation form, pre-service teachers were asked to find out the components of STEM education presented by their peers and they were asked to indicate the faults or deficiencies of their peers' presentations in terms of teaching-learning process, if any. They were asked to evaluate the differences of the lesson from an ordinary science lesson. Finally, they were also asked to evaluate the effectiveness of STEM lesson plans presented by their peers in real classroom environment.

*The Interview Form*

Interviews were carried out with the 21 pre-service science teachers to determine pre-service teachers' STEM education knowledge and skills and the effectiveness of STEM course design. To achieve this aim, the literature was examined during the preparation of the semi-structured interview form (e.g. Blackley, et. al., 2017; Pimthong & Williams 2018). The semi-structured interview form was reviewed by two STEM education experts. As a result, each pre-service science teacher was asked 8 questions in the interview form such as "What were the difficulties you encounter while planning STEM education (STEM activity and lesson plan)? What kind of solutions did you develop for the situations you had difficulties while planning STEM education?" Interviews were conducted by the first researcher and completed in an average of 18 minutes with each participant individually.

**Data Analysis**

Descriptive and content analysis techniques were used together in analyzing the qualitative data. Interview forms were analyzed after being transcribed. The written responses of the pre-service teachers to the STEM education needs analysis form, STEM education pre-information form, self and peer evaluation form were added to the data pool electronically and analyzed using two data analysis techniques.

Moreover, the data from the STEM lesson plan evaluation rubric were analyzed by calculating arithmetic averages ($X_{ort}$). The group interval coefficient suggested by Kan (2009) was used to make the arithmetic means obtained from the STEM lesson plans meaningful. Thus, group intervals are determined between 2.26-3.00 as very good, between 1.51-2.25 as good, between 1.50-0.76 as acceptable, and between 0.75-0.00 as initial level.

### Validity and Reliability

To provide validity of the research, data collection method and tools were diversified in the research. The research method, data collection and analysis stages, and the findings are presented in a detailed way. The opinions of two experts from STEM education were obtained in all phases of the data collection.

In the descriptive analysis of the data, themes were created by examining the research questions, the STEM course design developed within the scope of the research, the theoretical framework of STEM in teacher education and the findings of STEM-focused studies in teacher education. Themes and codes that emerged in the descriptive analysis were examined in more depth and unnoticed concepts and themes were discovered through content analysis. To provide reliability of the research, the researcher checked the codings by reading the data set at different times. In the second coding, the codes expressed in long sentences were shortened and several new categories were added. Direct quotations were presented in the results part. The opinion of an expert from STEM education regarding the codes, categories and themes were obtained. In addition, the STEM lesson plans of the participants were examined and scored by the researcher and another expert according to the STEM lesson plan evaluation form. The data obtained within the scope of the research were collected and documented systematically. The schematic representation of the STEM course design development process is as shown in figure 3 below.

## Findings

### STEM Education Course Design

Firstly, the nine main knowledge and skills, which were explained in-depth in the discussion part, have been determined in the educational design research cycles. The content of the STEM course has been planned according to the nine items. Then, activities for a group who did not take the STEM education were prepared and applied according to the hands on-minds on method with simple tools and equipment at the beginning level. In this study, activities were designed according to the transdisciplinary approach that enables pre-service teachers to find solutions to real-life problems. In determining the activities, the contexts used in the PISA questions and the contexts (e.g. Health, Energy Efficiency) explained by Bybee (2010) within the scope of the 2006 PISA framework were examined. Considering the outcomes of the science curriculum, activities have been developed as in the following Table 1.

Table 1. Disciplines and models related to STEM activities

| Context of the activity (STEM integration model) | Name of the activity | Science | Technology | Engineering | Mathematics |
|---|---|---|---|---|---|
| Designing a 21-st century house (Trans-disciplinary) | Earthquake-proof house | ✓ | ✓ | ✓ | ✓ |
| | Electricity generation by wind power | ✓ | ✓ | ✓ | ✓ |
| | Sound-proof house | ✓ | ✓ | ✓ | ✓ |
| Designing a vehicle (Trans-disciplinary) | Two-Stage Rocket Design | ✓ | ✓ | ✓ | ✓ |
| | Designing a tool to reduce the impact of air or water resistance | ✓ | ✓ | ✓ | ✓ |

Pre-service teachers were asked to design a 21-st century house and vehicle design by conducting various activities such as earthquake proof house, wind power electricity generation, sound-proof house design; two-stage rocket design and vehicle design to reduce the effect of air and water resistance, respectively. To

exemplify 21-st century house, the activity was associated with the 5th grade subject of destructive natural event in the science curriculum as shown in Table 2 below. In addition, a shaking table with a system consisting of a spring and motor was created by the researcher to test the groups' designs.

Table 2. STEM disciplines with which earthquake proof house design is associated

| STEM disciplines | Earthquake Proof House |
|---|---|
| Science (S) | Destructive natural events and ways of protection |
| Technology (T) | Designed earthquake-proof house, using necessary materials, using shake table |
| Engineering (E) | Engineering design process, knowledge and skills related to the field of engineering related to the activity, design thinking |
| Mathematics (M) | Length and time measurement, area calculation |

**The Effectiveness of STEM Course**

In order to determine the knowledge and skills of pre-service science teachers in STEM education, STEM education pre-information form was applied to the pre-service science teachers and their level of knowledge and skills were explained. In the form, the pre-service science teachers were asked to match the subject of "Connecting Light Bulbs" included in the science curriculum with three different scenarios included the teaching performances of teachers according to different methods. The reason for choosing this subject area is that it includes an experimental process. According to the result of STEM education pre-information form, the pre-service science teachers have difficulty to match the subject with different teaching methods, which showed that pre-service teachers had low level of STEM awareness. The pre-service teachers did not only have an explanation to interpret scenario 1, but also, they did not use the main characteristics of STEM education correctly. Their explanations did not go beyond repeating the scenario in general and making evaluations accordingly. To illustrate these results, the pre-service teachers said that calculations were made for design, but they did not state that it was an interdisciplinary practice or a STEM-oriented education. Moreover, the pre-service teachers used the expression of "design", mentioned in the scenario, but they did not explain the engineering design in their answers. Therefore, it can be said that pre-service teachers had superficial knowledge about STEM education at the beginning. An example of the responses of the pre-service teachers is as follow:

> *PST16… "The difference from other scenarios is that it does not arouse curiosity in students and there was no measurement and evaluation in the teaching process. I think it is not efficient to ask students directly design after the concepts are given to the students."*

When the STEM course design was implemented, significant improvements were made in the knowledge and skills of pre-service teachers about STEM education. At the end of the term, the lesson plans prepared by the pre-service teachers according to STEM activities and project-based learning method in STEM were evaluated according to the STEM lesson plan evaluation form. Sample projects from the training are shown in the figure 4. The results regarding the evaluation of STEM lesson plan were presented in Table 3.

Figure 4. Examples of project designs

Table 3. Findings obtained from the STEM lesson plan evaluation form (Number of groups (n) =7)

| Phases | | Item | Proficiency level |
|---|---|---|---|
| Pre-lesson (Preparation and planning) | 1 | the knowledge and skill of the pre-service teacher to determine the gains in STEM disciplines | Very good |
| | 2 | the knowledge and skill of the pre-service teachers to determine the appropriate period for the gains | Good |
| | 3 | the knowledge and skill of the pre-service teacher to use 21-st century skills divided into 4 groups within the framework of P-21 in STEM activities within the recommended period | Good |
| | 4 | the knowledge and skills of pre-service teachers to prepare STEM activities. | Very good |
| | 5 | the knowledge and skill of the pre-service teacher to use the Engineering Design Process stages while creating the product | Very good |
| | 6 | the knowledge and skill of the pre-service teacher to prepare an introductory paragraph (scenario) containing a real-life problem. | Very good |
| | 7 | the knowledge and skill of the pre-service teacher about limitations (time, budget, materials to be used) regarding the real-life problem. | Very good |
| | 8 | the pre-service teachers' knowledge and skill about the professions related to STEM disciplines and special to a problem situation. | Very good |
| Course Process (Using 5E Instructional Model) | 9 | "Engage" phase of the 5E instructional model: preparing stimulants (brainstorming with questions and answers, cartoons, videos, etc.) to evaluate the preliminary information and to arouse curiosity | Very good |
| | 10 | "Explore" phase of the 5E instructional model: preparing activities such as hands on-minds on activities, educational software, access to information from print resources, online and other experts, class discussions to reveal students' existing knowledge, skills, and misconceptions (if any) | Very good |
| | 11 | "Explain" phase of the 5E instructional model: preparing the concepts and definitions related to the outcomes of the science course to complete the STEM project. | Very good |
| | 12 | "Elaborate" phase of the 5E instructional model: preparing the content that reflects the gains of other STEM disciplines (Technology, Engineering, and Mathematics) related to STEM activity. | Good |
| | 13 | "Evaluation" phase of the 5E instructional model: using a measurement-evaluation approach for STEM education. | Very good |
| Course outcome (Design evaluation) | 14 | The knowledge and skill of the pre-service teacher to create an original and durable product that provides solutions to real-life problems. | Good |

As a result, i.) it was observed that the pre-service teachers had a very good level of knowledge and skill from the pre-lesson (preparation and planning) phase according to the STEM education approach. ii) pre-service teachers for using the 5E teaching model in the course process reached a very good level of knowledge and skill. iii) Pre-service teachers have good knowledge and skills about creating products at the end of the course. The findings obtained from the lesson plan evaluation rubric were also supported by the findings obtained from peer evaluation, self-evaluation, and interview forms. The similarities and differences in terms of themes and codes in peer evaluation, self-evaluation, and interview forms are presented in Table 4.

Firstly, the codes that emerged after the STEM activity and lesson plan of the presenting group were evaluated by pre-service teachers in terms of components of STEM education were given in Table 4. PT18 from the participants stated their views on the first theme as "*There is a project produced based on design and project, environmental and health literacy, entrepreneurship and self-management, productivity.*" in the form. In the interview form, pre-service teachers were asked to indicate similar or different aspects of the STEM education approach from other learning, teaching approaches, methods, and techniques to learn more about their knowledge and skills about STEM education.

Table 4. Comparative data of self and peer-assessment, and interview

| Theme | Code | Theme | Code | |
|---|---|---|---|---|
| 1.STEM education components included in the STEM activity and lesson plan | Peer assessment | 2.Similar or different aspects of the STEM education approach from other learning-teaching approaches, methods, and techniques | Interview | |
| | Including the integration of STEM disciplines | | Similar | Different |
| | Including 21-st century skills | | Determining the gains | Interdisciplinary |
| | Including a real-life problem | | Creating a design | Technology oriented |
| | Including Evaluation-PISA questions | | Creative thinking Cooperative learning | Including interaction within the group |
| | Product design | | 5E teaching model, Attracting attention, Brainstorming | Including designing process |
| | | | Summative assessment, Measurement - evaluation with concept maps | Project-based teaching-Including engagement activities-Using scientific process skills actively-Focusing thinking-Instructor guidance-Asking questions-Including explore and elaborate phases-Learning by doing-Implementation |
| | | | Using techniques such as fishbone, station | |
| 3.Whether STEM activity and lesson plans are effective and their reasons | Peer-evaluation | 4.Ineffective aspects of STEM activity and lesson plans-Changes in their ineffective performance | Self-assessment | Changes |
| | Suitability of the contents in the lesson plan (5E) | | There are no some disciplines (e.g. engineering or technology) | Using tinkercad and 3D paint |
| | Including STEM disciplines | | No determining the gains correctly | Associating the gains with the activity and the problem |
| | Including product design | | PISA question needs to be developed | Setting the class level correctly, improving preparation scoring key |
| | Focusing 21-st century skills | | Failure to prepare projects following the STEM education | Focusing on design, designing durable, useful and functional |
| | Fun-engaging | | Teacher effectiveness in the "explain" phase | Reforming |
| | Providing design-oriented thinking-Providing collaboration- | | | |
| | Including scientific process skills-Including engineering skills | | | |
| Theme | Code | | | |
| 5. Missing/wrong aspects in the STEM activity and lesson plans | Peer assessment<br>There is no mathematics discipline in STEM activities.<br>There is no technology discipline in STEM activities.<br>Shortcomings in the content of the course<br>Not suitable for STEM education approach | | | |
| Theme | Code | | | |
| 6. What can a lesson planned for STEM education bring to students? | Interview | | | |
| | 21-st century skills<br>Hand skills<br>Design thinking skill<br>Scientific process skills<br>Research-inquiry skills<br>Increasing students' motivation on and interest in the course-Professional career knowledge-STEM literacy-Increasing interest in STEM disciplines | | | |

*Note.* The codes in Table 4 were listed according to the frequency and the codes with the same frequency were shown side by side with the "-" symbol.

While pre-service teachers talked about similar aspects of STEM education, they mostly stated different aspects. For example, *"The feature that distinguishes STEM from others is that students are more active…In STEM, the teacher shows the students a certain way and encourages them to think. It provides an environment where students are active. In a normal science lesson, only science is taught … we don't associate it with other disciplines. In STEM, other disciplines - technology, engineering, mathematics - are also effective in design"* (PT5). The active learning environment that caused PT5 to have these thoughts is presented in the Figure 5.

Figure 5. An example from the project presentation of the pre-service teachers

Moreover, pre-service teachers evaluated whether the STEM activity and lesson plans of the presenter group were effective in terms of teachers and students and its reasons in the peer evaluation form. All of the pre-service teachers stated that it was effective but needed some minor adjustments. PT1 explained this situation as *"*STEM activity *was very suitable for the life problem. There were different and effective activities. PISA questions were adequate to measure and consistent with the project. Providing feedback with other assessment methods was enough to improve the students. It contained all outcomes in STEM disciplines. It was related to 21-st century skills. It improves students' scientific process skills*". Eight pre-service teachers' views on the ineffective aspects of STEM activity and lesson plans that were prepared as a group were coded as shown in Table 5 (Self-assessment form). PT18 expressed as *"The outcomes are not suitable for the project ... The PISA question was not suitable for the grade level."* and PT5 expressed her views as *"It does not include mathematics discipline."* The pre-service teachers, who evaluated ineffective aspects of their presentations explained how they would make changes in their future practices or had the opportunity to represent it again. For example, PT11 stated that *"I used to prepare the STEM activity and lesson plan in the same way. I would just improve explore phase and improve the PISA question… "* (PT11).

Figure 6. Two-stage rocket designs of pre-service teachers

Pre-service teachers were asked to state missing/wrong aspects in the STEM lesson plan and activities of the presenter group. Few pre-service teachers stated missing or wrong aspects. For example, PT11 explained as *"I*

*could not see anything related to mathematics. The technology part is missing. There were science and engineering disciplines." in the peer assessment form.* Figure 6 illustrates that the technology discipline is not effectively involved in the STEM project.

The pre-service teachers were asked to express their thoughts about the benefits of STEM education to their future students. PT13 expressed her thoughts as *"Students will be able to use their knowledge in their daily life. They will be able to design a vehicle. Entrepreneurship... While walking on the road, the student will constantly think about a problem. The student will think about solutions. His ability to interpret will improve. I think this a very effective activity. This activity helps to improve science literacy and mathematic literacy.*

## Conclusion and Discussion

This study proposed a STEM course design for pre-service science teachers and explored its effectiveness in increasing pre-service teachers' knowledge and skills in STEM education. The course design was developed in line with the feedback from the experts, the researchers and pre-service science teachers. Therefore, STEM course design reflects pre-service science teachers' needs (knowledge and skills) about STEM education. The knowledge and skills pre-service science teachers need to have about STEM education have been determined in the educational design research cycles as follows. In the research, pre-service teachers acquired the theoretical aspect of STEM. Similarly, Sanders (2009) emphasized that the foundations of STEM education should be in the content of teacher education. In the study, pre-service teachers learned the main characteristics of STEM disciplines. The STEM course design in this study supported the idea of STEM which was applied to encourage people to address authentic problems that cannot be solved with a single discipline, but require using the integration of the knowledge and processes of different STEM disciplines (Bybee, 2013; Nadelson & Seifert, 2017; Urban & Falvo, 2016). Moreover, effectiveness of teachers' teaching STEM disciplines depends on their competencies in these areas (Eckman et. al., 2016). The results of some studies also showed that pre-service teachers need the education to ensure the integration of STEM disciplines (Hacıoğlu et. al., 2016; Pimthong & Williams 2018). Pre-service teachers gained knowledge and skills about associating STEM lessons with 21-st century skills. In the literature, it is stated that teachers should equip their students with 21-st century skills and they should experience in these skills (Akpınar, 2014; Çakmak, 2015; Işık & Saygılı, 2015). Pre-service teachers used current science curriculum to plan a lesson according to STEM education. Considering that pre-service teachers will become the implementers of the programs in the future, they should know how to benefit from the program according to STEM education. In addition, pre-service teachers should know about the program to determine the outcomes of the science discipline that are suitable for STEM education. In the study, pre-service teachers examined STEM activities carried out in the context of Turkey and other countries. It should be ensured that pre-service teachers should see STEM activities in our country and other countries to gain different perspectives. Pre-service teachers gained knowledge and skills about measurement-evaluation methods and techniques in STEM education. According to the STEM education approach, a course can be evaluated with formative, summative and instant measurement-evaluation. NRC (2014) reported that measurement and evaluation in STEM education is that tests multidimensional and diverse learning outcomes and requires using various tools, methods and techniques spread throughout the process. In this process, technology-oriented applications (kahoot, plickers etc.), rubrics for design evaluation, etc. can be used. PISA questions also should be used to evaluate with context-oriented questions in STEM education. Pre-service teachers used different teaching methods and techniques (e.g. 5E teaching model, problem/project based learning methods) in STEM education. It is also emphasized in the literature, a teacher should apply effective teaching method and techniques for the successful learning process for students in STEM subjects (Lichtenberger & George-Jackson, 2013). Pre-service teachers studied in collaboration with their peers. It was discussed that interdisciplinary cooperation will be achieved by studying together with teachers from different fields in their professional lives. Pre-service teachers prepared a lesson plan according to STEM education and implementing it. In parallel with this study, Türk, Kalaycı, and Yamak (2018) concluded that teachers should have the knowledge and skills to prepare and implement a lesson plan suitable for STEM education in the study. It was stated that successful integration of STEM disciplines depends on whether teachers develop an understanding of the subject and conceptualize interdisciplinary connections (Pang & Good, 2000). As revealed in the study of Türk, Kalaycı, and Yamak (2018), this study also allows pre-service science teachers opportunity to develop thinking skills, to use technology effectively, to study interdisciplinary, to become effective in identifying and solving daily life problems, and to become STEM literate within the framework of identified nine knowledge and skills.

In parallel with the nine knowledge and skills, activities were prepared and applied according to the hands on-minds on method with simple tools and equipment at the beginning level. Hence, students learn concepts

specific to different disciplines such as science and mathematics during the product design process in a lesson planned according to the hands-on method (Zubrowski, 2002; Featonby, 2010; Thompson & Mathieson, 2001). It also improves students' social skills and thinking skills (Verma et. al., 2011). In addition, STEM knowledge of students is improved and their orientation towards STEM careers is provided (Knezek et al., 2013; Knezek et al., 2014). Moreover, it has been determined that hands on-minds method with simple equipment is mostly used in STEM activities for pre-service teacher education in implementation studies (Authors, 2020). Additionally, activities were designed according to the transdisciplinary approach that enables pre-service teachers to find solutions to real-life problems. Thus, 21st century skills, knowledge and attitudes towards real-world training and problem-solving strategies were combined. In the real-life-oriented education process, students can also discover engineering knowledge and skills. In the literature, teachers had problems in studies related to the engineering dimension and difficulties in the engineering process. This is due to the fact they did not receive any training in their university education process (Blackley & Howello (2015).

The effectiveness of the STEM course design in acquiring the knowledge and skills of pre-service teachers was also investigated. Firstly, it has been determined that pre-service science teachers had low STEM awareness. Indeed, their explanations generally didn't go beyond repeating the scenario concepts in the teaching process and making superficial evaluations. For example, the term "design" is mentioned in the scenario. But the pre-service teachers did not mention the engineering design process and cycle in any way by using this term exactly in their answers. This finding was consistent with many previous studies (Pimthong & Williams, 2018, 2020, 2021; Hacıoğlu et. al., 2016). For example, Hacıoğlu, Yamak, and Kavak (2016) determined that pre-service teachers explained STEM as science, technology, engineering, and mathematics, but they did not have any idea about the nature of integration, they could not explain how the four disciplines can be integrated. These findings are important in determining the effectiveness of STEM course design on pre-service science teachers' development of STEM education knowledge and skills.

In the STEM course, the knowledge and skills of pre-service science teachers about STEM education were expressed under three headings in lesson plans. According to the STEM education, it was observed that the pre-service teachers had a very good level of knowledge and skills at the pre-lesson (preparation and planning) phase, a very good level of knowledge and skill at the phase of using the 5E teaching model during the lesson, and a good level of knowledge and skill at the phase of creating products at the end of the course. All pre-service science teachers were encouraged to prepare and evaluate STEM lessons and activities. Thus, pre-service teachers were guided to understand the importance of preparing an environment for their students to apply knowledge and skills to solve complex and multidimensional issues or problems as stated in the literature (Bybee, 2013; Radloff & Guzey, 2017; Vasquez et al., 2013).

## Limitations and Recommendations

As stated in the previous sections, the effectiveness of STEM course design in pre-service science teacher's education was defined. This study's implications were vital in terms of implementing STEM education for pre-service teacher education. Nevertheless, this study is limited in terms of reflecting pre-service teachers' experience in a real classroom setting. It is recommended that future studies should provide collaboration with pre-service teachers, students, and in-service teachers. This study showed that pre-service teachers have problems in integrating knowledge and skills related to technology and engineering disciplines with their real-life problems. Thus, future studies should focus on developing the knowledge and skills of pre-service teachers about engineering and technology discipline and show how to integrate these disciplines into their real-life problems. This study focused only on pre-service science teachers. Therefore, future studies are recommended to be conducted with a mixed group from different departments (e.g. Engineering, Computer Education, and Instructional Technologies) to provide collaboration between different disciplines. In addition, it was found that pre-service teachers could not determine daily life problems for product design and PISA questions. Hence, context information may be enriched by providing awareness of current problems in the world through content education courses such as "Science Teaching Laboratory Trainings" and "Special Teaching Methods".

## Scientific Ethics Declaration

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

## Acknowledgements

This study is produced from the doctoral dissertation of the first author in the advisory of the second author.

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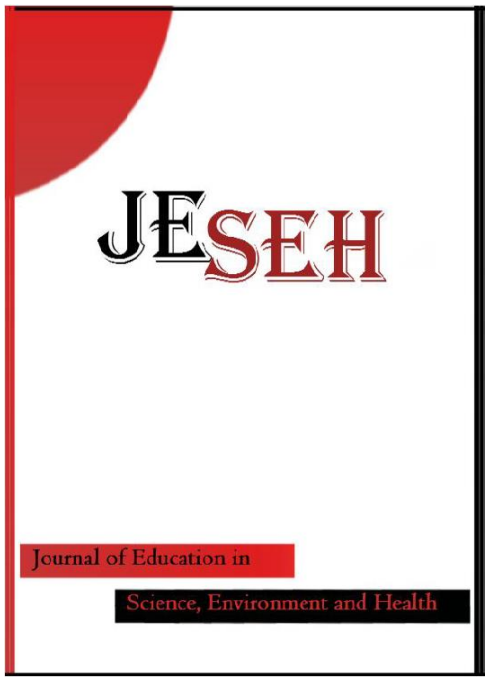
## Author(s) Information

**Kibar Sungur-Gul**
Nevsehir Hacı Bektaş Veli University
Faculty of Education, Department of Mathematics and Science Education, Nevşehir/Turkey
Contact e-mail: k.sngr89@gmail.com
ORCID iD: 0000-0002-9590-1439

**Mehmet Fatih Taşar**
Gazi University
Faculty of Education, Department of Mathematics and Science Education, Ankara/Turkey
ORCID iD: 0000-0003-1249-3482




**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

www.jeseh.net

# Student Attitudes towards Guided Inquiry Approach Supported by Digital Stories

**Merve Berika Kansoy**[1], **Ayse Sert-Cibik**[2]
[1]Ministry of National Education
[2]Gazi University

**To cite this article:**

Kansoy, M.B. & Sert-Cibik, A. (2023). Student attitudes towards guided inquiry approach supported by digital stories. *Journal of Education in Science, Environment and Health (JESEH)*, *9*(2), 101-118. https://doi.org/10.55549/jeseh.1279731

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1279731

# Student Attitudes towards Guided Inquiry Approach Supported by Digital Stories

**Merve Berika Kansoy, Ayse Sert-Cibik**

## Article Info

***Article History***

Published:
01 April 2023

Received:
26 February 2022

Accepted:
12 October 2022

***Keywords***

Attitude
Guided inquiry approach
Digital story
Mixed method

## Abstract

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

## Introduction

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

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

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

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

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

## Inquiry Approach

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

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

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

## Digital Storytelling Method

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

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

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

This study sought answers to the following research questions:

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

## Method

### Model of the Research

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

### Participating Students and Implementation Process

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

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

*Implementation Process*

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

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

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

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

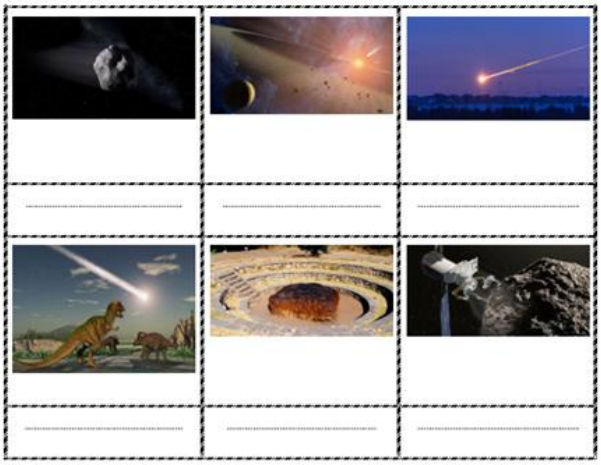


Figure 1. Storyboard view of the Asteroid Belt event

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

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

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

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

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

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

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

Figure 2. Pieces dropped in the sand

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

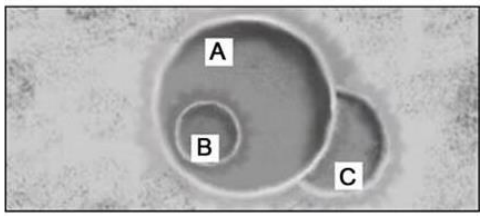



Figure 3. The visual in the evaluation question

**Data Collection Tools**

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

*Attitude Scale towards Research-Questioning (ASTRQ)*

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

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

*Observation Form and Teacher's Diaries*

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

*Focus Group Interview Questions*

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

## Validity-Reliability Check

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

## Analysis and Interpretation of Data

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

## Findings and Interpretation

### Attitudes of Lower, Middle and Upper Group Students towards Inquiry

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

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

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

p*<.05

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

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

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

p*<.05

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*Findings regarding the Teacher Sub-Factor in the Observation Form*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*Findings regarding the Student Sub-Factor in the Observation Form*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*Findings regarding the Lecturing Sub-Factor in the Observation Form*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## Discussion

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

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

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

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

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

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

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

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

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

## Conclusion

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

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

## Recommendations

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

## Scientific Ethics Declaration

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

## Note

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

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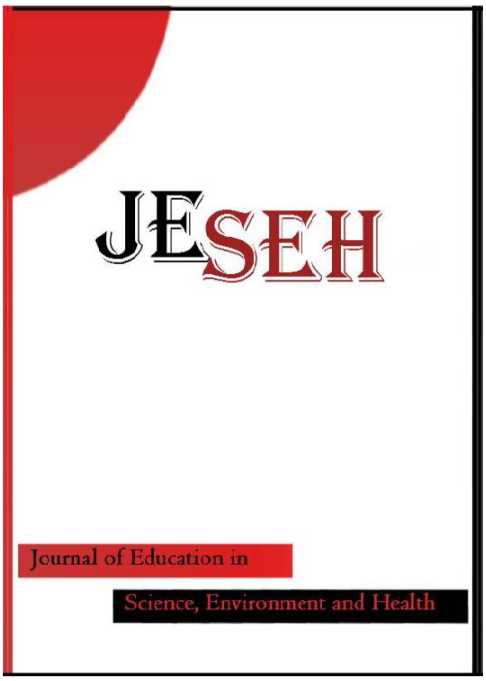
## Author(s) Information

**Merve Berika Kansoy**
Ministry of National Education, Ankara, Turkey
ORCID iD: 0000-0003-3352-9376

**Ayşe Sert Çıbık**
Gazi University
Department of Mathematics and Science Education, Ankara, Turkey
Contact e-mail: *sertay@gazi.edu.tr*
ORCID iD: 0000-0001-9648-3593




**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

**www.jeseh.net**

# The Effect of Educational Film Supported Augmented Reality Applications on Academic Achievement and Motivation for Science Learning

**Emre Guvenir[1], Ezgi Guven-Yildirim[2]**
[1]Ministry of National Education
[2] Gazi University

**To cite this article:**

Guvenir, E. & Guven-Yildirim, E. (2023). The effect of educational film supported augmented reality applications on academic achievement and motivation for science learning. *Journal of Education in Science, Environment and Health (JESEH), 9*(2), 119-130. https://doi.org/10.55549/jeseh.1279771

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1279771

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**Emre Guvenir, Ezgi Guven-Yildirim**

## Article Info

***Article History***

Published:
01 April 2023

Received:
28 April 2022

Accepted:
03 January 2023

***Keywords***

Augmented reality applications,
Educational film,
Science learning,
Motivation

## Abstract

The aim of this research is to investigate the effects of educational film-supported augmented reality applications in the teaching of the Solar System and Eclipses Unit of the 6th grade Science course on the academic success of the students and their motivation levels for learning science. The study group of the research consisted of 42 students attending the 6$^{th}$ grade in Kahramanmaraş in the fall semester of the 2021-2022 academic year. In this research, quasi-experimental design was used. The participants from whom the data were collected were determined by convenient sampling method. The experimental group (N=22) of the study consisted of the learning group with educational film supported augmented reality applications, and the control group (N=20) was the group that studied with the learning method specified in the current science curriculum. The results obtained from the study revealed that there was no significant difference between the achievement test and motivation scale pre-test scores of the experimental and control groups. Another result obtained from the study is that there is a significant difference in favor of the experimental group between the achievement test and motivation scale posttest mean scores of the groups as a result of the application process.

## Introduction

Today, most of the developments and changes in the world are undoubtedly taking place in the fields of information and technology. These technological developments provide convenience to individuals in numerous areas in daily life. The conveniences brought by these developments are also used within the scope of science courses. And it is stated that the use of technology in lessons is beneficial in terms of gaining students the desired features (Hancer, Sensoy, & Yildirim, 2003). In this context, it is not possible to think of the education system independently of the developments in technology at the point of raising individuals in accordance with the age, and it is almost a necessity to use technology in education in our age (Sahin, 2017). The use of technology in education is of great importance in terms of easier access to information as a result of rapid developments in technological tools, providing comfort to both the teacher and the student in terms of environment and time, and keeping up with the rapid changes in science and technology (Kenar & Balci, 2013).

While technology is used during learning and teaching activities in many different educational fields, technology is also used at various points while conducting science education. With the use of different types of teaching elements and technology in science education, students can associate the knowledge they have acquired with daily life. In addition, the use of educational technologies in science courses raises students' interest and attitudes towards the course even higher (Kirilmazkaya, Kececi, & Zengin, 2014). In addition, teaching using visual and auditory materials contributes positively to the permanence of the learned information, and the teacher undertakes a guiding task for the student in this process (Fidan, 2008). In this context, Sagliker (2009) emphasizes the necessity of increasing the richness levels of the environments in terms of visual and auditory in order to raise individuals who are interested in science and have the effort to succeed. Due to this and similar reasons, it is seen as a necessity to develop both the education and training environments and the teaching programs in a way that will allow the use of technological tools. Therefore, it is seen as a necessity to develop both the education and training environments and the curricula in a way that will allow the use of technological tools. At this point, individuals born in the period between 1995 and 2010, called the Z generation, actively use social networks as a generation that grew up with tablet computers and mobile phones. The concept of augmented reality has come to the fore in recent years in terms of providing a flexible learning process and environment for these individuals, diversifying education and creating an efficient learning environment for enriching (Yildirim, 2018).

Azuma (1997) defines augmented reality as a technology in which virtual and real objects are combined with simultaneous interaction. Augmented reality brings together the real world and virtual environment in which students continue their lives, to learners; It is a technology that supports the internalization of abstract concepts and provides a learning experience (Erbas & Demirer, 2014). Kara (2018) defines augmented reality as an information technology that provides experience to individuals, in which real life is extensively reproduced using virtual contents. Augmented reality technology is based on the principle of transmitting the image to the real environment after the information obtained with the help of different sensors (camera, glasses, etc.) from the real environment, after certain processing processes. When using augmented reality applications, reality emerges by adding sound, 2D - 3D object, video, text, animation or simulations obtained on the computer to the image of the real world environment (Altıntas, 2018). Recently, different augmented reality applications have been developed in order to enable a beneficial learning environment in which active participation of students is ensured. With these applications, it is possible to teach science subjects by providing visualization, and it is possible for students to internalize real-life situations and problems in a simpler way (Bulus Kirikkaya & Sentürk, 2018). The awareness level of augmented reality applications, which add different dimensions to the methods of increasing interaction among learners in educational environments, is increasing day by day. For this reason, many mobile applications are being developed for educational purposes. Since augmented reality applications provide high motivation to learners, it has been expressed as a subject worth researching in recent years (Bulus Kirikkaya & Sentürk, 2018).

Educational films are one of the learning objects that researchers focus on in educational environments with the recent introduction of technology into classroom environments (Barnett & Kafka, 2007; Bixler, 2007; Derjani Bayeh & Olivera Fuentes, 2011; Freudenrich, 2000; Gess, 2017; Liberko, 2004). Educational films are important technological materials that enable learners to gain a general experience on subjects they do not have knowledge about, embody abstract concepts, and also help students see theoretical knowledge in practice (Guven Yildirim, Koklukaya, & Selvi, 2015). Bruner (2008) also states that educational films are materials that allow learners to learn an idea easily when they are watched, provide guidance to them, include other necessary activities for students, and contribute to the learning process. In the light of this information, the importance of the use of augmented reality applications and educational films in education emerges once again. When the literature was reviewed, previous studies emphasized the contribution of augmented reality applications to science teaching (Akcayir, 2016; Eren, 2019; Kerawalla, Luckin, Seljeflot, & Woolard 2006; Lin, Hsieh, Wang, & Chang, 2011; Rosenbaum, Klopfer, & Perry, 2007; Sariyildiz, 2020) are studies. Similarly, studies in the literature using educational films in science teaching (Cavanaugh & Cavanaugh, 1996; Guven Yildirim, Koklukaya, & Selvi, 2015; Fraknoi, 2003; Gess, 2017; Kizilcik, Damli, & Unsal, 2014; Kizilcik, 2021; Liberko, 2004; Topal, Guven Yildirim, & Onder, 2020; Uzun, Guven Yildirim, & Onder, 2020). However, in previous studies, no other study was found in which augmented reality applications in science teaching were supported by educational films. With this aspect of the study, it is thought that it will contribute to the field as an original and important study. Therefore, with this research, it is aimed to examine whether augmented reality applications supported by educational films have an effect on students' academic achievement and motivation towards science learning in the $6^{th}$ grade Solar System and Eclipses Unit.

## Method

### Research Model

The designs that aim to define the relations of cause and effect between the variables are called experimental designs (Buyukozturk, 2010). Experimental studies to determine cause-effect relationships are studies in which data to be observed are produced under the control of the research (Karasar, 2012). In this research a quasi-experimental design with pretest-posttest control group was used in order to obtain the data. In this design, one of the predetermined groups is assigned as the experimental group and the other as the control group, and pre-test and post-test are applied to both groups (Fraenkel & Wallen, 2008; McMillan & Schumacher, 2010). Quasi-experimental research designs are frequently used in educational research when all factors cannot be fixed (Cohen, Manion & Marrison, 2007).

### Study Group

In this study, the participants from whom the data were collected were determined by the convenient sampling method (Cohen, Manion, & Morrison, 2007). In convenient sampling, the researcher selects the participants from whom the data will be collected from individuals who are easy to reach, suitable for the research and

volunteer (Gravetter & Forzano, 2012). In this study, the researcher chose to work with the relevant participants because it was easy to reach. The study group of the research consisted of 42 students attending the 6th grade in Kahramanmaras in the fall semester of the 2021-2022 academic year.

**Data Collection Tools**

In the study, the "Academic Achievement Test for the Solar System and Eclipses Unit" developed by Yesiltepe (2019) and the "Motivation Scale for Learning Science" developed by Dede and Yaman (2008) were used as data collection tools.

The achievement test developed by Yesiltepe (2019) consists of 25 multiple-choice questions in total. The reliability of the test was found as .85 by the researcher. Again, as a result of the analyzes carried out by the researcher, the item discrimination (rjx) index of the items in the test was calculated as .61 and the item difficulty (pj) value was calculated as .56. Another data collection tool used in the research is the "Motivation Scale for Learning Science" developed by Dede and Yaman (2008). This scale is in the form of a five-point Likert scale and consists of 23 items. The reliability coefficient of the scale was found by the researchers as $\alpha$= .80.

**Data Collection Process**

The data collection process of this research was carried out during the Science course, the 6th grade Solar System and Eclipses Unit. In the study, an experiment (N=22) and a control group (N=20) were formed and the groups were randomly assigned.

Before the implementation process, both groups were given the Solar System and Eclipses Unit Achievement Test and the Motivation Scale for Learning Science as a pre-test. The experimental process covered the weeks (4 weeks), 16 lesson hours, in which the Solar System and Eclipses Unit would be covered. After the experimental process was over, the test and scale applied as a pre-test were applied to the groups as a post-test. A calendar has been created for the application to be carried out in the research. Lesson plan was prepared in accordance with the methods of the research within the framework of the achievements and lessons were taught in accordance with these lesson plans every week.

Table 1. Educational films selected in accordance with the unit outcomes

| Outcomes number | Subject | Link | Screen time |
|---|---|---|---|
| F.6.1.1.1. | Solar system | https://www.youtube.com/watch?v=Ze7_-36qb20<br>https://www.youtube.com/watch?v=QNbs7aghFT8<br>https://www.youtube.com/watch?v=rGGZnh8W7Oo<br>https://www.youtube.com/watch?v=qD6XB8o0STg | 5 min 49 sec<br>4 min 39 sec<br>3 min 26 sec<br>3 min 9 sec |
| F.6.1.1.2 | Planets in the solar system | https://www.youtube.com/watch?v=3C3Jbr9xpSU<br>https://www.youtube.com/watch?v=nyAZoieovC4 | 7 min 53 sec<br>2 min 25 sec |
| F.6.1.2.1 | Solar eclipse | https://www.youtube.com/watch?v=vthxNOeIb6g<br>https://www.youtube.com/watch?v=WvDF31EdJxM | 2 min 22 sec<br>3 min 20 sec |
| F.6.1.2.2. | Lunar eclipse | https://www.youtube.com/watch?v=44tuIey8f10<br>https://www.youtube.com/watch?v=aa2qkl9b5kA | 2 min 10 sec<br>3 min |
| F.6.1.2.3. | Solar and lunar eclipse comparison | https://www.youtube.com/watch?v=BIC2HExXChg<br>https://www.youtube.com/watch?v=rcDAqCYSiVI | 2 min 31 sec<br>3 min 55 sec |

During the teaching of the unit in the experimental group, Galactic Explorer (Merge Cube), Solar System Scope, Space 4D+, Space Explorer 4D, Space4D, Planets AR, AR Solar System etc. Augmented reality applications were used These augmented reality applications, prepared by the researcher in accordance with the unit outcomes, were supported by educational films with scientific content. In the study, 18 educational films related to the unit topics and decided to provide content validity were selected by the researcher and watched several times. It has been taken into account that the films determined for the application meet the unit gains. While determining the films, attention was paid to the affective, cognitive and psychomotor developments of the age group, and the duration of the films that would not cause distraction. Expert opinions were received for 18

educational films that met these criteria, and the films were examined by experts in terms of content validity, language, and intelligibility for age groups. According to the feedback received from the experts, some educational films were produced and 12 educational films were included in process. The links of the films selected considering the unit objectives and the information about which films are used in the teaching of which unit outcomes are given in the table below (Table 1). The photographs related to the practices carried out in the experimental group during the teaching of the unit during the experimental process are given below (Figure 1).


Figure 1. Photos of the application process

In the control group, the lessons were taught in accordance with the 2018 Science Curriculum. In this group, the teaching of the relevant unit was limited to the textbook prepared by the MEB (2018) and the activities included in this book. In the teaching of the relevant acquisitions of the unit, importance was given to the active participation of the students in the activities. After the end of the application process, the achievement test and the motivation scale, which were given as a pretest at the beginning of the research, were applied to both groups as a posttest and the data collection process of the research ended.

### Analysis of Data

Microsoft Excel 2010 spreadsheet program and SPSS 25.0 statistical analysis package program were used in the analysis of the data of the research. Descriptive statistics techniques were used to reveal the general distribution of the answers to the items of the test and scale used in the research. The central tendency and central distribution values of the test scores were calculated and it was examined whether the data showed a normal distribution. Independent groups t-test was used to compare the pre-test and post-test mean scores of the groups.

## Findings

In this study, firstly, which statistical method will be used to the data was examined. In quantitative studies, parametric and non-parametric analyzes can be used in the analysis of the data collected as a result of the study. In order to perform parametric analyzes on the obtained data, the data collected from the participants should show a normal distribution (Cepni, 2007; Sim & Wright, 2002). For this reason, first of all, descriptive analyze

was applied in order to determine the statistical method to be used to the data collected from the Solar System and Eclipses Unit Achievement Test, and the analysis results are given in Table 2.

Table 2. Descriptive data regarding achievement test pretest and posttest scores of the groups

| Tests | Group | N | M | Sd | Med. | Mod | Kurt. | Skew | Var. |
|---|---|---|---|---|---|---|---|---|---|
| Pretest | Experimental | 22 | 47,64 | 7,89 | 48 | 48 | -,52 | -,352 | 62,33 |
| | Control | 20 | 43,80 | 10,17 | 42 | 36 | 1,58 | -,528 | 103,53 |
| Posttest | Experimental | 22 | 70,36 | 15,88 | 70 | 80 | -,721 | ,208 | 252,43 |
| | Control | 20 | 60 | 14,03 | 60 | 52 | -1,34 | ,114 | 197,05 |

The descriptive data regarding the pretest and posttest scores of the Solar System and Eclipses Unit Achievement Test of the groups are given in Table 2. When the data in the table is examined, it is seen that the median, mean and mode values of the Solar System and Eclipses Unit Achievement Test pretest scores of the participants in both the experimental and control groups are close. Similarly, the median, mean and mode values of the post-test scores of the groups are close to each other. The fact that these values are close to each other for the data obtained from the test and that the kurtosis and skewness values are between -2 and +2 are interpreted as the data are normally distributed (Buyukozturk, Cokluk, & Koklu, 2018; George & Mallery, 2003). In addition, when the sources in the literature are investigated, it is stated that the data are normally distributed when the sample size is n > 20 (Buyukozturk, 2010).

As a result of the descriptive analysis, it was accepted that the data obtained from the test showed a normal distribution and parametric tests were preferred for the analyses. Independent groups t-test was used to examine whether the mean scores of the groups differed significantly from the achievement test. The obtained results are given in Table 3.

Table 3. Independent groups t-test results regarding achievement test pretest scores

| Group | N | M | Sd | t | p |
|---|---|---|---|---|---|
| Experimental | 22 | 47,64 | 7,89 | 1,37 | ,18 |
| Control | 20 | 43,80 | 10,17 | | |

When Table 3 is examined, the Solar System and Eclipses Unit Achievement Test' score of the students in the experimental group is M= 47.64, and the Solar System and Eclipses Unit Achievement Test mean score of the students in the control group is M = 43.80. There was no significant difference between the pretest achievement scores of the students in the experimental and control groups ($t = 1.37$, $p > .05$).

It was examined whether there was a significant difference between the post-test achievement mean scores of the students in the experimental and control groups, and the results of the independent groups t-test applied to the posttest scores of the groups are given in Table 4.

Table 4. Independent groups t-test results regarding achievement test posttest scores

| Group | N | M | Sd | t | p |
|---|---|---|---|---|---|
| Experimental | 22 | 70,36 | 15,88 | 2,23 | ,03 |
| Control | 20 | 60 | 14,03 | | |

Table 4 shows that the Solar System and Eclipses Unit Achievement Test posttest mean score of the experimental group students is M = 70.36, and the Solar System and Eclipses Unit Achievement Test post-test mean score of the control group students is M = 60. After the application process, there was a statistically significant difference in favor of the experimental group students between the Solar System and Eclipses Unit Achievement Test scores of the groups ($t = 2.23$, $p < .05$).

Before the motivational findings of the research are presented, the statistical method to be used to the data collected from motivation scale in the study was investigated. For this reason, the data collected from the motivation scale were analyzed and the normality of the obtained scores was examined (Table 5).

Table 5. Descriptive data on motivation scale pretest and posttest scores of the groups

| Tests | Group | n | M | Sd. | Med. | Mod | Kurt. | Skew. | Var. |
|---|---|---|---|---|---|---|---|---|---|
| Pretest | Experimental | 22 | 93,68 | 10,06 | 91,50 | 90 | -,71 | -,04 | 101,27 |
| | Control | 20 | 92,90 | 8,69 | 94 | 94 | ,28 | -,70 | 75,56 |
| Posttest | Experimental | 22 | 103,36 | 7,22 | 103 | 99 | -,31 | -,24 | 52,14 |
| | Control | 20 | 96,55 | 7,14 | 98,50 | 92 | ,32 | -,82 | 51,10 |

Looking at the data in Table 5, the median, mean and mode values of the mean scores of the pretest and posttest scores of the groups from the scale are close to each other. The closeness of these values, skewness and kurtosis values in the table are in the appropriate value range (between -2 and +2), which is interpreted as the data being normally distributed (Buyukozturk, Cokluk, & Koklu, 2018; George & Mallery, 2003).

As a result of descriptive analysis, it was found that the data showed normal distribution and it was decided to applied parametric tests in the analysis of the data. Independent groups t-test was used to test whether there was a significant difference between students' Motivation Scale for Learning Science pre-test and test mean scores (Table 6).

Table 6. Independent groups t-test results regarding motivation scale pretest scores

| Group | N | M | Sd. | t | p |
|---|---|---|---|---|---|
| Experimental | 22 | 93,68 | 10,06 | ,26 | ,79 |
| Control | 20 | 92,90 | 8,69 | | |

According to the data in Table 6, the pretest mean score of the Motivation Scale for Learning Science of the students is M = 93.68 for the students in the experimental group and M = 92.90 for the students in the control group. There was no statistically significant difference between the groups' mean scores on the Motivation Scale for Learning Science ($t = ,26$, $p > .05$).

No statistically significant difference was found between the pretest mean scores of the Motivation Scale for Learning Science in the experimental and control groups, and whether there was a significant difference between the posttest scores of the groups was examined using the independent groups t-test (Table 7).

Table 7. Independent groups t-test results regarding the motivation scale posttest scores

| Group | N | M | Sd. | t | p |
|---|---|---|---|---|---|
| Experimental | 22 | 103,36 | 7,22 | 3,06 | ,00 |
| Control | 20 | 96,55 | 7,14 | | |

When the data in Table 7 are examined, it was found that the experimental group students' Motivation Scale for Learning Science posttest mean score was M = 103.36, while the control group students' Science Learning Motivation Scale posttest mean score was M = 96.55. There is a statistically significant difference in favor of the experimental group between the motivation scale scores of the students in the experimental and control groups after the study ($t = 3.06$, $p < .05$).

## Results, Discussion and Recommendations

This research was conducted to determine the effects of educational film-supported augmented reality applications in the teaching of the Solar System and Eclipses Unit of the 6$^{th}$ grade Science course on the academic success of the students and their motivation levels for learning science. In the study, firstly, it was found that there was no statistically significant difference between the groups' mean achievement pre-test scores on the solar system and eclipses unit. On the other hand, it was found that there was a statistically significant difference in favor of the experimental group between the students in the experimental and control groups after the study, in favor of the experimental group. These results show that augmented reality applications supported by educational films positively affect the academic achievement of students. It is thought that this result of the study is due to the fact that augmented reality applications supported by educational films are seen as a new learning environment for students and this situation increases the academic achievement of the lesson. When the literature is examined, it is stated that combining education with new technologies attracts the attention of learners, increases their efforts and motivation, enables them to be active in the learning process and facilitates the understanding of the subject (Kucuk, 2015; Kreijns, Acker, Vermeulen, & Buuren, 2013; Shen, Liu, & Buuren, 2013). Wang, 2013). Another reason for this result is thought to be that the objects on the papers appearing in three dimensions through augmented reality technology are perceived as almost like magic by the students (Billinghurst, Kato, & Poupyrev, 2001).

When the literature on the subject is examined, no other study has been found in which augmented reality applications are supported by educational films, similar to this study. However, in parallel with this finding of the research, it is seen that educational films and augmented reality applications increase academic success in science education and contribute to students' understanding of science subjects and concepts (Sumadio & Rambli, 2010; Sahin, 2017). In his study, Eren (2019) investigated the effect of augmented reality applications

on the success and permanence of 7th grade students within the scope of Elements and Compounds. As a result of this study, it has been determined that AR applications are more effective on the academic success of students and the permanence of their knowledge than the current curriculum. Sentürk (2018) examined the effects of teaching activities supported by augmented reality in science teaching within the scope of the Solar System and Beyond unit on students' academic achievement, motivation, attitudes towards science, technology and augmented reality applications. As a result of this study, it has been stated that the academic success of the students who teach by using augmented reality technology has increased. This result is in direct parallel with our study. Similarly, in Ates (2018)'s study in which he examined the effect of AR technology on academic achievement in the Particulate Structure of Matter and Pure Substances unit, the results of the analysis of the pretest and posttest scores of the experimental group students revealed that the application increased academic success of the students. Similar to the results of this study, many studies have emphasized that the use of AR applications has an impact on students' academic achievement (Bujak et al. 2013; Cankaya, 2019; Fleck & Simon, 2013; Hwang, Wu, Chen, & Tu, 2016).

When the relevant literature is examined, there are different studies that show that educational films increase academic success, similar to augmented reality applications. In this study, it is seen that educational films have a positive effect on student achievement. The educational films used in the study allowed the subjects related to the solar system, which are difficult to understand and abstract, to be conveyed in a more visual way. It is thought that this situation provides students with a better understanding of the subject. According to Ince Yakar (2013), educational films used in learning environments help to learn subjects that are difficult to understand more easily. It creates learning experiences that enable individuals to be successful. In addition Wenger (1943) and Bruner (2008) state that educational films are effective digital learning objects that can be used to ensure the success of teaching. As a result of their study, Pekdag and Marechal (2007) state that use of films in science teaching contributes to the understanding, learning and transmission of new scientific concepts. As a result of many researches on the subject, it is stated that films are an efficient learning object in terms of teaching the subject. In addition, it is said that educational films contribute to students' understanding of scientific concepts, their internalization and the formation of their mental structures (Anderson, Huston, Schmitt, Linebarger, & Wright, 2001; Linebarger, Kosanic, Greenwood, & Sai Doku, 2004; Cavanaugh & Cavanaugh, 2004; Michel, Roebers, & Schneider, 2007).

Another result obtained from the research is the effect of educational film supported augmented reality applications on motivation towards science learning. As a result of the analyzes made on the data obtained from the study, no significant difference was found between the pre-test mean scores of the students in the experimental and control groups of the Motivation Scale for Learning Science before the application. However, there was a statistically significant difference between the groups' Motivation for Science Learning Scale post-test scores. When the relevant literature is examined, it is noteworthy that there is no study that directly investigates the effect of educational film-supported augmented reality applications on motivation towards learning science. However, there are various study results in the literature that both augmented reality applications and educational films increase the motivation of students separately. In the study conducted by Cankaya (2019), the effect of augmented reality applications on the success, attitude and motivation of secondary school students in science lessons was examined and it was observed that augmented reality applications increased their attitudes and motivations towards the lesson and the subject. The results of the study conducted by Sentürk (2018) also revealed the positive effect of augmented reality applications on motivation. In parallel with this result, Di Serio, Ibáñez, and Kloos (2013) stated that increasing the interaction of students with their learning environment with the help of augmented reality activities increases their motivation. Again, as a result of the study by Wojciechowski and Cellary (2013), it was concluded that augmented reality applications are an effective tool to increase the motivation of primary school students towards the lesson and provide students with the opportunity to learn while having fun. In the study conducted by Farias, Dantas, and Burlamaqui (2011) it was concluded that the use of augmented reality applications in education contributes positively to the learning process, making the learning process remarkable and more effective.

During the implementation process, augmented reality applications were supported by educational films. In the literature, there are study results showing that educational films, which are the other components of the study, increase student motivation, similar to the results of this study. It is thought that the reason for this situation is that educational films eliminate the ordinary of the lesson and provide a different learning environment to the students. This helps them to be motivated to watch the lesson. Similarly, Weinstein (2001) states that the use of educational films as teaching materials eliminates the ordinariness and monotony of the lessons, and also increases student motivation towards the subjects being taught. In the research conducted by Topal, Guven Yildirim and Onder (2019), the views of teacher candidates on the use of educational films in science lessons were examined. As a result of the study, it was seen that while pre-service teachers talked about the benefits of

using educational films in science lessons, they stated that educational films made learning the subject easier and increased motivation and interest in the lesson. As a result of Oztaş (2008)'s study, it was concluded that with the use of educational films in the lesson, the interest and motivation of the students towards the subjects of history increased and the films directed the students to research. In addition, Watts (2007) states in his study that movies motivate individuals to learn by providing learning opportunity. In another study, Akridge and Balkanski (1990) emphasize that the active use of educational films in the learning environment will contribute to the students' having a good time in the learning process and to increase their attitudes and motivation towards the lesson. It is stated by other researchers that educational films and videos are important learning objects that create enjoyable teaching environments, increase interest and motivation towards the lesson, and form the basis for effective and permanent learning (Hébert & Peretz, 1997; Stoddard, 2009; Wagner, 1954).

The results obtained from the research and the results of previous studies on the subject reveal the benefits of the teaching process carried out with both educational films and augmented reality applications. The result of this research reveals that educational film supported augmented reality applications both contribute to the success of science course and increase the motivation for learning science. However, this research was limited to the effect of educational film supported augmented reality applications on student achievement and motivation only in the Solar System and Eclipses Unit. In addition, the study group and the duration of the application stand out as a limitation of the research. In this context, in the light of the findings of this study, the effects of educational film supported augmented reality applications on different variables can be examined in different units and subjects, in different sample groups and for a longer period of time.

## Scientific Ethics Declaration

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

The purposes and procedures of the current study were granted approval from the ethical committee of the Gazi University (26.04.2021 / 80287700-302.08.01- 71328).

## Acknowledgements or Notes

This article was produced from the master's thesis conducted by the first author under the supervision of the second author. Both authors contributed equally to the preparation of the article, and both authors read and approved the final version of the article.

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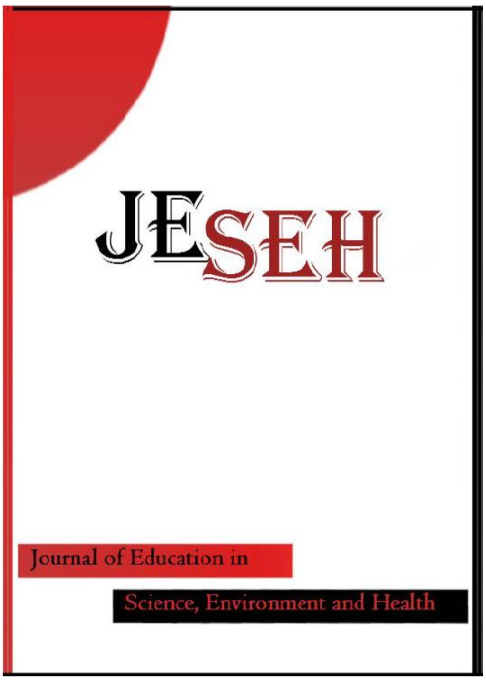
## Author(s) Information

**Emre Güvenir**
Teacher, Ministry of Education, Kahramanmaraş, Turkey
ORCID iD: https://orcid.org/0000-0002-2770-3377

**Ezgi Güven Yıldırım**
Assoc. Prof. Dr., Gazi University, Faculty of Education, Ankara, Turkey
Contact e-mail: ezgiguven@gazi.edu.tr
ORCID iD: https://orcid.org/0000-0002-8378-700X




**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

**www.jeseh.net**

# The Examination of Relationship Between the Approaches to Environmental Ethics and Environmental Behaviours of Teacher Candidates by Different Variables

**Mehpare Saka**
Trakya University

**To cite this article:**

Saka, M. (2023). The examination of relationship between the approaches to environmental ethics and environmental behaviours of teacher candidates by different variables. *Journal of Education in Science, Environment and Health (JESEH), 9*(2), 131-145. https://doi.org/10.55549/jeseh.1279772

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1279772

# The Examination of Relationship between the Approaches to Environmental Ethics and Environmental Behaviours of Teacher Candidates by Different Variables

**Mehpare Saka**

## Article Info

***Article History***

Published:
01 April 2023

Received:
03 July 2022

Accepted:
18 January 2023

***Keywords***

Environmental Ethics,
Environmental Behaviour,
Teacher Candidates

## Abstract

The aim of this study is to determine the environmental behaviour and the approaches to environmental ethics of teacher candidates whether or not they differ in terms of gender, department and place of residence. Moreover, the relationship between the approaches to environmental ethics of teacher candidates and their environmental behaviours was established and interpreted in the study. The research group of the study, in which screening model is used, consists of 881 third year and final year student teachers from the departments of science teaching, primary school teaching and social sciences teaching in five state universities. Out of the teacher candidates, 650 are female and 231 are male students. The data were obtained with Environmental Behaviour Scale and the Approaches to Environmental Ethics Scale. Descriptive statistics, Mann Whitney-U and Kruskal-Wallis H tests, and Spearman Rank-Difference Coefficient of Correlation methods were used for the analysis of the data which determined that there was a low level of relationship between the environmental behaviours and the approaches to environmental ethics of the teacher candidates and that the approaches to environmental ethics and the environmental behaviours differed for some of the variables including gender, department and place of residence.

## Introduction

Particularly today, economic growth and rapid consumption lead to serious environmental problems caused by humanity such as global warming, air pollution or pollution and depletion of water resources (IPCC, 2018). There are studies showing that the environmental perspectives, attitudes, value judgments and behaviours of human beings, who are responsible for these results, have a significant effect on these negativities. (Dunlop, 2008; Schulitz and Oskamp, 1996). Especially with environmental education, it is aimed that individuals exhibit positive attitudes and behaviours towards the environment (Salequzzman and Stocker, 2001; Bradley, Waliczek and Zajicek, 1999).

Emphasizing the relationship of individuals with their natural environment, environmental education aims to have the motivation of individuals to make decisions by taking responsibility for the environmental information, skills, and attitude and environmental problems. With the existing environmental problems, the importance of raising environmentally literate individuals by overcoming these problems and establishing positive behaviour towards the environment has become remarkable. In this process, ethical approaches that affect different perspectives on the environment are also a dimension that should not be ignored. It is also necessary to consider the compatibility of these approaches with environmental behaviours.

Family, society, and further education process are of great importance in relation to the formation of an individual's ethical approach and behaviour towards the environment. Especially, in addition to the environmental education programs prepared during the education process, teachers are one of the important factors in the management of the process. Therefore, the importance of the environmental perspectives and behaviours of teachers, who are the practitioners of the teaching process, is revealed in creating awareness in the individual with the right ethical approaches and transforming this awareness into behaviour, ensuring the protection and continuity of the environment. Accordingly, the paper attempts to determine the relationship and the level of the relationship, if any, between the environmental behaviour and ethical approaches of the prospective teachers and to find whether the ethical approaches were effective in terms of the behaviour of the group.

**Theoretical Framework**

Leopold's approach to environmental ethics, which is brought to the agenda especially with his approach to land ethics, is expressed as a systematic assessment that ensures and regulates the transition of people to nature and environment within the framework of certain rules by trying to understand the relationship of humans with the environment (Jardin, 2006; Sandler, 2013; Kılıç, 2008; ECCAP, 2012; Cochrane, 2006; Ertan, 2004, Huying, 2004). Ethical approaches that shape our thoughts and behaviours (Ertan, 2004) also constitute an important framework for the relationship of people with the environment (Gül, 2013). Trying to overcome the conclusion of what the concept of good and bad environmentalism is within the scope of environmental values, environmental ethics is in direct relation with human behaviours that are managed as a system of values developed directly individually (Raı & Sıırma, 2011). Moreover, environmental ethics is of great importance in making sense of the ecology and emphasizing the value of an asset (ECCAP, 2012). Defined as a sub-branch of applied ethics, environmental ethics basically deals with the correctness and incorrectness of the behaviours of humans and other living things towards inanimate objects (Benson, 2000).

Environmental ethics aims to make people live in harmony with nature (Homer and Kahle, 1988; Huying, 2004) while trying to determine what the right behaviour should be (Amerbauer, 1998, cited in Kılıç, 2008). Many environmental disasters that emerged in the second half of the 20th century increased the interest in environmental ethics and brought it into a systematic order. There are also different perspectives on environmental ethics which gained a scientific quality in the 1980s (Cochrane, 2006) within the framework of various opinions about whether there is an environmental crisis. With the discovery of iron, the period until the industrial revolution includes the period when the anthropocentric approach was adopted. The non-strict anthropocentric approach focuses primarily on the protection of people and adopts the approach of a balanced use of natural resources to maintain the people's quality of life (Dunlap and Van Liere 1978; Callicott and Frodeman 2009). In the strict anthropocentric approach, however, which basically argues that the entire environment exists to serve human beings, the idea that human being is the owner of nature and has the right to use all its elements prevail. Therefore, the interests and needs of human beings, who are regarded as the master of the environment in a sense, are seen as the priority. In this context, it is stated that the animate or inanimate values of human beings are valuable only if they are for the benefit of the person, who are supporting the approach that ethical principles are meaningful only when they exist for themselves.

Particularly in the 16th and 17th centuries, the idea that nature was put at the disposal of man (Gül, 2013), as scientists such as Bacon, Descartes and Newton stated, became more severe especially with the industrial revolution (Ertan, 2004). During that period, human beings became crueller to nature and adopted unlimited use and exploitation (Ertan, 2004). However, after the industrial revolution, with the increasing demands of people for a comfortable life (NRDC, 2012), the damage to the environment was observed to negatively affect people as well. Thus, in addition to the anthropocentric approach, the ecocentric environmental ethics approach, which includes primarily biocentric, earth ethics, deep ecology and social ecology approaches that emphasize the importance of harmony between the environment and human beings came to the fore. (Anemiya & Macer, 1999; Ertan, 2004; Kılıç, 2008). As for nature protection in the ecocentric approach, all animate and inanimate beings are valued, instead of people's pursuing their own personal interests (Dunlap and Van Liere 1978), and this value is applied to nature itself (Ertan 2004). With a holistic understanding, ecocentrism looks for the problems of animate or inanimate beings within the ecosystem without separating them that compose the nature itself. The metaphor of life is the world, not organisms, because all organisms have evolved from a continuous world (Rowe 1994). In addition to these basic ethical approaches, there are different approaches to environmental ethics such as deep ecology, land ethics, theocentric ethics, sustainable environmental ethics and ecofeminism.

According to the ecofeminist approach called the Futurist approach, women and nature in connection with each other are oppressed due to the patriarchal mentality and, in order to prevent this and to ensure equality for women, the relationship between nature and human should be much healthier (Scarce 1990). In fact, it is stated that, together with different environmental problems, individuals' perspectives, knowledge, and culture are effective in the formation of different ethical approaches towards the environment. Ethical approaches, which are stated to be effective in the thoughts and behaviours of individuals, are expected to be similar in terms of the environment.In addition, it is stated that individuals with an ecocentric approach have a mission to protect the environment and leave the ecosystem clean without destructing it with a sense of responsibility towards future generations (Akalın, 2019).

The value-belief-norm theory, which was created to explain the effect of human behaviours on ecology, states that people will display environmental behaviours when they have the belief that the environment is important to them (Berenguer, 2010). According to these views, it is the attitudes and value judgments formed by

individuals that have a role in the formation and shaping of individuals' behaviours (Fishbein & Ajzen, 2010). With similar interpretations in environmental ethics approaches, it is stated that individuals who have ecocentric approaches to environmental ethics will exhibit behaviours to protect the environment and solve problems related to the environment. In addition, values form the basis of human behaviours according to the value-attitude-behaviour theory based on values-belief-norms (McCarty & Shrum, 1994; Stern, 2000). According to some opinions, the attitude to the environment varies more easily than the environmental values (Sjöblom & Wolff, 2017; Steg, Bolderdijk, Keizer, & Perlaviciute, 2014). In this context, the tendency for environmental values can ensure that individuals have more positive environmental values.

In studies conducted in a number of different countries, an inverse relationship was found between environmental perception, which is described as egoistic, anthropocentric or human-centered, and environmental behaviours (Crumpei, Boncu, Crumpei, 2014). There are also studies showing that individuals with the ecocentric approach tend to display environmentally friendly behaviours. For example, in their study on the relationship of environmental attitude, motivation and value for the conservation of marine biodiversity, Halkos and Matsiori (2017) determined that those who display environmentally friendly behaviour have higher environmental attitude scores. However, some studies have found that individuals with environmentalist approach do not show this in their behaviour when their thoughts and feelings are not in harmony. In the research by Misfud (2011) with students who were about to complete the secondary education, it was found that they had a strong positive attitude towards the environment but took little positive action towards the environment. Similarly, in their study with 7th grade students, Rebolj and Devetak (2013) observed that while most of the students were concerned about environmental issues such as drought and thirst, they were not very willing to participate in environmental projects. Liu, Liang, Fang, and Tsai (2015) found in their study that teachers' knowledge and attitudes towards the environment were at a good level; however, they were at a low level in terms of action. It is stated that the results were mostly due to the education provided in a traditional way, especially in science programs. Therefore, environmental education and its importance, which is one of the important pillars in the development of positive attitudes and behaviours towards the environment, are highlighted.

The aim of environmental education is to enable individuals to acquire sufficient environmental knowledge, as well as positive attitude towards the environment, ethical approach, and value and to reflect these tendencies on behaviour in a positive way (Poortinga, Steg and Vlenk, 2004; Mackenzie and Edwards 2013). The purpose of environmental education is to enable individuals to produce solutions by increasing their sensitivity to both local and global environmental problems (Cole, 2007). It is stated that particularly applied environmental education, together with the basic knowledge gained through environmental education, will make an important contribution to the shaping of ecological values (Kempton, Boster, & Hartley, 1995; Kollmuss & Agyeman, 2002). Energy efficiency, which came to the fore upon the Tbilisi Declaration, is still valid today. Individuals sensitive to energy efficiency are sensitive to environmental knowledge, attitudes, emotions, values, awareness and behaviours and environmental problems (UNESCO, 1978). Studies have concluded that individuals who are aware of the environmental and harmful situations for the environment have higher bio-spheric values (Corner, Roberts, Chiari, Voller, Mayrhuber, Mandl & Monson, 2015; Howell, 2013; McMillan, Wright, & Beazley, 2004). Moreover, it is stated that values affect knowledge as well as cultural and socioeconomic factors. As for environmental education, both the content of the program created and the knowledge of educators, i.e. teachers, as well as their attitudes towards the environment, environmental values and behaviours, should be taken into account.

When the studies in literature examined, it was seen that, in general, case studies were conducted with different groups only in the context of environmental ethics (Bozdemir & Faiz, 2018; Cappellaro, 2016; Çobanoğlu, Karakaya, & Türer, 2012; Erten, 2007; Karakaya, 2009; Erten & Aydoğdu, 2011; Kortenkamp & Moore, 2001; Thompson & Barton, 1994; Thompson, 1998; Özdemir, 2014;) or only in the context of environmental behaviour (Özgen (2012) and Öcal (2013) Silkü (2011) Pe'er, Goldman and Yavetz (2007); Hsu (2004)). In addition, there are studies on whether environmental ethics or environmental behaviour change according to variables such as gender [(Şama, 2003; Çabuk & Karacaoğlu, 2003; Deniş & Genç, 2007; Manzaral, Barreiro, & Carrasquer, 2007; Erten, 2008; Kahyaoğlu, Daban, & Yangın, 2008; Karakaya, 2009; Şenyurt, Temel, & Özkahraman, 2011; Wongchantra & Nuangchalerm, 2011; Çobanoğlu, Karakaya, & Türer, 2012; Kiper, Korkut, & Üstün Topal, 2017; Karakaya & Yılmaz, 2017; Akyol (2014) Genç & Genç (2013); De Lavega (2004)] department [(Şama, 2003; Çabuk & Karacaoğlu, 2003; Kahyaoğlu, Daban, & Yangın, 2008; Karakaya, 2009; Saka, Sürmeli, & Öztuna, 2009; Şenyurt, Temel, & Özkahraman, 2011; Can, 2012; Kiper, Korkut, & Üstün Topal, 2017)], and class leveandl (Çabuk & Karacaoğlu, 2003; Manzaral, Barreiro, & Carrasquer, 2007; Can, 2012; Sungur, 2017).

In this study, besides determining the environmental ethics and environmental behaviour levels of the teacher candidates in the context of both environmental ethics and environmental behaviour, ethical and behavioural changes were examined according to gender, department and place of residence. Therefore, the difference of these variables in both the ethical point of view and the behavioural dimension was tried to be discussed from both angles. In addition, there are very few studies on the relationship between environmental education and environmental behaviour (Gheith, 2013; Liu, Liang, Fang and Tsai (2015; Kaida & Kaida, 2016Misfud (2011) Rebolj and Devetak (2013; Thapa, 2010)), and the harmony of ethical approach with behaviour was intended to be determined. In line with the data obtained, it is aimed to contribute to the processes of developing environmental ethics and environmental behaviour in different programs by contributing to the environmental education programs provided in the educational processes of the teacher candidates. Accordingly, the questions of the study are as follows:

- What are the approaches to environmental ethics (anthropocentric and ecocentric) and the environmental behaviour levels of the teacher candidates?
- Do the teacher candidates' approaches to environmental ethics (anthropocentric and ecocentric) and their environmental behaviours differ according to gender, department and place of residence?
- Is there a relationship between the teacher candidates' approaches to environmental ethics (anthropocentric and ecocentric) and their environmental behaviours?

## Method

This research was designed by combining two methodologies including cross-sectional research and correlation study under the quantitative research type. In cross-sectional researches, research data are collected from a predetermined population over a specified period of time. The descriptive analyses including the mean and standard deviation were calculated to reveal the level of environmental behaviour, anthropocentric and ecocentric attitudes of teacher candidates of science, primary school and social sciences. Relational studies aim to examine the relationships between the variables of the study (Fraenkel & Wallen, 2006). Within the scope of the research problem, a relational screening model, which aims to describe the current situation (Çepni, 2010; Karasar, 2000), was applied in order to determine the relationship between the approaches to environmental ethics and the environmental behaviours of teacher candidates.

### Study Group

The research group consists of 881 third year and final year student teachers from the departments of science teaching, primary school teaching and social sciences teaching in five state universities. Of the teacher candidates, 650 are female and 231 are male students. Of the teacher candidates participating in the study, 357 were science teacher candidates, 273 were primary school teacher candidates, and 251 were social sciences teaching graduates. The research data were collected in approximately 6 months. The data were presented to the teacher candidates in print, and a half-hour period was given to them for the application.

### Data Collection Tools

Approaches to Environmental Ethics Scale: In the study, Approaches to Environmental Ethics Scale (Saka & Sürmeli, 2013) was used to determine the approaches to environmental ethics of teacher candidates. The scale consists of 25 items and includes the 5-point Likert scale ranging from ‘Strongly disagree’ to ‘Strongly agree‘. The scale consists of three subscales, namely anthropocentric, biocentric and ecocentric subscales each of which was evaluated according to separate scores, rather than the whole scale. There are 8 items in the anthropocentric scale, 11 items in the biocentric scale, and 6 items in the ecocentric scale. In the study, anthropocentric and ecocentric dimensions of the scale were used. The results of confirmatory factor analysis during the development of the scale were RMSEA, 0.005; GFI, 0.86; AGFI, 0.83; NNFI and CFI were calculated as 0.96 (Saka and Sürmeli, 2013). The Cronbach α reliability coefficient of the scale was calculated as .73 for the total scale, .76 for the anthropocentric and .86 for the ecocentric (Saka & Sürmeli, 2013). The results of the Cronbach α reliability calculation repeated in this study was .80; .84; and .86 respectively. The evaluation of the scale is assessed according to separate scores gained from each sub-scale. The whole scale was used in the application phase of the research, but the biocentric approach was not taken into consideration in the evaluation. The research aims to find the relationship between change in variables and behaviours according to the most

environmentally friendly ethical approach (ecocentric) and the most non-environmental ethical approach (anthropocentric). Therefore, the results of the biocentric ethical approach were not included in this study.

Environmental Behaviour Scale: It was obtained as a result of adaptation to Turkish from the "High School Environmental Survey" scale published by Karatekin (2011) in Wisconsin Center for Environmental Education in order to measure the environmental behaviours of the teacher candidates. During the adaptation study, 7 items were added by the researcher to improve the content validity, and a 19-item scale was obtained according to the data obtained from the reliability and validity analyses conducted as a result of pilot schemes. The scale includes the 5-point Likert scale which has the following options as answers: "Always", "Generally", "Sometimes", "Rarely" and "Never". The scale has 3 sub-dimensions: Physical Protection Behaviour with 7 items, Individual and Social Persuasion with 5 items, and Political and Legal Behaviours with 6 items. As a result of the reliability analysis conducted by Karatekin (2011), the Cronbach α reliability coefficient of the whole scale was .85, and the sub-dimensions of Physical Protection Behaviour, Individual and Social Persuasion and Political and Legal Behaviours were respectively .73; .81 and .71. As a result of the reliability analysis carried out within the scope of this study, the Cronbach α value for the whole scale was determined as .89, and the sub-dimensions were determined as .68; .80 and .88 respectively.

### Data Analysis

In the study, SPSS 14 package program was used to process, analyse and interpret the raw data obtained from the Personal Information Form, Approaches to Environmental Ethics Scale and Environmental Behaviour Scale. In the statistical analysis, the percentage and frequency values that describe the general structure of the group were primarily included in line with the answers given by the sample group to the questions stated in the Personal Information Form. In addition, the mean (X), standard deviation (sd) and standard error (SEx) values of the scores the group received from the relevant measurement tools were calculated. The results of the skewness and kurtosis analysis conducted to determine whether the scores obtained from the tests show normal distribution are given in Table 1.

Table 1. Skewness and kurtosis analysis results for environmental behaviour scale and environmental ethics scale

| Variables | Skewness | Skewness standard error | Kurtosis | Kurtosis standard error | Mean | sd |
|---|---|---|---|---|---|---|
| Anthropocentric | ,454 | ,082 | -,316 | ,165 | 19,12 | 6,579 |
| Ecocentric | -,967 | ,082 | 1,144 | ,165 | 25,20 | 3,924 |
| Physical Protection Behaviour Subdimension | ,233 | ,082 | 1,568 | ,165 | 23,66 | 4,857 |
| Individual and Social Persuasion Subdimension | -,255 | ,082 | -,177 | ,165 | 20,91 | 4,676 |
| Political and Legal Behaviours Subdimension | ,805 | ,082 | -,255 | ,165 | 12,82 | 5,844 |
| Environmental Behaviour | ,231 | ,082 | -,239 | ,165 | 57,41 | 12,897 |

In the Kolmogorov Simirnov analysis, it was determined that normality could not be achieved in either of the measurement tools ($p < .01$). Since the Kolmogorov-Simirnov test is very precise in determining the normal distribution (Pett, 1997), the skewness and kurtosis values were also used. In the analyses, it was observed that the values obtained when the Skewness and Kurtosis coefficients were divided by the Skewness and Kurtosis standard error respectively were not between ± 1.96 (Liu, Marchewka, Lu, Yu, 2005; Pett, 1997); therefore, it was accepted that the distribution did not provide normality. For this reason, Mann Whitney U-Test (Mann-Whitney U-Test for Independent Samples) and Kruskal Wallis H-Test (Kruskal Wallis H-Tests for independent samples) tests were applied for non-parametric unrelated measurements. In addition, Spearmen Rank Differences Test was applied to determine the relationship between the approaches to environmental ethics and environmental behaviour and the sub-dimensions.

## Results

In this section, firstly the analysis results regarding the environmental ethics and environmental behaviour levels of the teacher candidates constituting the research group are presented. Along with these levels, there are results

regarding whether there is a difference in the environmental ethics and environmental behaviours based on the variables of gender, department of education and place of residence. Finally, the results of the relationship between the teacher candidates' approaches to environmental ethics and environmental behaviours are provided. While the results of the approach to environmental ethics levels of the teacher candidates are presented in Table 2, Table 4 shows the environmental behaviour levels.

Table 2. Descriptive statistics results for teacher candidates' levels of approach to environmental ethics

| | N | Minimum | Maximum | Mean | S.D. |
|---|---|---|---|---|---|
| Anthropocentric | 881 | 8.00 | 38.00 | 19.12 | 6.57 |
| Ecocentric | 881 | 9.00 | 30.00 | 25.20 | 3.92 |

As a result of the analysis, it was determined that the anthropocentric approach of the teacher candidates was at the level of I disagree ($\bar{x}$ = 19.12), while the ecocentric environmental ethics approach ($\bar{x}$ = 25.20) was at the level of I agree.

Table 3. Descriptive statistics results for teacher candidates' environmental behaviour levels

| | N | Minimum | Maximum | Mean | S.D. |
|---|---|---|---|---|---|
| Physical Protection Behaviour | 881 | 10.00 | 35.00 | 23.66 | 4.85 |
| Individual and Social Persuasion | 881 | 6.00 | 30.00 | 20.91 | 4.67 |
| Political and Legal Behaviours | 881 | 6.00 | 30.00 | 12.82 | 5.84 |
| Environmental Behaviour | 881 | 24.00 | 95.00 | 57.41 | 12.89 |

When Table 3 was examined, it was seen that the environmental behaviours of the teacher candidates ($\bar{x}$ = 57.41) were generally at the level of I agree. However, while the physical protection behaviour ($\bar{x}$ = 23.66) and the individual and social persuasion behaviours ($\bar{x}$ = 20.91) were at the level of sometimes, the political and legal behaviours ($\bar{x}$ = 12.82) were found to be at the level of rarely in the analysis results. Table 4 and Table 5 presented the variability of the approaches to environmental ethics and the environmental behaviours of the teacher candidates according to the variable of gender.

Table 4. Mann-Whitney U test comparison results for teacher candidates' levels of approach to environmental ethics by gender variable

| | Gender | n | Mean rank | Total rank | U | p |
|---|---|---|---|---|---|---|
| Anthropocentric | Male | 231 | 467,67 | 108032,50 | 68913,500 | .063 |
| | Female | 650 | 431,52 | 280488,50 | | |
| Ecocentric | Male | 231 | 372,96 | 86153,00 | 59357,000 | .000 |
| | Female | 650 | 465,18 | 302368,00 | | |

Table 4 presented the results showing whether the scores of the teacher candidates from the environmental ethics scale differed according to the gender variable. According to the results, it was determined that the gender variable did not make a difference in the approaches to anthropocentric environmental ethics of the teacher candidates (p> .05). In addition, a significant difference, which seemed to be in favour of women, was observed in the approaches to ecocentric environmental ethics (p <.05).

Table 5. The comparison results of the Kruskal Wallis test for the levels of teacher candidates' approach to environmental ethics according to the department variable

| | Teaching Department | n | Mean Rank | sd | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| Anthropocentric | Science | 357 | 431,82 | 2 | 3,292 | ,193 |
| | Primary School | 273 | 430,39 | | | |
| | Social Sciences | 251 | 465,60 | | | |
| Ecocentric | Science | 357 | 471,21 | 2 | 9,099 | ,011 |
| | Primary School | 273 | 428,29 | | | |
| | Social Sciences | 251 | 411,85 | | | |

Based on the analyses conducted on whether there was a difference in the approaches to environmental ethics of the teacher candidates according to the departments they studied, only a difference in the approach to ecocentric environmental ethics ($\chi$2 (sd = 2, n = 881) = 9,099; p <.05) was found. Considering the mean rank of teacher candidates' ecocentric scores among science, social sciences and primary school teacher candidates, it was observed that this difference was in favour of prospective science teachers in both groups.

Table 6 and Table 7 showed the variability of the approaches to environmental ethics and the environmental behaviours of the teacher candidates according to the variables of place of residence. When Table 6 was examined, it was seen that there was no difference in any of the approaches to environmental ethics of the teacher candidates according to the variable of place of residence.

Table 6. The comparison results of the Kruskal Wallis test for the levels of environmental ethics by the variable of place of residence of the teacher candidates

| | Place of Residence | n | Mean Rank | sd | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| Anthropocentric | Village | 106 | 475,42 | 4 | 8,993 | ,061 |
| | Town | 45 | 456,01 | | | |
| | County | 122 | 429,48 | | | |
| | City | 210 | 472,17 | | | |
| | Metropolis | 398 | 417,22 | | | |
| Ecocentric | Village | 106 | 461,41 | 4 | 1,989 | ,738 |
| | Town | 45 | 433,36 | | | |
| | County | 122 | 456,23 | | | |
| | City | 210 | 425,25 | | | |
| | Metropolis | 398 | 440,07 | | | |

Table 7. Mann-Whitney U test comparison results for the teacher candidates' environmental behaviour levels by gender variable

| | Gender | n | Mean rank | Total rank | U | p |
|---|---|---|---|---|---|---|
| Physical Protection Behaviour | Male | 231 | 400,87 | 92602,00 | 65806,000 | ,006 |
| | Female | 650 | 454,60 | 295038,00 | | |
| Individual and Social Persuasion | Male | 231 | 399,97 | 92392,50 | 65596,500 | ,004 |
| | Female | 650 | 455,58 | 296128,50 | | |
| Political and Legal Behaviours | Male | 231 | 478,80 | 110603,50 | 66342,500 | ,008 |
| | Female | 650 | 427,57 | 277917,50 | | |
| Environmental Behaviour | Male | 231 | 431,06 | 99574,00 | 72778,000 | ,511 |
| | Female | 650 | 443,86 | 288066,00 | | |

Table 8 presented the analyses carried out to determine whether gender caused a difference in environmental behaviour and environmental behaviour sub-dimensions. According to the analysis results, while the environmental behaviour of the teacher candidates did not differ according to gender ($p > .05$), it was observed that there was a significant difference in all three sub-dimensions ($p < .05$) which was found to be in favour of females for physical protection behaviour and individual and social persuasion behaviours, and in favour of males for political and legal behaviour.Table 8 and Table 9 showed the variability of the approaches to environmental ethics and the environmental behaviours of the prospective teachers according to the department variable.

Table 8. The comparison results of the Kruskal Wallis test for the environmental behaviour levels of the teacher candidates by department variable

| | Teaching Department | n | Mean Rank | sd | $\chi^2$ | p | Significant Difference |
|---|---|---|---|---|---|---|---|
| Physical Protection Behaviour | Science | 357 | 466,76 | 2 | 10,166 | .006 | Science>Social Sciences |
| | Primary School | 273 | 443,15 | | | | Primary> Social sciences |
| | Social Sciences | 251 | 400,28 | | | | |
| Individual and Social Persuasion | Science | 357 | 463,09 | 2 | 6,726 | .035 | Science> Social sciences |
| | Primary School | 273 | 441,66 | | | | |
| | Social Sciences | 251 | 408,86 | | | | |
| Political and Legal Behaviours | Science | 357 | 433,17 | 2 | ,590 | .744 | - |
| | Primary School | 273 | 447,82 | | | | |
| | Social Sciences | 251 | 444,72 | | | | |
| Environmental Behaviour | Science | 357 | 455,14 | 2 | 5,096 | .078 | - |
| | Primary School | 273 | 449,31 | | | | |
| | Social Sciences | 251 | 410,14 | | | | |

As a result of the analyses carried out on whether there was a difference in the environmental behaviours and sub-dimensions of the teacher candidates according to their departments, only physical protection behaviour ($\chi 2$ (sd = 2, n = 881) = 10.166; p <.05) and individual and social persuasion dimension difference ($\chi 2$ (sd = 2, n = 881) = 6.726; p <.05) was determined. It was observed that the difference was in favour of the Science teacher candidates among the Science and Social sciences under the sub-dimension of Physical Protection Behaviour and of Primary School teaching among Primary School Teaching and Social sciences teacher candidates. Considering the mean rank between the Science and Social sciences teacher candidates, it was seen that the difference was in favour of the prospective science teachers under the individual and social persuasion sub-dimension.

Table 9**.** The comparison results of the Kruskal Wallis test for the environmental behaviour levels of the teacher candidates by place of residence

| | Place of residence | n | Mean Rank | Sd | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| Physical Protection Behaviour | Village | 106 | 414,10 | 4 | 1,716 | ,788 |
| | Town | 45 | 421,51 | | | |
| | County | 122 | 447,34 | | | |
| | City | 210 | 447,32 | | | |
| | Metropolis | 398 | 443,99 | | | |
| Individual and Social Persuasion | Village | 106 | 433,67 | | ,743 | ,946 |
| | Town | 45 | 443,27 | | | |
| | County | 122 | 432,53 | 4 | | |
| | City | 210 | 453,23 | | | |
| | Metropolis | 398 | 438,84 | | | |
| Political and Legal Behaviours | Village | 106 | 420,85 | 4 | 2,490 | ,215 |
| | Town | 45 | 433,42 | | | |
| | County | 122 | 402,59 | | | |
| | City | 210 | 466,81 | | | |
| | Metropolis | 398 | 445,38 | | | |
| Environmental Behaviour | Village | | 414,76 | 4 | 5,791 | ,646 |
| | Town | | 436,94 | | | |
| | County | | 427,66 | | | |
| | City | | 458,60 | | | |
| | Metropolis | | 442,15 | | | |

Table 9 demonstrated that there was no difference in any environmental behaviour of the teacher candidates according to the variable of place of residence. Below are the results of the analysis conducted to determine whether there was a relationship between the approaches to environmental ethics of the teacher candidates and their environmental behaviour levels, and, if any, the level of this relationship.

Table 10. Spearman rank differences correlation results for the teacher candidates' approaches to environmental ethics, environmental behaviours and environmental education self-efficacy

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Anthropocentric | 1 | -,034 | ,110** | ,076* | ,307** | ,208** |
| Ecocentric | | 1 | ,313** | ,333** | ,102** | ,285** |
| Physical Protection Behaviour | | | 1 | ,668** | ,525** | ,857** |
| Individual and Social Persuasion | | | | 1 | ,485** | ,834** |
| Political and Legal Behaviours | | | | | 1 | ,827** |
| Environmental Behaviour | | | | | | 1 |

* Significance at p <.05 level

** Significance at p<.01 level

Table 10 showed that anthropocentric approach had a positive relationship with low significance with political and legal behaviours (r = .307, p <.01), environmental behaviour (r = .208, p <.01) and physical protection behaviours (r = .110). , p <.01). The ecocentric approach had a positive relationship with low significance with environmental behaviour (r = .285, p <.01) and physical protection behaviour (r = .313, p <.01), political and legal behaviour (r = .102, p <.01), and individual and social persuasion (r = .333, p <.01).

## Discussion and Conclusion

This section present the findings regarding whether the ethical approaches and behaviours of the teacher candidates differ according to their gender, department and place of residence, as well as the results of the relationship between the ecocentric and anthropocentric approaches to environmental ethics and the environmental behaviours of the prospective teachers. It is observed that the teacher candidates generally do not adopt anthropocentric approach in terms of environmental ethics as expected. It is seen that ecocentric approaches to environmental ethics are at a good level (I agree), which mean they have an environmentalist approach that takes into account the environment in terms of all living and non-living entities. Similar results were obtained in some studies conducted with teacher candidates (Çolak, 2017; Güriçin, Sevinç, 2020; Karakuş & Çimen, 2020; Özdemir, 2012; Rachmatullah, Lee, Ha, 2020; Sönmez, 2019), which points out that the teacher candidates adopt an environmentalist approach and take into account the importance of all beings living in the environment.

Moreover, in terms of environmental behaviours, it is observed that the teacher candidates "sometimes" perform actions as part of physical protection behaviours and individual and social persuasion behaviours. These results show that individuals' behaviours of working directly for the natural world and persuading other individuals and communities in order to prevent or solve environmental problems (Volk and Mcbeth, 2001, cited in Karatekin, 2011) are not at a sufficient level. It was determined that they rarely display political and legal behaviours. Therefore, it was determined that teacher candidates rarely behave in terms of participating in environmental activities (Volk and Mcbeth, 2001, cited in Karatekin, 2011) to use political tools, to prevent and solve environmental problems, and to support and strengthen laws. When addressed together with the sub-dimensions, it is seen that they rarely display positive environmental behaviours in general. Koç and Karatekin (2013) found in their study conducted with geography teachers that prospective teachers showed environmentalist behaviours at a moderate level. In another study carried out with primary school teachers, the conclusion that the positive environmental behaviours were at a low level, although environmental attitudes were high (Erbasan & Erkol, 2020), is similar to the result of this study.

The gender factor can be an effective factor making a difference in individuals' attitudes, tendencies or beliefs, along with their behaviour patterns. It is stated that such difference is significantly effective not only in biological but also in psychological and socio-cultural variables in the context of biology (Bandura, 1986; Bussey & Bandura, 1999). According to the results obtained from this study, it could be stated in terms of gender that females adopt more ecocentric approaches in ethical approaches. In terms of environmental behaviours, it is understood that females are more environmentally friendly in their physical protection behaviour and individual and social persuasion behaviours. Although there are studies concluding that gender is not effective in terms of environmental behaviour (Erbasan & Erkol, 2020; Karakaya, Avgın & Yılmaz, 2018; Karakaya, Avgın & Yılmaz, 2018; Karakuş & Çimen, 2020 Özdemir, 2012; Sungur, 2017), they indicate that females have a more friendly approach to the environment than males (Fernandez Manzanal, Rodriguez-Barreiro and Carrasquer, 2007; Güriçin, Sevinç, 2020; Karakaya and Yılmaz, 2017; Keleş and Özer, 2020; Plavsic, 2013; Sönmez, 2020; Sönmez, 2019; Zelezny, Chua and Aldrich, 2000). Ecofeminist literature suggests that females relate to the environment at a more empathetic level and there are gender differences in human relationships (Bloodhart & Swim, 2010; Stephens, Jacobson, & King, 2010). It is stated that women are more sensitive and concerned about environmental issues such as environmental health and climate change than men (Ciocirlan & Pettersson, 2012, Talu, 2016). In addition, it is also stated that being more aware of social and environmental issues women can make more efforts to create values for social and environmental issues and improve them (Buil-Fabrega, Alonso- Almeida and Bagur- Femenias, 2017). Gender-specific structural differences in society and family life can cause differences in the environment as well as in many aspects of social life. While technical solutions are at the forefront for men, changing the lifestyle (such as demand of green space, low consumption of energy and water) is more important for women and they strive for this (Johnsson-Latham, 2007).

Moreover, it was found that the male teacher candidates displayed more friendly behaviours to the environment in terms of political and legal environmental behaviours. The higher risk-taking tendency of men is shown as a reason for their less environmentalist perspective than women (Eisler, Eisler, & Yoshida, 2003). The view that females have an important effect on environmental protection is shown as a reason leading them to have more environmentalist perspectives and behaviours than males (Eisler, Eisler and Yoshida, 2003).

As for the departments, it can be stated that prospective science teachers adopt an ecocentric approach more than both primary school and social sciences teacher candidates, which is considered to be a result of the relevant department as only the science teaching program includes a course for environmental education. In

addition, there are some acquisitions especially in the context of the Science course of Turkey's Ministry of National Education. The fact that these subjects are constantly being addressed as part of the education provided to the teacher candidates is considered to be effective. Similarly, in the studies conducted by Güriçin and Sevinç (2020), Tan (2014) and Sönmez (2019), it was observed that science teacher candidates had higher level of ethical approaches to the environment, while another study conducted with prospective science and primary school teachers (Sönmez, 2019) determined that the department was not effective. In another study conducted with students studying in economics, sociology, psychology and biology departments, no difference was found in terms of department (Özdemir, 2012). In addition, in the study conducted by Dalbudak (2013), it was determined that biology teaching students' attitudes towards the environment were significantly different from physics teacher candidates, which may be due to the fact that the content of the courses of biology teaching department is more related to environmental issues.

Considering the effect of the department on environmental behaviours, it can be stated that both prospective science teachers and primary school teacher candidates exhibit more environmentally friendly behaviours than social sciences teacher candidates in terms of physical protection behaviour. In addition, it is observed that science teacher candidates exhibit more environmentally friendly behaviours than social sciences teacher candidates in terms of individual and social persuasion behaviours. Therefore, it indicates that prospective science teachers tend to show more environmental behaviours in terms of persuading other individuals and the society, in addition to solving environmental problems and taking measures for possible problems (Volk and Mcbeth, 2001, cited in Karatekin, 2011).

It is observed that the place of residence of the teacher candidates does not make a significant difference in terms of both environmental ethics approaches and environmental behaviours. Although Turkey has a wide geography, it is observed that working from different universities and living in different residential areas does not have an impact. While no ecocentric difference was observed in the studies of Karakuş and Çimen (2020), it was determined that the anthropocentric tendencies of the teacher candidates living in rural areas were higher. In some studies conducted with prospective teachers, it was concluded that place of residence did not make a difference in prospective teachers' environmental awareness (Güriçin & Sevinç, 2020), environmental ethics (Dikicil, 2018) or environmental awareness level (Erol & Gezer, 2006; Yalçın, 2009). The research by Plavsic (2013) determined that students who are part of the campus life have an environmentalist approach at a similar level with those who live with their families. It is stated that such behaviour patterns are affected more by social norms. Considering the views suggesting that language, lifestyle, history and geography of cultural structure are more effective in terms of perspective and evaluation of events (Eisler, Wester, Yoshida, & Bianchi, 1999; Shweder, 1990; Triandis, 1996), it is seen that common culture is more effective on the environment.

According to the analyses, it is observed that the ecocentric approaches of the teacher candidates are mostly correlated with physical protection and individual and social persuasion environmental behaviours. However, it is remarkable that the said relationship is at a low level since the main purpose of ensuring that individuals acquire ethical approaches is to help individuals acquire more environmentalist behaviours. According to the results, it is seen that the approaches to environmental ethics of the teacher candidates do not have much effect on environmental behaviours. Similarly, in the study by Said, Ahmadun, Paim and Masud (2003), it was concluded that teachers' environmental knowledge was at a good level, but they were incapable of understanding the underlying causes of environmental problems, and there was not a sufficient level of harmony between teachers' environmental knowledge and anxiety levels and behaviours. Again, Liu, Yeh, Liang, Fang, Tsai (2015) observed that, although Taiwanese teachers have a high level of environmental awareness and attitude, they are inadequate in terms of responsible environmental behaviours. In another study conducted by Yılmaz, Yıldız, and Arslan, it was determined that environmental sensitivity and attitudes of university students explained 28% of the change in environmental behaviour, while Siu and Cheung (1999) put forward that the actual behaviour towards the environment was at 19%, and the level of explanation of environmental attitude for the actual behaviour level was very low. In their study conducted with prospective science teachers, Uçar and Canpolat (2019) concluded that although the ecocentric tendency was high, the compliance with behaviour was not at a sufficient level. This study and previous results show that ethical approaches of prospective teachers towards the environment and their environmental behaviour patterns are not in harmony as expected.

Another significant conclusion is that anthropocentric approaches are directly correlated with political and legal behaviour, albeit at a low level. In some studies, it is seen that, although environmental awareness is high, individuals calculate cost-benefit rather than positive behaviour towards the environment, especially in consumption habits (Said, Ahmadun, Paim and Masud, 2003). It is stated that media tools have an effect on this result. In a study conducted by Erve (2013) with young people between the ages of 21 and 26 with different education levels, it was observed that, although they have a positive attitude towards the consumption of

environmentally harmless products, the attitude-behaviour relationships arising from the prices of the products are in the opposite direction. It is seen that the age, gender, personality traits and social environment of individuals are effective in the formation of environmental risk perception. Especially attitudes and values based on culture are expressed as determinants of risk and uncertainty (Vaughan & Nordenstam, 1991). In the studies conducted, it was concluded that individuals who adopt environmental approaches exhibit positive behaviour towards the environment (Gheith, 2013; Kil, Holland, & Stein, 2014; Martin & Bateman, 2014; Thapa, 2010). Moreover, there are results indicating that the environmental protection behaviours of individuals with anthropocentric approach may be in the opposite direction, in addition to the results showing that there is an inverse relationship (Kaida & Kaida, 2016).

## Recommendations

It should be remembered that teachers are important role models, as well as planners and implementors of the teaching process. To this end, ethical approaches to the environment of teachers and their environmentally friendly behaviours will be effective in the behaviours and approaches of their students. Studies should be carried out to detect the obstacles to the transition between ethical approaches and behaviour, by looking at the focus of environmental values that are not in harmony with environmental behaviours. Environmental approaches and environmental behaviours of teachers should be evaluated properly and developed with in-service trainings in line with the data obtained. Such and similar studies show that training in environmental education of teachers is either not at all available or incomplete. According to the results of this study and similar studies, it is stated that prospective teachers who have received environmental courses in undergraduate programs and who are more interested in the environment as a field are more involved in the environmentalist approach and behaviour compared to teacher candidates from other branches. The said result reveals that environmental education courses should be added to teacher education programs. However, the results of the study show that the low-level relationship between environmental approaches and environmental behaviour is not only due to environmental education courses. During the creation of the contents of such courses, they should be designed not only for teaching environmental information, but especially for practical purposes, to ensure the acquisition of the ability to evaluate and solve environmental problems. Programs and applications, especially with non-class practices, which involve industry and sector creators and policy makers should be developed. While creating such programs and contents, it can be ensured that individuals are aware of the ethical dimension of environmental problems, by including environmental ethics education. As in the new teaching approaches, the use of arguments together with critical thinking skills in the environmental ethics education process increases the tendency towards the concept of ethics, while there are a few studies showing that individuals who encounter environmental climates can apply ethical thinking. (Baker, Grundy, Junmookda, Macer, Manzanero, Reyes, Tuyen & Waller, 2019). The results show that long-term education of environmental ethics is more motivational for individuals to be involved in solving environmental problems (Baker et al., 2019). Therefore, creating environmental education programs that include different perspectives and different applications beyond solely providing information can affect the thinking and behaviour of not only teachers but also teacher candidates and students.

## Scientific Ethics Declaration

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

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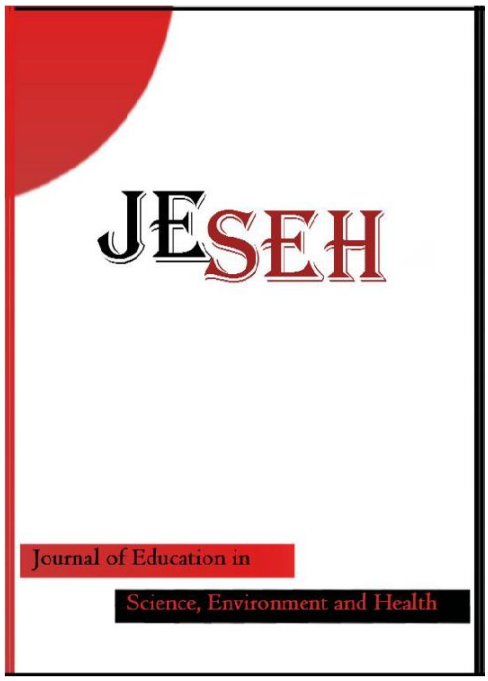
## Author(s) Information

**Mehpare Saka**
Trakya University Faculty of Education,
Edirne, Turkey
Contact e-mail: *mehparesaka@email.com*
ORCID iD: 0000-0001-9730-8607




**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

**www.jeseh.net**

# Design-Based Natural Disaster Education Practices for Primary School Teachers

**Ahmet Oguz Akcay**[1],
**Engin Karahan**[2],
**Mehmet Arif Bozan**[3],
**Feyzanur Ardic**[4],
**Omer Garan**[5],
[1]Eskisehir Osmangazi University
[2]Midde East Technical University
[3]Istanbul Aydin University
[4] Etkin College
[5] TOBB Science and Art Center

**To cite this article:**

Akcay, A.O., Karahan, E., Bozan, M.A., Ardic, F., & Garan, O. (2023). Design-based natural disaster education practices for primary school teachers. *Journal of Education in Science, Environment and Health (JESEH), 9*(2), 146-161. https://doi.org/10.55549/jeseh.1279773

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1279773

# Design-Based Natural Disaster Education Practices for Primary School Teachers

**Ahmet Oguz Akcay, Engin Karahan, Mehmet Arif Bozan, Feyzanur Ardic, Omer Garan**

## Article Info

***Article History***

Published:
01 April 2023

Received:
14 September 2022

Accepted:
15 February 2023

***Keywords***

Design-based activity,
Disaster education
Professional development,
Primary school teachers

## Abstract

The goal of this study was to uncover primary teachers' perspectives on the use of design-based activities in disaster education and to thoroughly examine the plans. The study is designed as a case study. The participants were chosen using the purposeful sampling method. The study included 24 primary school teachers (12 male and 12 female) from various regions of the country. The data collection tools were group-prepared lesson plans and follow-up focus group interviews, which aimed to reveal their experiences and opinions on the lesson plan design process. The data was analyzed using the content analysis method. The findings revealed that the use of design-based activities in primary school, the importance of disaster education in the primary school curriculum, and the importance of disaster education awareness at the primary school level were all highlighted. The primary school teachers' lesson plans were examined, and the themes of drawing attention, design, material, career connections, and assessment-evaluation emerged. The significance of using design-based activities in primary schools, as well as the pedagogical benefits of using design-based activities in disaster education, was emphasized. Despite their abstract nature, natural disasters can be made more understandable through design-based education, particularly for primary school students who are in the concrete operational stage and have limited experience.

## Introduction

Recent scientific and technological advancements have made our lives easier, but they also pose a threat to the environmental, social, economic, and cultural areas. Climate change, drought, natural resource depletion, pollution, biodiversity loss, and hunger are among the most visible of these global issues (Fomby et al., 2009; Barlas, 2013). Humans are destroying nature as a result of the rapid urbanization that has resulted from the advancement of technology. According to Duran (2021), Akkuzu-Guven, and Uyulgan (2021), one of the causes of environmental problems is human beings. People have an impact on the environment, either directly or indirectly, and people must be educated in order to reduce environmental problems (Erdas-Kartal & Ada, 2022). On the other hand, the effects of natural disasters have recently increased as a result of climate change, as has the community's social life (Becken et al., 2014). Along with it, we face man-made and natural disasters like erosion, flooding, and drought.

Disasters are events that occur as a result of natural or man-made causes, causing people to suffer physical, economic, and social losses. These occurrences have the potential to have a significant impact on human life. Natural disasters have become more common around the world (Seddighi & Bahatmand, 2020), and there are 31 different types of natural disasters (Disaster and Emergency Management Presidency, 2020; Shaluf, 2007). These are geological disasters (e.g., earthquake, landslide, rockfall, and tsunami), climatic disasters (e.g., heat-cold wave, hail, flood, icing, air pollution, and excessive snow), biological disasters (e.g., erosion, forest fires, epidemics, insecticides) and social disasters (e.g., fires, wars, terrorist attacks). Natural disasters affected one out of every 39 people between 2004 and 2013 (UNISDR, 2015).

Disasters are divided into two types based on their causes. These are classified as both natural and man-made disasters. Human-caused disasters, as opposed to natural disasters caused by natural hazards, have an element of human intent, negligence, or error involving a failure of a man-made system (Central Washington University, n.d.). Natural disasters include earthquakes, floods, volcanoes, and hurricanes, whereas man-made disasters include war, pollution, nuclear explosions, and transportation accidents (Zibulewsky, 2001). Fires, for example, can fall into either category depending on how they start.

Natural disasters such as earthquakes, fires, tsunamis, floods, hurricanes, and drought have occurred on a global scale recently. In this context, people should be aware of natural disasters and be prepared to take precautions against them in order to reduce the dangers posed by them. A significant proportion of those who died in disasters were children, and it was stated that the number of people affected by disasters has increased due to weak structures and unplanned urbanization (Kousky, 2016; Limoncu & Atmaca, 2018). Natural disaster awareness and preparedness studies should be taught to children at a young age. Children's early experiences with common disasters will guide them throughout their lives. In this regard, it is critical to start teaching children about natural disasters at a young age. Possible problems that may be experienced as a result of natural disasters can be minimized by raising awareness and consciousness among students about natural disasters, so individuals of all ages are expected to have natural disaster literacy.

Disaster literacy is defined as the ability to read, understand and use knowledge for the purpose of mitigating the impact of disasters, preparing for disasters, making better decisions in terms of response and avoiding disasters, and following instructions (Brown et al., 2014). Many people in disaster-prone areas may be underinformed about how to protect themselves and take precautions. As a result, disaster literacy and education are critical for reducing disaster risk. Teachers and school administrators' natural disaster literacy was inadequate (Chung & Yen, 2016; Sözcü, 2019). On the other hand, teachers are not well-informed about natural disasters and thus cannot effectively instruct their students on natural disasters. According to Sözcü and Aydınözü (2019), while the curriculum includes achievements for natural disasters, it is insufficient for natural disaster literacy.

In response to changing conditions within the context of the needs of the twenty-first century, interdisciplinary problem-solving skills are required from an early age (Bybee, 2010), so innovative strategies, approaches, and methods have begun to be implemented in education. The design-based education approach, particularly the engineering design process, is one of the most important of these. The following is a description of the engineering design process:

> *Engineering design is a systematic and thought-provoking process used by engineers to create, evaluate and define solutions for devices, systems, or processes whose form(s) and function(s) meet customer goals and meet user needs, under certain limitations. In other words, engineering design is a reflective process used to create plans or schematics for devices, systems, or processes that achieve given goals while adhering to certain limitations* (Dym et al., 2009, p. 7).

**Design-based Disaster Education Project Implementation Process**

To reduce the devastation caused by natural disasters, teachers must first gain knowledge and awareness before passing on their knowledge and experiences to their students. According to Tuswadi (2014), teachers' knowledge and skills in disaster teaching are insufficient. The goal of this study is to determine primary school teachers' opinions on design-based natural disaster education and to examine the lesson plan designs they have prepared in this direction. It is the goal of design-based natural disaster education to ensure that participants use various disciplines together and to raise awareness about the professions and occupations associated with these disciplines. As a result, the participants help students become more aware of natural disasters. As a result, the project's objectives are as follows:

- To increase the knowledge and awareness of the teachers participating in the project about natural disasters,
- To equip the teachers participating in the project with competencies towards design-based teaching and interdisciplinary STEM approach, which are innovative teaching approaches in the teaching of natural disasters,
- To ensure that the teachers participating in the project develop activities for the teaching of natural disasters and implement them in their classrooms through interactive applications based on the guidance of the project team,
- To develop a design-based activity pool for natural disasters and to make it available to stakeholders by sharing the activity plans developed by the project team and participants within the scope of the project.

Following the training, teachers must implement design-based disaster practices in their classrooms. In accordance with the stated research objectives and questions, teachers were asked to prepare a lesson plan reflecting what they learned following the design-based disaster education practices. The purpose of requesting lesson plans from teachers is to see how much of what has been learned can be reflected in lesson plans.

**Purpose of the Study**

Teachers have been determined to be ineffective in disaster education (Tuswadi, 2014), so examining how teachers currently perform disaster education is critical. Finally, the teachers' perspectives on the design-based disaster activities and their applicability are important. As a result, the following questions were addressed in this study:

- How do teachers collaboratively design their lesson plans after participating in a design-based disaster education professional development?
- What are teachers' views on current design-based disaster education practices in primary schools?

In accordance with the project's objectives and research questions, the implementation process is divided into three stages, namely the preliminary stage, activity implementation, and the process of developing lesson plans.

Table 1. Activities

| Day | Activities | Explanation |
|---|---|---|
| Day 1 | Activity 1: What is a disaster? Disaster awareness<br>Activity 2: Ice-breaking action | On the first day of the project, participants were informed about common disasters in order to raise disaster awareness. Furthermore, instructions on what to do before, during, and after the disaster were provided. A drama activity was also held on the first day of the project so that the participants could get to know each other, warm up, and form a group. |
| Day 2 | Activity 1: We produce natural solutions to drought<br>Activity 2: Environmentally friendly alternative solutions to the problem of urbanization | In the first event of the day, participants studied the adaptations of various plants and animals to meet their water needs in low-rainfall areas, and based on these animals, they created designs that would store more water in the event of a drought. In the other activity, participants were asked to focus on the problems caused by uncontrolled urban population growth (unplanned urbanization, concretization of green areas, air and water pollution, etc.) and create designs that necessitate alternative solutions. |
| Day 3 | Activity 1: We create a post-disaster living space<br>Activity 2: Journey to the science center | The first activity of the day asked participants to build a home for the creatures affected by the fire. Following that, a trip to the Science Experiment Center and Sabancı Space House was organized, where the trainers asked the participants to design a bridge that could remain intact after disasters such as earthquakes and floods in order to raise disaster awareness. In addition, the disaster simulations in these locations exposed the participants to earthquake, tornado, and flood disasters. |
| Day 4 | Activity 1: Durable towers<br>Activity 2: Disasters experience with virtual reality goggles | The first event of the day was a discussion about how earthquake-resistant structures should be, and participants were asked to design durable towers based on the criteria provided. The participants created virtual reality goggles in the second activity of the day. They examined concrete examples of natural disasters in mobile applications and experienced virtual disasters using the goggles they designed. |
| Day 5 | Activity 1: Flood? What's that? Where was it?<br>Activity 2: Erosion Simulation | In the first activity of the day, participants were asked to design a settlement, taking care to include an area that would be least affected by the flood. The second activity of the day required participants to work in groups to create two different surfaces, one without vegetation and one with vegetation. |
| Day 6 | Activity 1: User friendly masks<br>Activity 2: Where to position ambulances? | With the first event of the day, it was requested that ambulances be placed in various parts of the city, using the modeling method, to respond to people who contract disease during the epidemic process as quickly as possible. In the other event, participants were challenged to create user-friendly masks while considering the positive and negative experiences they encountered during the Covid-19 pandemic. |
| Day 7 | Activity 1: I have finalized my materials I am preparing an e-portfolio<br>Activity 2: Presenting the lesson plans | The participants presented the lesson plans they designed in groups on the final day of the project and received feedback from the other groups and the project team. |

### Preliminary Stage

During the preliminary phase, themes were developed for the activities to be carried out within the scope of the project, and appropriate activities were developed for each theme (drought, earthquake, erosion, fire, flood, and epidemic). The final version of the activities was given in accordance with the activities by interviewing the experts in their fields and who would best implement these activities.

### Activity Implementation

Field specialists delivered design-based disaster education for six days, two sessions per day. The first 30 minutes of training included information about the topic, the next 2 hours included creating designs in accordance with the given criteria, and the final 30 minutes were dedicated to the presentation of the prepared designs, for a total of 3 hours. The following is a day-by-day breakdown of what has been accomplished in the project. Table 1 shows details of the activities.

### Process of Developing Lesson Plans

At the end of each day, participants met in groups of four to prepare design-based lesson plans for each disaster case given within the project. Within the two-hour period given at the end of the day that focused on that specific type of disaster, these lesson plans were developed with the assistance of the project team (project team and experts who carried out the activity on the relevant subject).

## Method

The purpose of this study is to examine the lesson plans prepared by primary school teachers in disaster education using design-based approaches, as well as to present their opinions and perspectives on their experiences during this process. The research was targeted to uncover primary school teachers' perspectives on the use of design-based activities in disaster education and to thoroughly examine the plans they developed for this purpose. The study is structured as a case study, which is defined as an in-depth examination of one or more limited cases over time using multiple data sources (Creswell, 2007). A case study design was chosen for this study because it aimed to deal with the products, experiences, and perspectives of the participants in a specific time period in a thorough and holistic manner.

### Participants

The purposeful sampling method was used to select study participants. One of the criteria in this context was to select teachers who taught at the primary school level, and the other was to select teachers who had received design-based activity preparation training. According to the criteria established, 24 primary school teachers were chosen, 12 of whom were female and 12 of whom were male. The participation of teachers from various regions was ensured in order to increase diversity when selecting project participants. It was hoped that by doing so, the project's overall impact would be increased. Table 2 displays participant information.

### Data Collection Tools

The lesson plans developed by the participants in groups and the follow-up focus group interviews to reveal their experiences and opinions on these lesson plans were used to collect data within the scope of the research. These two data sources were combined to gain a holistic perspective in order to find answers to the research questions.

Lesson plans prepared by participants in groups of four within the scope of the project were obtained as the primary data source in the research. Given the project's focus and content, these plans were based on a natural disaster chosen by the participants and included design-based learning processes. While the participants were given freedom to decide the content of the lesson plans, a consensus was reached on the 5E model, which the teachers were familiar with due to their regular use of the format. As a result, while the participants' lesson plans were ensured to be consistent with one another, their applicability in the classroom was also increased.

Table 2**.** Information of participant

| Nickname | Grade level served | Age | Professional seniority | Education level |
|---|---|---|---|---|
| Daisy | 1 | 26-30 | 5 | Bachelor |
| Mike | 4 | 31-35 | 8 | Bachelor |
| Anna | 1 | 26-30 | 4 | Bachelor |
| Nicole | 4 | 26-30 | 7 | Bachelor |
| Iris | 4 | 36-40 | 15 | Bachelor |
| Kevin | 2 | 41-45 | 21 | Bachelor |
| Alice | 2 | 36-40 | 13 | Bachelor |
| Amy | 2 | 26-30 | 2 | Bachelor |
| Garry | 2 | 36-40 | 13 | Bachelor |
| Brian | 1 | 46-50 | 23 | Bachelor |
| Adam | 1 | 31-35 | 15 | Bachelor |
| Owen | Principal | 31-35 | 9 | Master |
| Lively | 2 | 46-50 | 22 | Bachelor |
| Nate | 1 | 36-40 | 17 | Bachelor |
| Julia | Multigrade (3-4) | 36-40 | 16 | Bachelor |
| Eve | 2 | 41-45 | 21 | Bachelor |
| Jack | 1 | 31-35 | 9 | Bachelor |
| Carol | 2 | 41-45 | 20 | Bachelor |
| Jordan | 4 | 36-40 | 17 | Bachelor |
| Harrison | 3 | 31-35 | 11 | Bachelor |

The secondary data collection tool for the research was focus group interviews, in which the teachers worked collaboratively to prepare lesson plans and participated in groups throughout the process. As a result, in these interviews, which were conducted in groups of four, the participants were asked about their experiences and perspectives on the process of designing the lesson plan within the scope of the project. Given that the participants went through the process with the group they were in, it was thought that focus group interviews would provide more detailed information. Each focus group interview lasted approximately one hour. The researchers were in charge of the moderation and transcription of the focus group interviews.

### Data Analysis

The content analysis method (Miles & Huberman, 1994) was used in the analysis of the data obtained within the scope of the research. The NVivo qualitative data analysis program was used to inductively analyze the lesson plans and transcripts of the semi-structured interviews prepared by the participants. The findings were organized in accordance with the codes, categories, and themes derived from the data analysis. In the study, construct validity was tried to be established by using multiple data collection tools (focus group interview form, and course syllabus draft). Furthermore, an effort was made to ensure reliability by involving more than one researcher in data collection and analysis (Merriam & Tisdell, 2016). Finally, direct quotations from the data were used to ensure reliability, and participant confirmation was obtained to ensure validity (Creswell & Poth, 2018).

## Findings

Within the scope of the research, groups of teachers were asked to prepare the lesson plans and interviews were held regarding the process of preparing these lesson plans. In this context, data from interviews and lesson plans were analyzed separately and presented under headings corresponding to the themes that emerged.

### Lesson Plans

Teachers were asked to reflect on their training and prepare a disaster education lesson plan in groups of four. They were divided into groups for this purpose and designed a lesson plan based on the 5E model. The data obtained from these lesson plans are presented under the headings of "engage, explore, explain, elaborate, and evaluate".

*General Information on Lesson Plans*

Table 3 represents the course, grade level, and type of disaster targeted in the lesson plans.

Table 3. Course, grade level, type of disaster targeted in lesson plans

| Group | Grade | Selected courses | Type of disaster |
|---|---|---|---|
| 1. Group | 2 | Life Science, Visual arts | Epidemic |
| 2.Group | 3 | Life Science, Literacy, Mathematics, Visual arts | Drought |
| 3.Group | 4 | Social Studies, Literacy | Fire |
| 4.Group | 4 | Social Studies, Literacy, Mathematics, Visual arts | Flood |
| 5.Group | 2 | Life Science | Earthquake |
| 6.Group | 4 | Social Studies, Mathematics | Erosion |

Table 3 reveals that teachers do not prioritize first grade in their lesson plans. However, acquisitions in Life Science and Social Studies were prioritized. It was discovered that some groups (for example, 2 and 4) mostly targeted course outcomes, whereas the 5th group only targeted one course outcome.

*5E Process*

Table 4 displays lesson plan content prepared using the 5E model.

Table 4. Lesson plan contents prepared according to the 5E model

| Group | Engage | Explore | Explain | Elaborate | Evaluate |
|---|---|---|---|---|---|
| 1.Group | using a mask | Checking student preliminary information | Q&A-video | Experiment | Game |
| 2.Group | Using a news text | Brainstorming | Asking students for a solution regarding the problem situation, creating a design | Discussing the designs created | Discussing the final version of the designs |
| 3.Group | Using a scenario | video playback | Sample case | Creating a design for the problem situation | Determination of the most appropriate fire response method |
| 4.Group | Using images and story text | Discussion | Bringing an expert, Creating a design for the problem situation | Discussion on created designs | Display of designs |
| 5.Group | Using a disaster kit | Creating a simulation | Creating a video, drill, disaster kit | Coding work | station technique |
| 6.Group | Creating and presenting a story | Watching videos | Experiment, graphing, video | Creating designs to prevent erosion | Process evaluation form |

*Drawing Attention*

When Table 4 is examined, it can be seen that teachers use various materials to attract students' attention during the introduction portion of the lesson. The first group, for example, described the situation in the lesson plan as follows: *"The teacher enters the classroom wearing a crow-nose mask. He questions the class about why he is wearing the mask."* Furthermore, the fifth group attempted to pique the students' interest by bringing a disaster kit to class:

> *"The teacher entered the classroom with a disaster and emergency bag (go-bag). He asked students to guess what its contents were. The bag was opened and examined. A game on the subject was opened on the smart board. The materials that should be in the bag were placed with the students."*

The third group attempted to draw attention through a scenario and preferred the drama method for the students, with the goal of allowing students to recognize human behaviors that lead to disasters.

> *"A small fire broke out (planned for drama before the fire) when a butt, unconsciously thrown into the trash can in front of the school, ignited with pieces of paper in there."*

Another method used by teachers in the introduction is the use of their own stories or news texts. The questions and answers with the students over a created text were used to create an introduction to disaster issues. Group 4's lesson plan, for example, stated the situation as follows:

> *"Students were shown a photograph of houses and natural beauties built in places such as creeks. They were asked the question "Would you like to live here?" and the answers given by the students were heard. Afterward, the students were told the story of two siblings, who lived in a place like the one in the photo."*

The second group intended to capture the students' attention by bringing a real-life news text about drought to the classroom.

> *"Within the scope of the news titled "the villagers have returned to their traditions due to the drought", the students were made to feel the problem without using the term "drought" and they were attracted to the visual."*

Finally, the sixth group wrote a story about erosion and shared it with the students, asking them to answer questions about the text.

> *"The reading passage "What Was the Reason" was distributed to the students. They were asked to answer questions about the text. The answers to the questions were discussed and brainstormed."*

*Design*

The fifth group devised an earthquake experiment. Thus, the goal was for the students to understand how the furniture in the house should be designed in the event of an earthquake. Students were asked to create solution-oriented designs for the experiment to be carried out in this direction.

> *"In order to teach the precautions to be taken before the earthquake, artificial tremors were created in the model house, whose furniture was not fixed with the materials prepared in advance, by using the design-based education method. The damage caused by the earthquake was noticed and the students were asked to design solutions. It was ensured that the students understand that the items in the house should be fixed as a solution. The items in the model house were fixed and another artificial tremor was created. The damage caused by the tremor was examined. They were asked to make comparisons about tremors where the items were fixed and not fixed."*

Finally, the fifth group intended to do coding activities with the students in order to provide disaster education. It is hoped that this course will provide students with the skills necessary to prepare a disaster emergency plan using coding.

> *"Coding activity was performed. A family disaster emergency plan was prepared. After the disaster, the family knew the meeting place they had to go."*

While attempting to attract attention through a scenario, the third group preferred the drama method for the students. It was aimed that this would help students understand the human behaviors that lead to disasters.

> *"A small fire broke out (planned for drama before the fire) when the butt, unconsciously thrown into the trash can in front of the school, ignited with pieces of paper inside it."*

Then, videos that can support the activity carried out in the introductory part were used.

> *"After returning to the classroom, students were divided into groups. After the fire drama watched in the garden with the students, they were made to watch a video."*

Following the viewing of the videos, the third group presented a problem situation to the students and instructed them to create a suitable design. The students were expected to create a design that would enable the evacuation of animals in the event of a forest fire, which is a current disaster, as the design criteria.

> *"Ayşe, who resides in Datça, is looking for a solution to intervene by air, land, or water for the evacuation of animals in the district with the least damage from the forest fire she witnessed in July. How can Ayşe save animals in the fastest and most economical way?"*

After the houses of the students living near the flood were destroyed in the story written by the fourth group, the students in the class were asked to design a new house.

> *"The students were divided into groups of three. They discussed among themselves the solutions they found to the problem. At this stage, it was stated to the students that they would design new houses for two siblings. First of all, they were asked to make a draft of their designs and to show the solutions they found on a sketch."*

The second group challenged the students to create a settlement where water is saved in order to find a solution to the drought problem mentioned in the attention-grabbing section of the news.

> *"The real situation was discussed with their solutions and the materials they designed. The drafts prepared by the students were discussed and the materials they would use during the design phase were given to the students."*

In the sixth group design section, students were asked to create an erosion-resistant area. The plan was for the students to create a first example using the materials they were given, and then conduct experiments to see if this area functions efficiently.

> *"Students were asked to design a product to prevent erosion by discussing in groups and to produce drawings of these designs. The following materials were given to the students. They were asked to prepare and present their designs as models. The designs were completed considering the given criteria and limitations."*

*Material*

While the groups were making their plans, they asked the students to design products. At this point, they gave the students some materials to work with in order to create products. When course syllabuses are examined for this purpose, it is discovered that teachers select materials for use in designs from materials used in their daily lives. For example, the second group stated that the designs would be made with the following materials: background cardboard, skewers, toothpicks, cardboard, colored papers, soil, and water. Similarly, the fourth group, which asked students to create designs to keep people living near the stream from being flooded, listed materials that the students could easily access. The fifth group chose materials that students could easily access after identifying the theme of an earthquake as a natural disaster in the course syllabus. Finally, the sixth group, which chose the theme of erosion disaster, decided on the materials that students should use during the design phase, which included soil, artificial grass, water, chenille, egg carton, blow dryer, and paper towel.

*Career Connections*

Teachers planned to collaborate with other professional groups to learn the subject they had chosen. For example, the sixth group, which identified erosion as a theme, intended to contact a Disaster and Emergency Management Presidency (DEMP) official during the learning phase and request a presentation on the subject. Furthermore, they considered listening to their experiences by hosting a person who had witnessed the erosion event.

> *"Career experts were invited to the school and information was obtained. A live history study (sharing the life and experiences of the person who has suffered erosion) was conducted."*

The fifth group, which chose earthquake as a theme, intended to collaborate with "DEMP volunteers, geological engineers, architects, and environmental engineers" to explain various aspects of the earthquake to the students.

The fourth group planned to invite a flood expert to the class to educate the students about the flood theme in their lessons.

*Measurement-Evaluation*

The groups preferred to use different assessment strategies at this final stage of lesson plan preparation. For example, the second, third, and fourth groups aimed to reveal the change in the students' learning levels during the process by discussing the products prepared by the students. After the students presented their designs, Group 2 planned for the entire class to evaluate the advantages and disadvantages of the designs.

> *"Students present their designs in groups in class. Advantages and disadvantages are evaluated."*

During the evaluation phase, the first group aimed to teach students to follow the mask, distance, and hygiene rules during the pandemic through educational games.

Another preferred method of evaluation is the station technique. The fifth group, which preferred to use this technique, divided the students into groups and planned to assess earthquake awareness using stations such as painting, music, and poetry.

> *"Using the station technique, students are divided into groups regarding earthquakes. Groups are made to work on painting, music, poetry, and letters."*

Finally, Group 6 intended to use a "Process evaluation form" to assess students throughout the procedure.

**Themes Obtained Through the Interviews**

The themes of the use of design-based activities, disaster education in the curriculum, and the importance of providing disaster education were obtained from the data obtained from the interviews (See Figure 1).

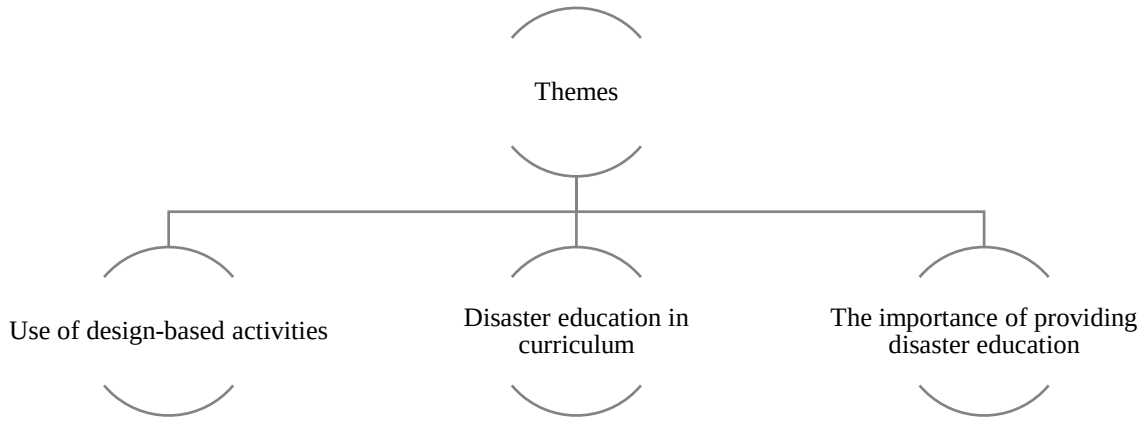



Figure 1. Themes obtained through the interviews

*Use of Design-Based Activities*

The potential of design-based activities was one of the highlights of the participant interviews. During the interview process, many participants mentioned the pedagogical benefits of design-based activities. The concretization of abstract concepts, which are difficult for primary school children to learn, through direct experience within the scope of design-based activities is at the forefront of these points.

> *"I think that design-based learning is concretizing the abstract concepts at the primary school level and making them more tangible by supporting them with visual materials."* Mike

Design-based activities, it has been claimed, give meaning to abstract subjects in younger age groups. Furthermore, it was emphasized that it is a fun learning process that will boost students' motivation and attitudes

in this age group. Nicole, for example, emphasized the fact that design-based teaching can be carried out using simple and easily accessible materials and described it as activities that can increase the motivation of children when they become bored in class.

> *"Actually, we didn't use very different things here, we created beautiful designs using simple materials. This is what we do in class. We use materials and activities to gamify things that remain abstract or when children are suffocated by lecturing."*

Amy stated that design-based teaching is a process that necessitates the execution of numerous complex actions. Furthermore, he emphasized that the design process is not just an internal process and that the design can be restructured cyclically as a result of sharing ideas and critical feedback.

> *"I think it is work that requires a process. First, we design and share ideas, then we can move on to a new design by discussing the disadvantages-advantages. While creating a product with the process, we can say that the product is actually being restructured with the criticisms provided."*

In addition to these, participants mentioned a variety of dimensions related to the process and outcome of design-based activities. For example, Anna described design-based activities as "the emergence of a product as a result of learning". Daisy defined it as "learning by doing and living". With the words "the child's creation of his/her own product with his/her original thought and being able to produce a solution in line with the problem," Iris stated that it is essential to produce a solution to a problem while creating an original product in design-based activities.

Participants emphasized certain points in order to improve the efficiency of design-based activities. For example, Adam emphasized the importance of selecting a problem situation from real life for use in design-based activities and stated that the problem situations chosen from real life do not have a single solution, allowing students' skills such as creativity to be developed.

> *"In real life, there is a problem situation, and we take it. We want students to create solutions, and in design-based learning, there are no ready-made solutions. We solve it by making it more realistic. Is our solution practical or not? There were various scenarios ranging from "let's put the ambulance center here" to "let's do this" in the activities we held for a week. It also inspires creativity because it can happen in real life."*

Eve emphasized that group work is one of the prerequisites for design-based activities to achieve learning objectives. She used to want her students in her class to do individual studies, but she saw the effectiveness of group work on learning during the project process.

> *"I used to educate children individually. But here I saw that when you do something as a group, there better learning takes place."*

Another issue that arose in the context of the effect of design-based activities on learning was the persistence of learning. With the following statements, Jack stated that the applicability of the activities for the teacher was increased by the introduction of concrete designs, and for the students, they resulted in permanent learning:

> *"I think it increases persistent learning. When we do the projects concretely, I think it fits in a more applicable way."* Jack

Similarly, Carol stated that the student internalized what she learned as follows: *"We internalize the problems we encounter; we will have experienced them rather than just seeing them."* In addition to the benefits of design-based activities mentioned by participants, some drawbacks were also mentioned. Nicole, for example, argued that design-based activities take time, which is a disadvantage for teachers when using design-based activities. She cited crowded classes as one of the reasons for this:

> *"Because the classroom is crowded, it is not possible to do it in 40 minutes in our classrooms. If we are planning a material production activity, we are certainly sacrificing 2-3 lecture hours."* Nicole

Similarly, Julia stated that, while design-based activities have many benefits, they are time-consuming: *"We may experience situations where design-based teaching takes a little more time in small age groups and there are not enough class hours, but the benefits are too numerous."*

*Disaster Education in the Curriculum*

The participants' perspectives and opinions on disaster-based training, which is another aspect of the project process, were solicited. Participants made statements about the role of disaster-related activities in the curriculum at this point. One of the participants, Garry, argued that disaster-related activities are sufficiently included in the primary school curriculum and that they can be handled in an interdisciplinary manner by associating different courses with their outcomes, as follows:

> *"Certainly not enough. As we've seen, it can be related to both mathematics and science courses. We only see it as an achievement in social studies, and social studies outcomes in fourth grade are very intense. The majority of them are abstract ideas. However, as a result of this project, I realized that we never associate it with courses like painting and music."*

Garry was not the only participant who emphasized the importance of implementing disaster education practices through interdisciplinary approaches. Jordan, like Garry, stated that curricula have limitations in integrating disaster issues and that the integration of different disciplines is one way to overcome these limitations. According to Jordan, this interdisciplinary approach can be realized not only through life studies, science, and mathematics but also through courses such as music and physical education:

> *"I think we should integrate natural disasters into the curriculum; there should be a place for it not only in life studies and social studies but also in science. In mathematics, for example, it can be addition and subtraction. We can play games about rapid escaping in music, and physical education."*

Harrison emphasized that by establishing a relationship between the courses in each semester, these subjects can be realized much more effectively as a result of the spiral structure of the curriculum. He emphasized that the spiral structure allows the interdisciplinary approach to be realized at higher levels.

> *"The interdisciplinary structure needs to be at a high level. At the same time, the spiral structure must be active. It is necessary to maintain the relationship between courses in a spiral structure from one term to another, not from one year to another."*

Amy, who criticized the lack of disaster subjects in the curriculum, emphasized that it is a contradiction that disasters occur so frequently in our country, yet they are included in the curriculum with so few learning outcomes.

> *"It is constantly being said that we are a country of earthquakes, a country of natural disasters. But there are only two or three outcomes in the curricula related to this."*

*The Importance of Providing Disaster Education*

In addition to the placement of disaster-based teaching approaches in the curriculum, participants evaluated their inclusion in classrooms. Participants argued that disaster-related topics should be taught, particularly in primary school, and emphasized the pedagogical benefits of this subject. For example, Owen stated that it is critical for children to become aware of disasters at a young age and that by doing so, great progress can be made in disaster preparation.

> *"We believe it will be very useful, particularly in the preparation and before. An old dog cannot be taught new tricks. If the child learns about disaster education and prevention early on, he may not be able to prevent the disaster, but as an adult, he will raise his own child in this manner. It makes a significant contribution."*

Furthermore, Adam stated that many disasters on a local and global scale are possible in the future, and emphasized the critical importance of disaster education, particularly for primary school children, in order to cope with these disasters. He also argued that primary school disaster education should focus on how to deal with these disasters.

> *"According to projections for the next five years, a disaster such as a drought is on the way, and by raising awareness of this, we will have more water resources. It is critical to raise awareness. Unfortunately, it appears that natural disasters will become more common in the next 5-10 years. I*

> *believe it is critical to provide education on how to deal with natural disasters, particularly at the primary school level."*

*"When you touch a child, his/her parents, grandmothers, and grandfathers become multipliers of this widespread effect, and an aunt and grandmother who never knew it learns something,"* Lively said of disaster education given to children her age in primary school to create social awareness. She emphasized the importance of primary schools in raising social disaster awareness.

Participants, on the other hand, criticized disaster-based teaching practices in schools. For example, Anna stated that the disaster activities they conducted in their schools were mostly on paper and could not be implemented by the students. Anna, who stated that disaster education practices in schools, in general, were limited, expressed her uncertainty about the effectiveness of these activities with the following statements:

> *"Clearly, we haven't gotten very far in disasters until now. Based on the activities here, I believe we will be more focused on paper. When it comes to what to do in the event of an earthquake, we say this is done or that is done and leave it at that, or we conduct earthquake drills with all school students. I'm not sure how effective it is, but I doubt we'll get very far."*

Nicole shared a case on the effectiveness of disaster education in schools, describing how they were caught in an earthquake during class in her school building, and how neither she nor her students were able to put what they had learned into practice.

> *"I realized this: yes, we teach only earthquakes for four years, but at the end of four years, we notice that there is not even a spiral. We practice earthquake drills in advance, but once we were caught in an earthquake at school. We have seen from experience that we did not give it. Neither as a result nor a practice. I would like to criticize this here, there is no such thing as disaster education of high quality in the curriculum. We were snagged during recess. We were in the teachers' room, and we rushed into the classrooms to collect the students. We were also stunned; the children ran from one location to another, and everyone dispersed somewhere. When we discovered the truth, it was extremely difficult. In fact, we were unable to teach it, we were unable to provide adequate information, and we observed that the children were unaware of it."*

Anna, who supports Nicole's experiences with similar criticisms, believes that the current disaster education given in schools is insufficient. She stated that the consequences of this deficiency could be severe:

> *"We always practice earthquake drills in class. For example, Nicole was caught in the earthquake at school, but the student could be in the restroom, outside during a break, or in the corridors."*

Furthermore, it has been stated that only disaster-related education activities take place in schools, while other disasters are ignored. Daisy, for example, stated that natural disaster education practices generally progressed while earthquakes and other natural disasters remained in the background.

> *"I noticed it as well, especially here. When it comes to natural disasters, we usually think of earthquakes. We always try to teach children about earthquakes, but we struggle with other natural disasters. They appear to be natural disasters, but I learned here that flooding is the most common."*

Harrison stated that the disaster examples in textbooks are limited to earthquakes and that other disasters are not adequately covered. He argued that the students' disaster awareness is limited as follows:

> *"Instead, I believe it would be better if we examined the issue of natural disasters under a broader theme each year. Most of the examples in the books are given in relation to earthquakes. Children are more likely to be affected by earthquakes; they are unaware of avalanches and floods. We only cover earthquakes in general; the rest are up in the air."*

Kevin also argued that because the country is constantly subjected to various disasters, disaster-related training should be given on a regular basis to all grade levels:

> *"Actually, disaster education should be given from the first grade, because our country is one that struggles with disasters. A regular disaster education should be given from the first grade to the last year of high school."*

There are criticisms of the existing content, in addition to the fact that the data obtained from the interviews do not provide enough content for disasters. Daisy, for example, stated that the examples given in disaster textbooks are above grade level: *"I taught fourth grade. It is given in greater detail because it pertains to social studies, but at a higher level, as opposed to storytelling."* The courses she taught about disasters before receiving design-based disaster education, on the other hand, were not very permanent due to the age of the children: *"We make them watch videos and show them pictures, but there are not many pupils who really experienced it because the children are very young, and the videos are so far."*

## Discussion and Conclusion

This study intended to ascertain primary school teachers' perspectives on design-based natural disaster education and to examine the design-based lesson plans they prepared. The use of design-based activities, the place of disaster education in the curriculum, and the importance of disaster education awareness emerged as a result of the interviews. Furthermore, the primary school teachers' lesson plans were scrutinized, and the topics of drawing attention, design, material, career connections, and assessment evaluation were thoroughly examined.

The importance of using design-based activities in primary schools was emphasized, as were the pedagogical benefits of using design-based activities in disaster education. The disaster remains a very abstract issue, particularly for primary school students who are in the concrete operational stage and have limited experience. It is possible to make natural disasters more understandable through design-based education. In addition, choosing the problem situation in disaster education from a real-life situation and highlighting the disasters that may occur frequently in the vicinity of the students will increase the interest and awareness of the students on these issues. Similarly, King and English (2016) stated that in order for learning to be more permanent, engineering experiences must be presented in the context of the real world by combining science, mathematics, and technology concepts. The study's findings also revealed that natural disasters provide a strong real-life context for design-based activities.

Furthermore, the limitations of disaster education can be overcome through an interdisciplinary approach that incorporates disaster education into the primary school curriculum and associates different classes with disaster education learning outcomes. According to Wood (1997), in an interdisciplinary teaching approach, children must use more than one source in order to gain a broader perspective. It is critical that children gain a broad perspective on disaster education and that this education be given in an interdisciplinary manner. Natural disasters are only directly addressed in the curriculum's Life Studies course in the second grade. Natural disasters, on the other hand, have no learning outcomes in the curriculum of courses such as science, mathematics, social studies, and literacy. Participants are seen to criticize the situation, and in their course syllabus designs, they attempt to overcome this barrier through "indirectly related gains" related to the subject.

Disaster education should begin at a young age, and students should be taught how to respond to disasters before, during, and after they occur so that they can transfer these skills to their lives as future engineers and scientists. According to studies, children who receive disaster education at a young age not only protect themselves properly during events but also warn those around them (Shaw, 2015; Amelia et al., 2020). Both the project dimension's objectives and findings highlight the students' outcomes of disaster education practices prepared for primary school students.

Because earthquakes are commonly associated with disasters and other types of disasters are overlooked, deficiencies in disaster education occur. Furthermore, the fact that curricula are not prepared in accordance with the level of the students is emphasized. Furthermore, disaster-related topics (such as epidemics, floods, and erosion) should be included in the curricula. Similarly, Çevik et al. (2022) stated that disasters such as epidemics are included in science programs to increase students' socioscientific perspective. It was also stated that earthquake drills for disaster education in schools, as well as fire extinguishing activities, were carried out in the schoolyard. Disaster education in schools is seen to be simple and ineffective in this regard. Indeed, studies have shown that such practices in schools are simple actions that are not appropriate for real-life situations due to the need to maintain school safety (Ramirez et al., 2009; Lund, 2013; Gong et al, 2021). Furthermore, during the research interviews, one of the teachers stated that they were caught in an earthquake at school and that they were surprised by the event and couldn't do anything about it.

The primary school teachers' lesson plans were examined, and the findings were organized around the themes of drawing attention, design, material, career connections, and measurement evaluation. According to Brittin (2005), teachers should create a learning environment in which students can learn effectively, and a good course

syllabus includes materials, effective teaching strategies, and appropriate timing for the student level. Teachers used a variety of methods to draw students' attention to disasters. According to Seddighi et al. (2022), teachers should use various educational equipment for natural disaster preparation, and the curriculum should be revised for better disaster education. All groups that took learner characteristics into account began the class with a drawing attention activity appropriate to the students' level. Several studies have concluded that it is critical to draw primary school students' attention to the classroom (Şahin, 1994; Bartan, 2018). The availability of the materials that teachers intend to present to students, in particular, will facilitate student participation in the process. If the materials used in design-based activities are expensive and difficult to obtain, it makes implementation in classrooms, particularly in primary schools, difficult. According to some studies, obtaining materials was difficult (Siew et al., 2015; Garcia-Carrillo et al., 2021). In their study, Siew, Amir, and Chong (2015) stated that obtaining materials was difficult.

Teachers who placed a high value on career connections emphasized careers related to the subject, with a particular emphasis on disaster-related work, when developing lesson plans. Students will be able to focus more consciously on their careers as a result of such activities that will guide them in choosing a profession. Developing career awareness at a young age will lead to a better career choice in the future. Concerning STEM career options in particular, emphasis was placed on the importance of early intervention in students' STEM-oriented career choices, as well as the importance of increasing students' awareness of STEM-oriented career options (Moore & Richards, 2012). To that end, educational approaches should be used, particularly from a young age, to steer children in the right direction in their career choices.

## Scientific Ethics Declaration

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

## Acknowledgements

This study was made possible by TUBITAK 4005 Grant (Project Number: 121B288). The findings, conclusions, and opinions herein represent the views of the authors and do not necessarily represent the view of personnel affiliated with the TUBITAK.

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## Author(s) Information

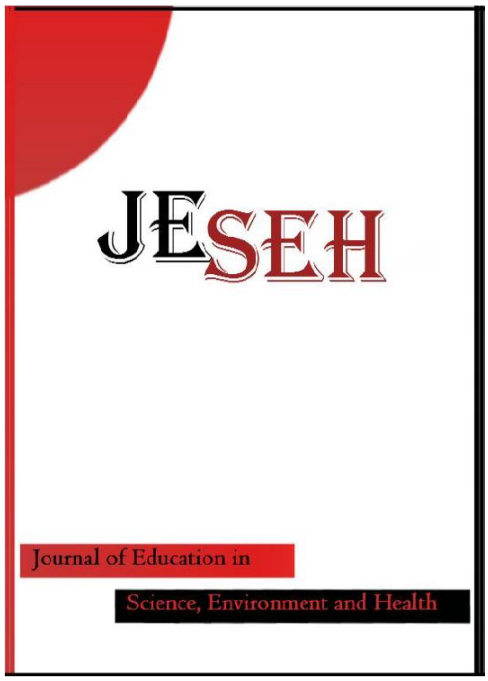
**Ahmet Oğuz Akçay**
Eskisehir Osmangazi University
Faculty of Education, Department of Early Childhood & Primary Education, Eskisehir/ TURKEY
Contact e-mail: *aoguzakcay@gmail.com*
ORCID iD: 0000-0003-2109-976X

**Engin Karahan**
Middle East Technical University
Faculty of Education, Department of Mathematics and Science Education, Ankara/ TURKEY
ORCID iD: 0000-0003-4530-211X

**Mehmet Arif Bozan**
Istanbul Aydın University
Faculty of Education, Department of Early Childhood & Primary Education, Istanbul/ TURKEY
ORCID iD: 0000-0003-3554-4828

**Feyzanur Ardıç**
Etkin College, Eskisehir/ TURKEY
ORCID iD: 0000-0003-1898-8638

**Ömer Garan**
TOBB Science and Art Center, Eskisehir/ TURKEY
ORCID iD: : 0000-0002-8750-9357




**ISSN:** 2149-214X

**Journal of Education in Science, Environment and Health**

www.jeseh.net

# Investigation of Protective Factors against Career Stress of Senior University Students Using Mixed Pattern Method

**Ahmet Kara**[1]
[1]Kastamonu University

**To cite this article:**

Kara, A. (2023). Investigation of protective factors against career stress of senior university students using mixed pattern method. *Journal of Education in Science, Environment and Health (JESEH), 9*(2), 162-177. https://doi.org/ 10.55549/jeseh.1279774

JESEH
Journal of Education in Science, Environment and Health
Volume 9, Issue 2, 2023
https://doi.org/10.55549/jeseh.1279774

# Investigation of Protective Factors against Career Stress of Senior University Students Using Mixed Pattern Method

**Ahmet Kara**

**Article Info**

***Article History***

Published:
01 April 2023

Received:
12 May 2022

Accepted:
10 January 2023

***Keywords***

Hope
Career stress
Career adaptability
Career decision-making

**Abstract**

Career stress includes negative career experiences such as encountering career barriers, career indecision. This research aims to analyse and evaluate the protective factors against the career stress of senior university students with mixed-method research. For this purpose, an embedded design was used. A total of 353 individuals [AgeMean =23.55, AgeSd = 3.87], determined by sampling method, participated in the research. Data, Dispositional Hope Scale, Career Adaptabilities Scale, Career Decision-Making Self-Efficacy Scale, Career Stress Inventory, and Online Questionnaire were used. Structural equation modeling was used in quantitative data analysis. The content analysis technique was used for qualitative data analysis. As a result of the structural equation modeling analysis in quantitative findings, a protective structural model was obtained against the career stresses of senior university students. The participants revealed several ways to cope with career stress in qualitative findings. The study also examines hope, expectations for self-development, orientation towards activities that make senior students feel good, presence of those experiencing similar stress, positive inculcation, and evaluation of the effects of intrinsic/extrinsic motivators.

## Introduction

Individuals may encounter different sources of stress in different developmental areas during their life. One of these areas of development is career development. In this field, the concept of stress experienced by university students is career stress (Creed, Fallon & Hood, 2009).

### Career Stress

Stress is a disturbing emotional reaction shaped and developed by the individual's personal, social, and business life and creates a feeling of tension in the individual (Lazarus & Folkman, 1984). Stress can manifest itself in different areas. For example, the most common form of stress among university students is career stress (Choi et al., 2011). *Career stress* involves negative career experiences such as encountering career obstacles, career indecision, and career incompatibility (Creed, Hood, Praskova & Makransky, 2016). Further, career stress is a three-dimensional concept specific to Turkish culture. These dimensions include career ambiguity, lack of information, external conflict, and employment pressure (Özden & Sertel-Berk, 2015). Individual and environmental factors also affect career stress (Demirtaş & Kara, 2022). Personal factors include positive and negative points. Career decision-making self-efficacy, career adaptability, and hope are positive personal factors.

### Career Decision-Making Self-Efficacy

Betz (1992) defined career decision-making self-efficacy as the level of self-confidence in fulfilling the professional development tasks of the individual in the career development process. In addition, career decision-making self-efficacy is described as a concept that includes five components. These components are self-appraisal, planning, goal selection, problem-solving, and occupational information (Situmorang & Salim, 2021). Therefore, it is essential to develop career decision-making self-efficacy in individual career development. Strong individual career decision-making self-efficacy increases career aspiration (Al-Bahrani, Abu Shindi, Allawati & Bakkar, 2021) and career expectancy (Abe, Chikoko & Lubinga, 2021). Accordingly, career decision distress (Guardado, 2019) and career decision-making difficulties decrease (Dursun & Kara, 2019).

### Career Adaptability

Career adaptability is a psycho-social structure that shows the ability to cope with sudden or unexpected changes, difficulties, or obstacles in individual career development (Boo, Wang & Kim, 2021; Eryılmaz & Kara, 2018). It is a structure consisting of four coping competencies in the Savickas Career Construction Model (2013). In other words, confidence, concern, curiosity, and control are conceptualized as coping competencies that constitute career adaptability (Eryılmaz & Kara, 2020; Savickas & Porfeli, 2012). Further, career adaptability is a vital psycho-social resource for individual career development. An individual increases stress coping (Stoltz, Wolff, Monroe, Farris & Mazahreh, 2013), career decision-making self-efficacy (Stead, LaVeck & Rúa, 2021), and resilience (Xu et al., 2020) by using the resource. On the other hand, it decreases career stress (Demirtaş & Kara, 2022) and career anxiety (Shin & Lee, 2019).

### Hope

Hope includes high-level cognitive processes such as setting goals, imagining how to reach these goals, planning, and mentally discovering new situations (Snyder, 2002). On the other hand, Jacoby & Goldzweig (2014) further emphasized the emotional aspect of hope. It is a three-dimensional emotional construct of intrapersonal, interpersonal, and transpersonal elements. It is another crucial structure in the individual career development process. An individual's hope level increases career exploration (Hirschi, Abessolo & Froidevaux, 2015), career adaptability and career decision-making self-efficacy (Kara, Orum-Çattık & Eryılmaz, 2022), and career decisions, career planning, and career self-efficacy beliefs (Hirschi, 2014) and decreases perceived stress (Sucan, 2019).

### The Career Construction Model of Adaptation

This study utilized the Career Construction Model of Adaptation (Savickas, 2013) to develop the hypothetical model. There are four essential concepts in the Career Construction Model of Adaptation: adaptivity, adaptability, adapting responses, and adaptation results. These concepts are comprehensively conceptualized to measure and explain the relationships between psycho-social variables. For example, adaptivity is a psychological feature that includes individual readiness and willingness to adapt to changes or transitions in career development. In previous studies (Kara, Orum-Çattık & Eryılmaz, 2022; Rudolph, Lavigne & Zacher, 2017a), the hope variable has been used to measure the concept of adaptivity. Accordingly, hope has been included in measuring the concept of adaptivity in the current research. Adaptability reflects an individual's skills to cope with developmental tasks, transitions, and traumas in career development (Savickas, 2013). In previous studies, measuring the concept of adaptability was discussed with the career adapt-abilities variable (Johnston, 2018; Neureiter & Traut-Mattausch, 2017). In the current research, career adapt-abilities explain the concept of adaptability.

Meanwhile, adaptive responses are adaptive behaviors exhibited by the individual to adapt to changing conditions in career development (Hirschi, Herrmann & Keller, 2015). Career decision-making self-efficacy has been evaluated in measuring the concept of adapting responses in previous quantitative studies (Kara, Orum-Çattık & Eryılmaz, 2022) and meta-analysis research (Rudolph, Lavigne & Zacher, 2017a). Based on previous studies' theoretical and empirical findings, the concept of adapting responses in the current research was measured with the career decision-making self-efficacy variable. Finally, the concept of adaptation results is the career results obtained by the individual during the process of structuring his career development (Šverko & Babarović, 2019). Previous theoretical explanations (Rudolph, Lavigne & Zacher, 2017a; Rudolph, Lavigne, Katz & Zacher, 2017b) stated that the concept of adaptation results could explain career stress. Based on these theoretical explanations, the concept of adaptation results determined career stress.

Based on the labor market performance of undergraduate university graduates in Turkey, only 7.5% of the prospective teachers were employed for six months before graduation. Those employed in the first six months after graduation were 58.7%, and 26% were employed for one year or more after graduation (TR Presidential Human Resources Office, 2022). In addition, the unemployment rate for the young population (15-24 age group) is 24.7%, and the employment rate is 30.1%. This age group's labor force participation rate is 39.9% (TÜİK, 2021). These findings reveal a pessimistic view of employment and unemployment trends in Turkey.
Most senior university students in Turkey fear unemployment (Kara, Altınok & Şahin, 2019). Therefore, one of the most common problems among university graduates in Turkey is career stress (Gürpınar, Emül & Siyez, 2021). The most critical career problems experienced by university students in Turkey are the lack of self-

evaluation, difficulties in setting appropriate goals, and inadequate decision-making skills (Işık, 2010). Accordingly, the present study focuses on research samples of Turkish university graduates.

The current research is vital in determining the factors that reduce the career stress of senior university students. The decrease in individual career stress also lowers unemployment anxieties (Demirtaş & Kara, 2022), career indecisions (Kang, Lee & Lee, 2020), and depression (Jeong, 2016). On the other hand, career expectations (Gürpınar, Emül, & Siyez, 2021) and commitment to a career choice (Lee, 2015) increase. As a result, researching the protective factors of senior university students against career stress provides valuable insights for such students' career and mental health development. Based on previous studies of quantitative research on the Career Construction Model of Adaptation (Hirschi, Herrmann & Keller, 2015; Kara, Orum-Çattık & Eryılmaz, 2022) and meta-analysis studies (Rudolph, Lavigne & Zacher, 2017a; Rudolph, Lavigne, Katz & Zacher, 2017b), there is a lack of research testing a model with mixed design. Therefore, this research aims to analyze and evaluate the protective factors against senior university students' career stress through quantitative (Figures 1 and 3) and qualitative research methods (Figure 4).

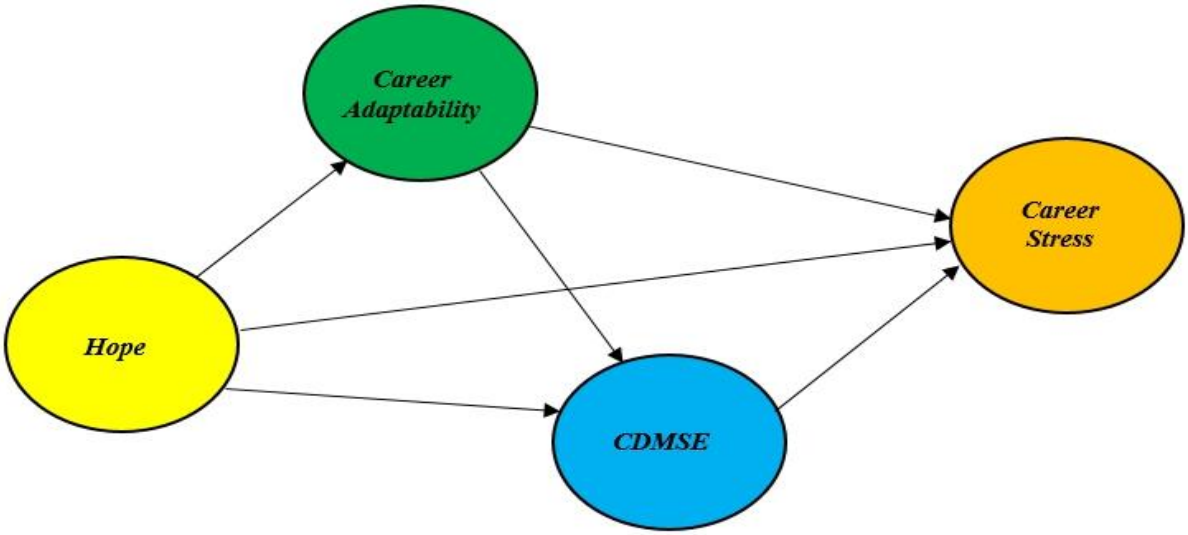



Figure 1. The hypothetical model

Note: CDMSE: Career Decision-Making Self-Efficacy.

## Method

### Research Model

The current research uses an embedded design. Therefore, quantitative or qualitative data are collected and analysed before, after, or together. Any data (qualitative or quantitative) in this design must support the other (Creswell, 2012). In the current research, quantitative data constitute the primary data set, while qualitative data plays a supporting role as the second data set. In addition, the causal design constitutes the quantitative part of the current research. The causal research design establishes cause-effect relationships between variables (Neuman, 2016). Hope, career adaptability, and career decision-making self-efficacy are the cause variables, and career stress is the outcome variable. On the other hand, a phenomenological design determines perceptions, experiences, and meanings about a phenomenon (Patton, 2014). The current research used a phenomenological design to explore the perceptions and experiences of senior university students about the phenomenon of career stress and the meaning attributed to this phenomenon.

### Participants and Procedure

Research data was obtained through Google Docs consisting of two parts, quantitative and qualitative. In the quantitative part, the participants were asked to mark the appropriate items in the quantitative data collection tools. In contrast, in the qualitative part, the participants were asked, "When you feel stressed about the profession you have chosen, how do you go about overcoming it? What are your coping resources?" The answer

tab was opened to respond to the question sentence, and the participants were asked to write their responses. The data set excluded those reluctant to participate in the research (7 people), who attended the second grade (2 people), and who attended the third grade (28 people). A total of 353 individuals [AgeMean =23.55, AgeSd = 3.87], determined by the criterion sampling method (criteria: being a senior student at a public university in Turkey and volunteering), participated in the research. There were more female participants, with261 women (73.9%) and 92 men (26.1%).

**Data Collection Tools**

*Dispositional Hope Scale (DHS)*

Snyder et al. (1991) developed the DHS tool. Meanwhile, Tarhan and Bacanli (2015) adapted DHS to Turkish conditions and performed the validity and reliability analysis with eight items and two dimensions (actuating thinking and alternative ways thinking). Further, Tarhan and Bacanli (2015) examined construct validity using the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) techniques. The EFA of DHS was 61% of its explained variance. The findings show CFA's the goodness-of-fit values were at an acceptable level (RFI = 0.90, CFI = 0.96, GFI = .96 and RMSEA = 0.07). In line with Tarhan and Bacanli's (2015) reliability analysis, the Cronbach Alpha internal consistency coefficient of the DHS total score was 0.84; and the test-retest reliability coefficient was 0.86.

*Career Adaptabilities Scale (CAS)*

The researchers who developed CAS are Savickas and Porfeli (2012). Subsequently, Kanten (2012) adapted CAS to Turkish conditions and conducted a validity and reliability analysis. CAS's original form has a 24-item and four-dimensional structure (confidence, concern, curiosity, and control). Kanten (2012) looked at construct validity through the confirmatory factor analysis technique (CAF). It has been proven that CAF has 19 items, a four-dimensional structure, and an acceptable level of goodness-of-fit values ($\chi 2/df = 3.5$; NNFI= 0.92, RFI= 0.90, CFI= 0.93 and RMSEA = 0.07). The Cronbach Alpha internal consistency coefficient among the sub-dimensions of CAS ranged between .61 and .81 in Kanten's (2012) reliability analysis.

*Career Decision-Making Self-Efficacy Scale (CDSS)*

The researchers who developed the CDSS are Betz et al. (1996). Işık (2010) is the researcher who adapted the CDSS to Turkish conditions and conducted a validity and reliability analysis. CDSS is a data collection tool with 25 items and five dimensions (self-appraisal, planning, goal selection, problem-solving, and occupational information). Işık (2010) examined construct validity through exploratory (EFA) and confirmatory factor analysis (CFA) techniques. Accordingly, the total explained variance in the EFA findings was 49%. In the CFA findings, CDSS was at an acceptable level ($\chi 2/df = 1.37$, GFI = 0.90, CFI = 0.90, SRMR = 0.07 and RMSEA =0.04). In the reliability analysis by Işık (2010), the Cronbach Alpha internal consistency coefficient of the total score of the CDSS was .88; and the test-retest reliability coefficient was 0.81.

*Career Stress Inventory (CSI)*

CSI was developed by Choi et al. (2011). Subsequently, Özden & Sertel-Berk (2015) adapted CSI to Turkish conditions and analyzed its validity and reliability. CSI has 20 items and a three-dimensional structure (career ambiguity, lack of information, external conflict, and employment pressure). Construct validity was evaluated with the exploratory factor analysis (EFA) technique by Özden & Sertel-Berk (2015). In the EFA findings, the total explained variance of CSI was 64.7%, and its eigenvalue was above 1. In addition, within the scope of reliability analysis, the Cronbach Alpha internal consistency coefficient of the total score of the CSI was 0.94; and the test-retest reliability coefficient was 0.81.

*Online Survey Form*

An Online Survey Form prepared by the researcher was used to collect qualitative data. In the questionnaire form, the participants were asked, "When you feel stressed about the profession you have chosen, how do you

go about overcoming it? What are your coping resources?" The answer tab was opened to respond to the question sentence, and the participants were asked to write their responses. The expressions and thoughts of the participants written on this form were evaluated as a qualitative data source.

### Data Analysis

*Quantitative Data Analysis*

Preliminary analysis was performed before the quantitative data analysis. After the preliminary analysis, the data were analyzed using the structural equation modeling technique in two stages (first stage: testing the measurement model; the second stage: testing the structural model) (Anderson & Gerbing, 1988). In evaluating the measurement model and the structural model, some goodness-of-fit indices [$3 \leq \chi 2/df \leq 5$, $.90 \leq$ CFI, IFI, NFI, TLI $\leq .95$ (Baumgartner & Homburg, 1996; Bentler, 1980; Kline, 2015), $05 \leq$ RMSEA $\leq .09$ (Chen, Yeh & Huan, 2014; Steiger, 1990)], standardized and unstandardized factor loads, path coefficients, standard error, t values, and $R^2$ values were used. Skewness and kurtosis values for normality, correlation, VIF, and tolerance were also considered for multicollinearity (Finney & DiStefano, 2013; Kline, 2015). Finally, the significance of the indirect effects was tested by making 1000 resamples using the bootstrapping analysis method (Hayes, 2017).

*Qualitative Data Analysis*

The content analysis technique was used to evaluate qualitative data. The analysis was carried out in four main stages. Firstly, the coding of the data was carried out. Next, the coded data were classified according to similarities and differences, and sub-themes and main themes were reached. In the third stage, the central theme and sub-themes were arranged by reviewing their suitability. Finally, the findings were defined and interpreted (Corbin & Strauss, 2015). The validity and reliability of the findings obtained in the current research were verified. In this context, the researcher used a detailed description and expert supervision to increase internal validity (credibility). In order to increase the external validity (transferability), the researcher scrutinized the qualitative data and described the participants' views in detail. Finally, using the data diversity method, the researcher increased reliability (consistency) (Merriam, 2009).

## Results

### Quantitative Findings

In this section, the preliminary analysis is made first (see Tables 1 and 2). Then the measurement model test (see Figure 2 and Table 3) was performed, followed by the structural model test (see Figure 3 and Table 4). Finally, the bootstrapping method was used to test the significance of indirect effects (see Table 5).

Table 1. Descriptive statistics

| Variables | Mean | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|
| Alternative Ways Thinking | 26,05 | 4,48 | -1,075 | 2,567 |
| Actuating Thinking | 23,95 | 5,38 | -,808 | ,667 |
| Concern | 11,49 | 2,53 | -,432 | -,274 |
| Control | 21,47 | 3,12 | -1,087 | 2,026 |
| Curiosity | 19,59 | 3,79 | -,464 | -,077 |
| Confidence | 25,97 | 3,49 | -,921 | 1,491 |
| Self-Appraisal | 20,25 | 3,18 | -,406 | -,072 |
| Occupational Information | 19,81 | 3,08 | -,478 | ,071 |
| Goal Selection | 20,03 | 3,38 | -,552 | ,367 |
| Planning | 19,17 | 3,47 | -,535 | ,378 |
| Problem-Solving | 18,08 | 3,78 | -,203 | -,542 |
| CALI | 27,40 | 11,94 | ,369 | -,768 |
| External Conflict | 10,28 | 5,29 | ,615 | -,643 |
| Employment Pressure | 24,32 | 7,13 | -,638 | -,068 |

Note: CALI: Career Ambiguity and Lack of Information

*Preliminary Analysis*

Before proceeding to the structural equation modeling approach, the accompanying assumptions were checked. Firstly, the skewness and kurtosis values for the normality assumption were evaluated. The skewness values of the current research vary between (-1.08 and .61) and kurtosis values (-.76 and 2.56). These values are within the limits of normality as the kurtosis value is not greater than +/-7, and the skewness value is not greater than +/-2, in line with Finney & DiStefano (2013).

The multicollinearity assumption was evaluated with VIF and tolerance values. The VIF values ranged from 2.07 to 4.46; tolerance values vary between .22 and .48. Since these values are within the tolerance greater than .10 and VIF less than five recommended by Kline (2015), there is no multicollinearity problem in the current study.

Table 2. Correlations

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Alternative Ways Thinking | 1 | | | | | | | | | | | | | |
| 2. Actuating Thinking | ,688** | 1 | | | | | | | | | | | | |
| 3. Concern | ,413** | ,502** | 1 | | | | | | | | | | | |
| 4. Control | ,469** | ,538** | ,532** | 1 | | | | | | | | | | |
| 5. Curiosity | ,393** | ,380** | ,660** | ,525** | 1 | | | | | | | | | |
| 6. Confidence | ,596** | ,538** | ,484** | ,627** | ,522** | 1 | | | | | | | | |
| 7. Self-Appraisal | ,482** | ,611** | ,530** | ,563** | ,537** | ,551** | 1 | | | | | | | |
| 8. Occupational Information | ,447** | ,489** | ,496** | ,445** | ,511** | ,425** | ,727** | 1 | | | | | | |
| 9. Goal Selection | ,444** | ,553** | ,501** | ,521** | ,518** | ,485** | ,825** | ,703** | 1 | | | | | |
| 10. Planning | ,441** | ,606** | ,574** | ,548** | ,549** | ,520** | ,790** | ,670** | ,787** | 1 | | | | |
| 11. Problem Solving | ,422** | ,579** | ,461** | ,390** | ,439** | ,391** | ,639** | ,583** | ,620** | ,664** | 1 | | | |
| 12. CALI | -,301** | -,377** | -,460** | -,477** | -,334** | -,351** | -,546** | -,454** | -,561** | -,565** | -,346** | 1 | | |
| 13. External Conflict | -,206** | -,171** | -,189** | -,348** | -,128* | -,218** | -,283** | -,187** | -,342** | -,296** | -,114* | ,653** | 1 | |
| 14. Employment Pressure | -,138** | -,215** | -,159** | -,196** | -,149** | -,126* | -,229** | -,173** | -,240** | -,327** | -,312** | ,495** | ,381** | 1 |

Note: CALI: Career Ambiguity and Lack of Information, **p<.01, *p<.05.

Table 2 shows the relationships between the observed variables. Based on Table 2, the relationships among the observed variables are significant. The highest correlation between the observed variables was between actuating thinking, one of the sub-dimensions of hope, and self-appraisal, one of the sub-dimensions of career decision-making self-efficacy (r = .61, p < .01).

Table 3. Data findings of the measurement model

| Predicted | | Predictor | Estimate | S.E. | *t* |
|---|---|---|---|---|---|
| CALI | <--- | Career Stress | 1,000 | | |
| External Conflict | <--- | Career Stress | ,272 | ,024 | 11,307* |
| Employment Pressure | <--- | Career Stress | ,275 | ,032 | 8,718* |
| Confidence | <--- | Career Adaptability | 1,000 | | |
| Curiosity | <--- | Career Adaptability | 1,072 | ,082 | 13,079* |
| Control | <--- | Career Adaptability | ,926 | ,067 | 13,742* |
| Concern | <--- | Career Adaptability | ,734 | ,055 | 13,439* |
| Problem-Solving | <--- | CDMSE | 1,000 | | |
| Planning | <--- | CDMSE | 1,129 | ,069 | 16,296* |
| Goal Selection | <--- | CDMSE | 1,111 | ,067 | 16,483* |
| Occupational Information | <--- | CDMSE | ,892 | ,062 | 14,474* |
| Self-Appraisal | <--- | CDMSE | 1,071 | ,064 | 16,865* |
| Alternative Ways Thinking | <--- | Hope | 1,000 | | |
| Actuating Thinking | <--- | Hope | 1,391 | ,095 | 14,680* |

Note: *p<.001, CALI: Career Ambiguity and Lack of Information, CDMSE: Career Decision-Making Self-Efficacy.

*Structural Equation Modeling (First Stage: Measurement Model)*

The measurement model of this research was based on four latent variables (hope, career adaptability, career decision-making self-efficacy, and career stress) and 14 observed variables (alternative ways thinking, actuating thinking, concern, control, curiosity, confidence, self-appraisal, occupational information, goal selection, planning, problem-solving, career ambiguity and lack of information, external conflict, and employment pressure). The values of goodness-of-fit [$\chi 2$/df (291.908/71) = 4.11, p=.00, CFI = 0.93, IFI = 0.93, NFI= 0.91, TLI= 0.91, RMSEA = 0.09] were at an acceptable level. In addition, the standardized factor loads of the measurement model ranged between .48 and 1.03 (see Figure 2), and all t values (see Table 3) were significant. In other words, the observed variables in this research represent the latent variables in a meaningful way. Thus, the measurement model was validated.

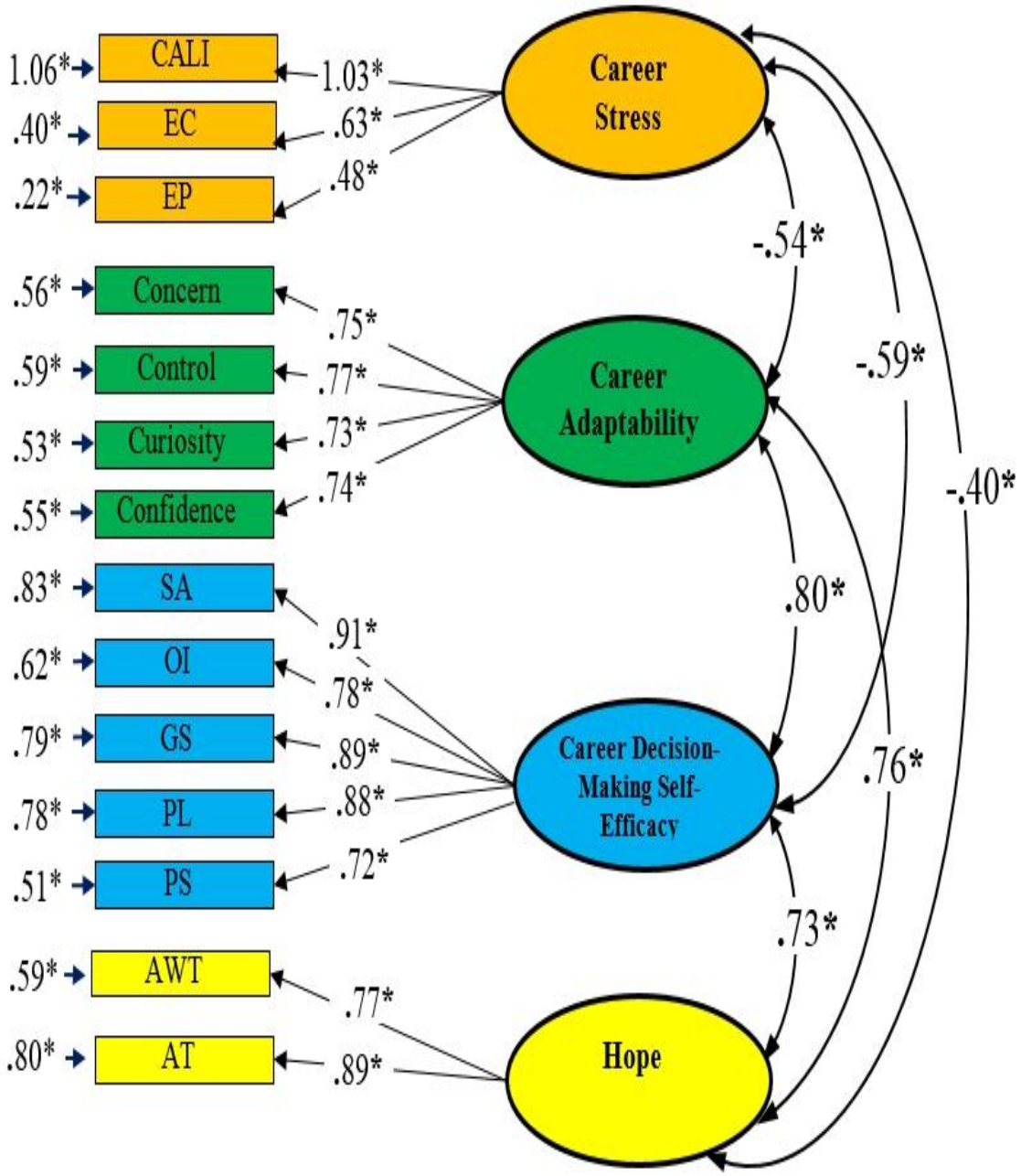



Figure 2. Standardized factor loads of the measurement model

Note: *p<.001, CALI: Career Ambiguity and Lack of Information, EC: External Conflict, EP: Employment Pressure, SA: Self-Appraisal, OI: Occupational Information, GS: Goal Selection, PL: Planning, PS: Problem-Solving, AWT: Alternative Ways Thinking, AT: Actuating Thinking.

*Structural Equation Modelling (Second Stage: Structural Model)*

In this research, the measurement model was validated in the first stage. Next, the structural model was tested. The goodness-of-fit values were at an acceptable level [$\chi 2/df$ (291.908/71) = 4.11, p=.00, CFI = 0.93, IFI = 0.93, NFI= 0.91, TLI= 0.91, RMSEA = 0.09]. In addition, the structural model's standardized path coefficients (see Figure 3), non-standardized path coefficients, standard error, and t values (see Table 4) exist.

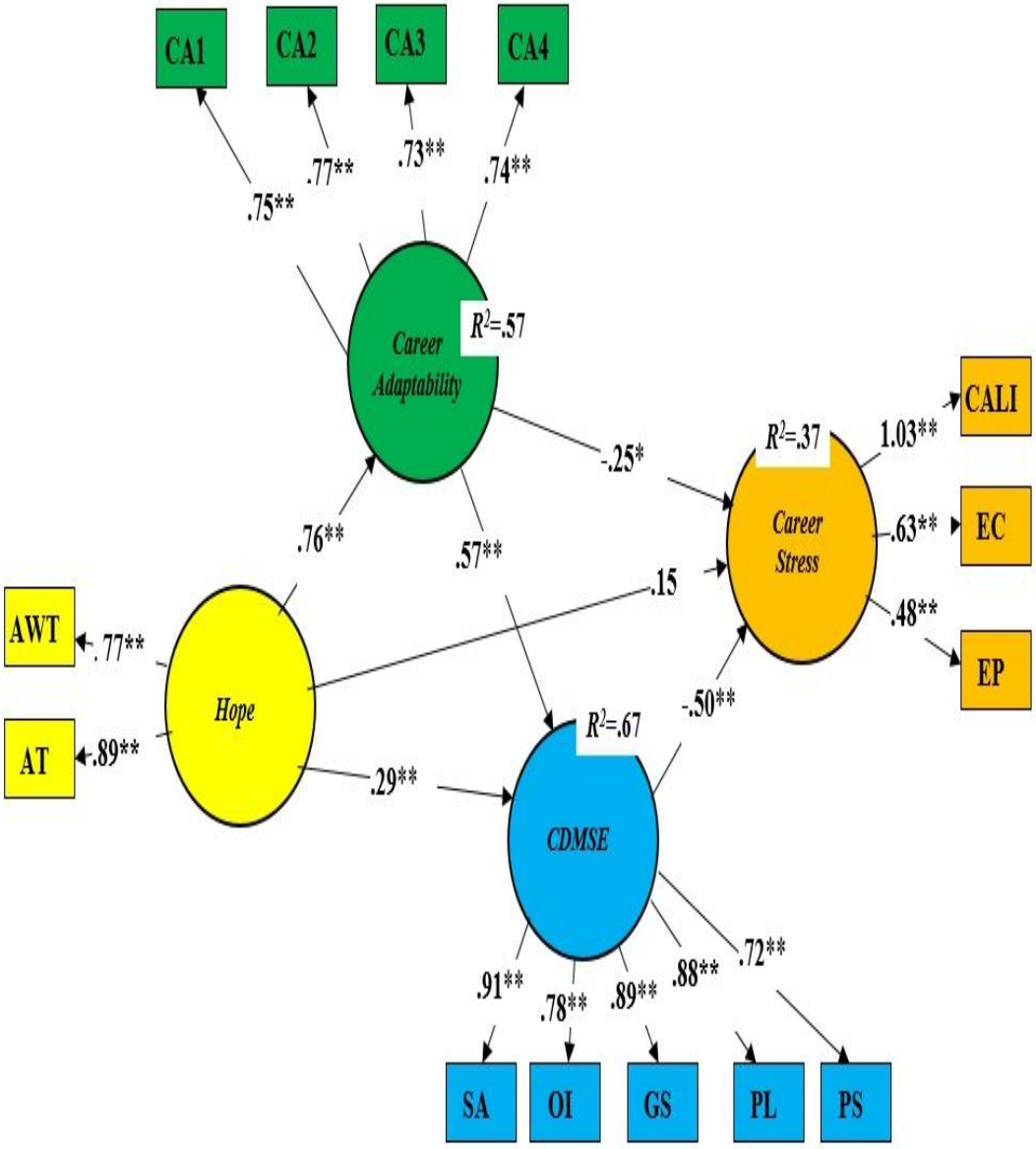



Figure 3. Standardized path coefficients of the structural model

Note: **p<.001, *p<.05. CALI: Career Ambiguity and Lack of Information, EC: External Conflict
EP: Employment Pressure, SA: Self-Appraisal, OI: Occupational Information, GS: Goal Selection, PL: Planning,
PS: Problem-Solving, AWT: Alternative Ways Thinking, AT: Actuating Thinking.
CA1: Concern, CA2: Control, CA3: Curiosity, CA4: Confidence.

Based on Figure 3, a one-unit increase in hope increases career adaptability by 0.76 (t=11.099; p<.001). A one-unit increase in career adaptability increases career decision-making self-efficacy by 0.57 (t=6.670; p<.001). Meanwhile, a one-unit increase in career decision-making self-efficacy reduces career stress by 0.50 (t=-5.554; p<.001). A one-unit increase in hope increases career decision-making self-efficacy by 0.29 (t=3.770; p<.001). Further, a one-unit increase in career adaptability reduces career stress by 0.25 (t=-2.427; p<.05). The explained variances revealed that hope accounts for 57% of career adaptability. Hope and career adaptability contributed 67% of career decision-making self-efficacy. While hope, career adaptability, and career decision-making self-efficacy accounted for 37% of career stress.

Table 4. Data findings of the structural model

| Predicted | | Predictor | Estimate | S.E. | *t* |
|---|---|---|---|---|---|
| Career Adaptability | <--- | Hope | ,416 | ,038 | 11,009** |
| CDMSE | <--- | Career Adaptability | ,820 | ,123 | 6,670** |
| CDMSE | <--- | Hope | ,229 | ,061 | 3,770** |
| Career Stress | <--- | Hope | ,542 | ,306 | 1,769 |
| Career Stress | <--- | Career Adaptability | -1,621 | ,668 | -2,427* |
| Career Stress | <--- | CDMSE | -2,286 | ,411 | -5,554** |
| CALI | <--- | Career Stress | 1,000 | | |
| External Conflict | <--- | Career Stress | ,272 | ,024 | 11,307** |
| Employment Pressure | <--- | Career Stress | ,275 | ,032 | 8,718** |
| Control | <--- | Career Adaptability | 1,261 | ,090 | 13,939** |
| Curiosity | <--- | Career Adaptability | 1,460 | ,110 | 13,249** |
| Confidence | <--- | Career Adaptability | 1,362 | ,101 | 13,439** |
| Concern | <--- | Career Adaptability | 1,000 | | |
| Problem-Solving | <--- | CDMSE | 1,000 | | |
| Planning | <--- | CDMSE | 1,129 | ,069 | 16,296** |
| Goal Selection | <--- | CDMSE | 1,111 | ,067 | 16,483** |
| Occupational Information | <--- | CDMSE | ,892 | ,062 | 14,474** |
| Self-Appraisal | <--- | CDMSE | 1,071 | ,064 | 16,865** |
| Alternative Ways Thinking | <--- | Hope | 1,000 | | |
| Actuating Thinking | <--- | Hope | 1,391 | ,095 | 14,680** |

Note: **p<.001, *p<.05. CALI: Career Ambiguity and Lack of Information. CDMSE: Career Decision-Making Self-Efficacy

*Bootstrapping Analysis (Significance Levels of Indirect Effects)*

The researcher used the bootstrapping method to test the significance of the indirect effects of 1000 resamples (Hayes, 2017). Table 5 shows the results of the analysis.

Table 5. Data findings of the bootstrapping analysis

| Standardized Indirect effect | β | SE | 95% CI Lower | 95% CI Upper |
|---|---|---|---|---|
| Hope → Career Adaptability → CDMSE | .43* | .21 | .231 | 1.091 |
| Career Adaptability → CDMSE → Career Stress | -.28* | .11 | -.509 | -.162 |
| Hope → Career Adaptability → CDMSE → Career Stress | -.55* | .21 | -1.126 | -.403 |

Note: *p<.05, β: Standardized path coefficient, SE: Standard Error, CDMSE: Career Decision-Making Self-Efficacy.

The criterion for accepting the mediation effects as significant in Table 5 is that the lower and upper bound confidence intervals do not contain zero (Shrout & Bolger, 2002). Based on the bootstrapping analysis, the mediation effect of career adaptability was significant between hope and career decision-making self-efficacy ([β = .43, 95% CI (.231, 1.091)].

In addition, the mediation effect of career decision-making self-efficacy was significant in the relationship between career adaptability and career stress ([β = -.28, 95% CI (-.509, -.162)]. Finally, the mediation effect of career adaptability and career decision-making self-efficacy was significant in the relationship between hope and career stress ([β = -.55, 95% CI (-1.126, -.403)].

**Qualitative Findings**

The qualitative data analysis revealed the central theme of coping with career stress. Six sub-themes were also identified: (1) hope, (2) research and self-development, (3) tending to feel-good activities, (4) positive inculcation, (5) universality, and (6) intrinsic and extrinsic motivators.

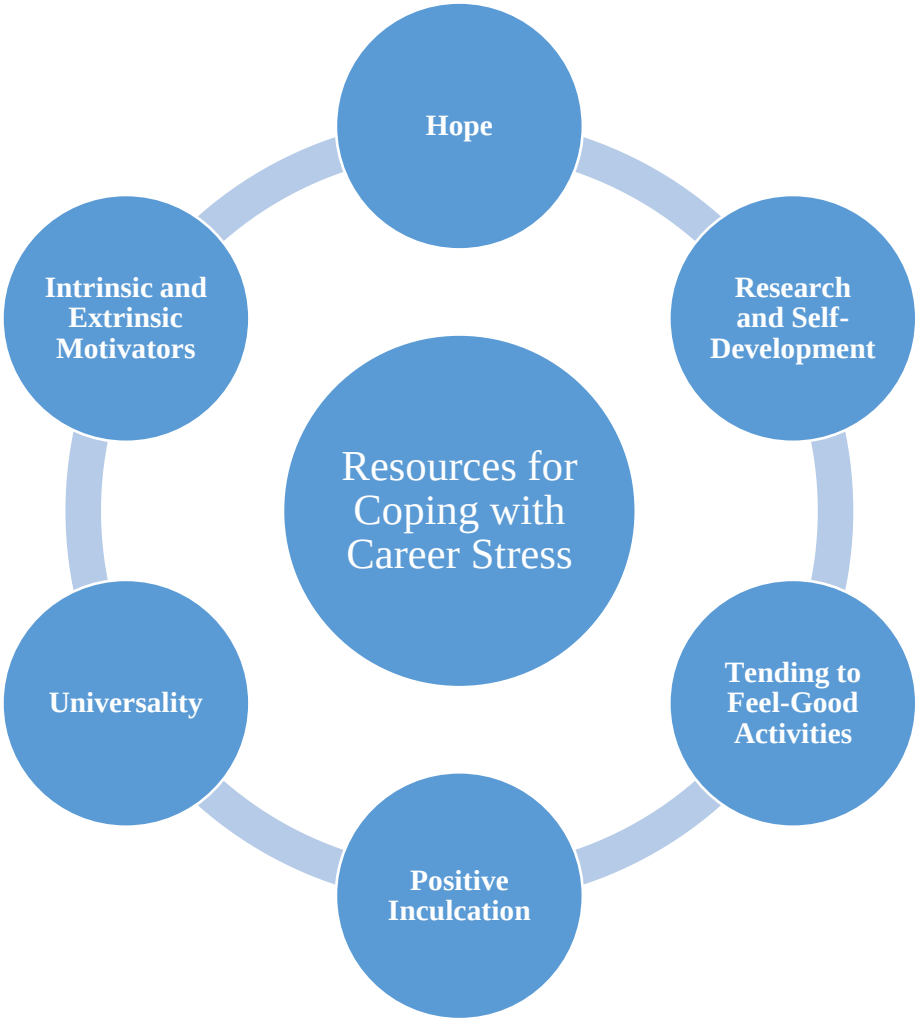



Figure 4. Central theme and sub-themes of coping with career stress

*Hope*

University seniors emphasized the characteristics of different resources in coping with career stress. The first of these sources is hope. One of the participants said that by instilling a sense of hope and not giving up on his/her dreams, hope became a resource for coping with stress. Another participant stated that another way of coping with stress is to think it is not long to reach their dream. The opinions of senior university students on this subject are given below.

> *My coping resources are generally based on what I can do, my faith and hope. My dreams for the future. I try to think more positively and try to be positive towards life by looking at the glass as half full (Mehmet).*

> *I try to be hopeful to cope, and I try to think hopeful that I can do as successful people in the profession did. (Ezgi).*

*Research and Self-Development*

The participants stated that they alleviated stress through detailed research and planning for the future. This finding highlighted the importance of research and self-development to cope with career stress as follows:

> *I try to learn as much as I can by reading more. I create plans for the future to reduce my stress and design backup plans considering the possibility of these plans not being realized. I try to improve*

*myself so that I can perform my job better and get rid of stress. I can cope by doing more research and learning (Ayşe).*

*I'm trying to create a roadmap for myself. About what I will do when I graduate, what kind of training I will receive and which exams I will attend. As this uncertainty disappears, I realize that my stress decreases (Meryem).*

*Tending to Feel-Good Activities*

Another point senior university students mentioned as a resource for coping with career stress is focusing on activities that make them feel good. For example, one of the participants said that when he/she is stressed, he/she listens to his/her favourite music, feels good, and continues to work. One of the participants stated that he/she reduced his/her stress by doing physical activities and examining his/her negative thoughts. The opinions of senior university students on this point are given below.

*When I'm feeling stressed, I turn on my favourite music and try to relax, and then I feel better (Ali).*
*I tend to activities that I like, such as breathing exercises and relaxation exercises, to feel more positive, to question non-cognitive thoughts, to get away from this feeling of stress (Nurcan).*

*Positive Inculcations*

One of the resources that senior university students apply in coping with career stress is the positive inculcations they make for themselves. The participants stated that they could encourage themselves by remembering their previous successes, stimulating their motivation to succeed. One of the participants also stated that he/she has the power to change regardless of the conditions and processes and that he/she can reduce stress by inspiring himself/herself to achieve it step-by-step. This point is based on the opinions of senior university students as follows:

*When I feel stressed about my chosen profession, I usually remind myself that I am qualified for this profession and that I have received the necessary training. I remind myself not to give up. I focus on what I've accomplished before, so I see what I've done and suggest that I can do it now (Hakan).*

*I remind myself that I took the best opportunity that I could in the current circumstances and that it was wiser to follow this path, and I remind myself that it is always in my hands to change the course when the conditions and process change. Everything will be step-by-step, don't worry, as long as you work, I encourage myself, this relaxes me (Serap).*

*Universality*

Another primary method of senior university students coping with career stress is that participants feel they are not alone (principle of universality). The participants viewed career stress problems as acceptable. Examples of this situation are given below:

*Knowing that many people are just like me gives me some relief. I think all graduates experience this situation (Canan)*

*I think that many people can go through the same paths and reach their goals, and I am not lacking in them (Nuray).*

*Intrinsic and Extrinsic Motivators*

One of the participants said that by dreaming of practicing his/her profession and thinking about the stories of successful people, he/she increased his/her internal motivation, thus overcoming stress. Another participant stated that external motivation from employed graduates made him/her feel good and decreased his/her stress. The opinions of senior university students on this point are given below:

> *I try to increase my motivation by imagining the times when I do my job. When I think I can't succeed, I try to motivate myself by thinking about how successful people succeed and it reduces my stress (Fatma).*
>
> *Listening to the speeches of the settled alumni and motivational words relax me. I also talk to my friends who will positively influence and motivate me (Murat).*

Therefore, the qualitative and quantitative findings in the structural model of the current study have some similar points. First, both quantitative and qualitative findings revealed protective factors against career stress. The sub-theme of hope in qualitative findings is similar to the exogenous hope variable in the structural model. In addition, the sub-themes of research and self-development and intrinsic and extrinsic motivators correspond to the structural model's career decision-making self-efficacy mediator variable. Finally, the sub-themes of tending to feel-good activities, positive inculcation, and universality are associated with the structural model's career adaptability mediator variable.

## Discussion and Conclusion

This research aims to analyse and evaluate the protective factors against career stress among senior university students using quantitative and qualitative research methods. As a result of the structural equation modeling analysis in quantitative findings, a protective structural model was obtained against the career stresses of senior university students. In qualitative findings, the participants revealed ways of coping with career stress: hope, research and self-development, orientation to feel-good activities, the presence of those experiencing similar stress, positive inculcation, and evaluation of the effects of intrinsic/extrinsic motivators.

The structural career stress-coping model in the quantitative part was established based on the Career Construction Model of Adaptation (Savickas, 2013). Previous quantitative studies (Hirschi, Herrmann & Keller, 2015; Kara, Orum-Çattık & Eryılmaz, 2022) and meta-analysis (Rudolph, Lavigne & Zacher, 2017a; Rudolph, Lavigne, Katz & Zacher, 2017b) were examined. However, there is a limited number of studies on the effectiveness of the Career Construction Model of Adaptation. Therefore, the current research is essential to fill the gaps in existing studies on the subject matter.

Two structures make the current research different from existing studies. First is the quantitative or meta-analysis method to test the Career Construction Model of Adaptation. The current research has gone beyond the Career Construction Model of Adaptation by extensively testing it with a mixed research design that includes both qualitative and qualitative research. Likewise, there are theoretical explanations in the literature that career stress is a dependent variable in explaining the concept of adaptation results (Rudolph, Lavigne & Zacher, 2017a; Rudolph, Lavigne, Katz & Zacher, 2017b). In this regard, the present research went a step further from existing studies by using career stress to measure the concept of adaptation results to confirm theoretical explanations empirically.

The quantitative part of the current research examined a protective structural model of senior university students against career stress. The research findings support the Chaos Theory of Careers by Bright and Pryor (2005). According to this theory, career development is constantly changing and filled with stress and uncertainties. Although chaos is perceived as obscurity, confusion, and coincidence, it encourages individuals to develop flexible behaviours and increase their tolerance for chaos to reach an identifiable orderly structure. In addition, individuals can take uncertainty in a positive light by exhibiting specific behaviour and tendencies in situations of uncertainty. Bright (2020) explained this situation with the metaphor of traffic lights. Individuals try to reduce and manage uncertainty when the traffic light is yellow. These individuals plan and make predictions of their behavioural outcomes. On the other hand, individuals tend to accept and embrace change when the traffic light is green. These individuals plan and exhibit risk-taking behaviours (Korkut-Owen, 2021). The current research shows hope and career adaptability as a yellow light (planning and predicting). This planning and predicting (hope and career adaptability) alone is not enough. In order to reduce the uncertainties that will arise, the green light, symbolized as accepting, internalizing, and revealing the changes for the future, should be put into practice.

When the qualitative data obtained within the scope of the research were examined, the participants underlined being hopeful in coping with career stress. Previous studies emphasized increasing the concept of hope, which has both cognitive and emotional aspects, in coping with individual perceived stress (Sucan, 2019). The quantitative findings of the current research confirmed that the hope variable is a protective factor against career

stress. Likewise, similar findings in the statements of the participants show how effective hope is in eliminating career stress.

The participants also stated the necessity of research and self-development to cope with career stress. The participants in the current research showed that they cope with career stress by having the "what is in there" foresight and engaging in behaviours that improve their career decision competency expectations, such as research and self-development. Individuals getting to know themselves better, developing a perspective on their interests and choices, and pursuing their career goals more actively are indicators of their professional commitment. Career stress decreases, and career decision-making self-efficacy develops through correct self-assessment, learning about the profession, and goal setting (Guardado, 2019).

Another qualitative finding revealed that the participants could cope with stress by engaging in feel-good activities and positive inculcations. According to Lazarus and Folkman (1984), stress is a factor that forces or impairs the psychological well-being of individuals. In other words, stress negatively affects the psychological well-being of individuals, such as their personal development, self-acceptance, positive social relationships, and meaningful purpose in life (Günay & Çelik, 2019). For this reason, the participants must focus on activities that make them feel good and have positive inculcations about themselves. This way, they develop a coping resource to overcome career stress. Further, the findings on feel-good activities and positive inculcations are explained by the A life-span, life-space approach to career development (Super, 1980). According to this theory, career development and mental health are related processes from the perspective of lifelong development (Kara, 2016; Eryılmaz & Mutlu, 2017). In the current study, individuals engaging in activities that made them feel good and positive inculcations show that they want to improve their mental health. Therefore, they reduced career stress by carrying this positive development into career development areas.

In the present research, the qualitative findings show that when participants see other individuals experiencing similar career stress, they feel the stress is acceptable. Yalom talked about healing factors that provide change and development in the group counseling process. One of them is universality. The principle of universality is that individuals feel that they are not alone in the group process and begin to see the problem they experience as acceptable (Koydemir, 2012). The participants in this research are individuals in their last year as senior students. They were relieved that other individuals like them also had similar experiences, thus lowering their stress.

In the last qualitative finding, the participants emphasized the existence of internal and external motivators in coping with career stress. Higher success-oriented motivation in university student's decreases career stress (Yemenici, Bozkurt & Özkara, 2020). In the current research, some participants reduced their career stress by dreaming of a successful career. In other words, intrinsic motivation is a factor that reduces career stress among senior university students. In addition, other participants stated that positive motivational words from the external environment reduced their career stress. In other words, external motivators, such as the external environment other than internal motives, also reduce career stress among senior university students.

## Limitations and Recommendations

The current research has some limitations. First, the quantitative data were obtained instantaneously and involved a cross-sectional research group. Second, qualitative data were collected through an online questionnaire. Nevertheless, the current research examines career stress among senior university students through a protective structural model and quantitative and qualitative findings. The dimensions of this model shed light on experimental research that includes psycho-educational programs to reduce career stress in the future. In the qualitative finding of the current research, the participants stated that they used six resources to cope with career stress. These qualitative data may constitute variables in quantitative research on career stress in the future. Finally, the present study's qualitative and quantitative data will guide the strategies of career counsellors for clients experiencing career stress.

## Scientific Ethics Declaration

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

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## Author(s) Information

**Assoc. Prof. Dr. Ahmet Kara**
Kastamonu University
Department of Developmental Psychology
Kastamonu, Turkey
Contact e-mail: ahmetkara@kastamonu.edu.tr
ORCID ID: 0000-0002-1155-619X