JESEH

VOLUME
6
ISSUE
4

YEAR
2020

Journal of Education in Science, Environment and Health

e-ISSN 2149-214X

Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020 e-ISSN:2149-214X

EDITORIAL BOARD

Journal of Education in Science, Environment and Health (JESEH)

The Journal of Education in Science, Environment and Health (JESEH) is a peer-reviewed and online free journal. The JESEH is published quarterly in January, April, July and October.The language of the journal is English only. As an open access journal, Journal of Education in Science, Environment and Health (JESEH) does not charge article submission or processing fees. JESEH is a non-profit journal and publication is completely free of charge.

The JESEH welcomes any research papers on education in science, environment and health using techniques from and applications in any technical knowledge domain: original theoretical works, literature reviews, research reports, social issues, psychological issues, curricula, learning environments, book reviews, and review articles. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to the JESEH.

Abstracting/ Indexing

Journal of Education in Science, Environment and Health (JESEH) is indexed by following abstracting and indexing services: SOBIAD, Scientific Indexing Service (SIS), Education Resources Information Center (ERIC).

Submissions

All submissions should be in electronic (.Doc or .Docx) format. Submissions in PDF and other non-editable formats are not acceptable. Manuscripts can be submitted through the journal website. All manuscripts should use the latest APA style. The manuscript template for formatting is available on the journal website.

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 6, Issue 4, 2020
e-ISSN:2149-214X

CONTENTS

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.792984

Investigation of the Views of Biology Teachers on Distance Education during the COVID-19 Pandemic

Ferhat Karakaya, Selcuk Arik, Osman Cimen, Mehmet Yilmaz

Article Info

Article History

Received:
16 March 2020

Accepted:
04 September 2020

Keywords

Distance education
Biology education
Biology teachers
COVID-19
Use of technology

Abstract

Coronavirus disease has caused the death of many people since its first identification in Wuhan, China, in December 2019. Countries have implemented emergency action plans in many areas to prevent the disease from spreading further. In order to reduce the spread of the disease throughout the country, there has been a transition to distance education in the Turkish education system. In this research, it is aimed to determine the views of biology teachers about distance education in COVID-19 Pandemic process. The research using phenomenological study was carried out with 62 biology teachers. Semi-structured interview form prepared by the researchers was used to collect the data. The data were evaluated by using content analysis method. As a result of the research, it has been determined that distance education increases technology use, cooperation, empathy and positive thinking about lessons. However, it has been determined that there are problems arising from the lack of technological infrastructure and knowledge. It has been understood that in order for the distance education systems to be applied in situations such as the COVID-19 pandemic, the technological infrastructure and the knowledge of the stakeholders should be improved.

Introduction

Today, the whole world has been struggling with a disease that first emerged in Wuhan, China in December 2019. The disease was identified as the new coronavirus (2019-nCoV) in its beginning stage (Wang, Wang, Chen, & Qin, 2020). In the later period, the new coronavirus pneumonia was named "COVID-19" (coronavirus disease 2019) by the World Health Organization (WHO, 2020). Coronaviruses causing the disease are enveloped, positive and single stranded RNA viruses (Velavan, & Meyer, 2020). Coronaviruses which has an envelope (outer layer) enter into the cell by binding their glycoproteins to the specific sensing molecules on the surface of the host cell (Madigan, Bender, Buckley, Sattley & Stahl, 2019: p.313; Reece, Urry, Cain, Wasserman, Minorsky, & Jackson, 2017: p.404-405). Coronaviruses cause respiratory infections in humans and other animals, including about 15% common colds and SARS. Respiratory diseases that are caused by coronavirus rapidly spread in humans and cause deaths (Rasmussen, Smulian, Ladnicky, Wen, & Jamieson, 2020).

In order to minimize the speed of spread and fatal effects of epidemics, global measures should be taken. In fact, measures such as closing restaurants, using masks, working part-time or working from home have been brought into action across the world in order to reduce the spread rate of the COVID-19 pandemic. Face to face education was interrupted in many countries to prevent the spread of pandemic among students. In the COVID-19 pandemic process, distance education has become the preferred education concept worldwide. Distance education is a form of education implemented through corporate and communication technologies, differently from the environments in which formal education is implemented. (Moore & Kearsley, 2012). In other words, distance education is the concept of education in which interaction between students, teachers and educational materials is realized by using communication technologies (Özgöl, Sarikaya & Öztürk, 2017). The first Covid-19 case was detected as of March 10, 2020, in Turkey. With the detection of the disease, both individual and institutional measures have been activated across the country. Ministry of National Education (MoNE) announced that on March 16, 2020, face to face education was interrupted in primary, secondary and high education institutions. On 23 March 2020, it decided to switch to distance education in order for the education process not to be interrupted and students not to be victimized. In this context, Education Information Network (EBA) created by the Ministry of Education and serving as Turkey's official digital learning platform strengthened its infrastructure and began the process of distance education (Özer, 2020). Additionally, it has cooperated with Turkey Radio and Television Corporation (TRT) so that distance education can be made across

the country and all the students can benefit from it distance learning (Özer, 2020). As a result of the collaboration, three national channels were started to broadcast to provide distance education at primary, secondary and high school levels. In higher education, the education process was interrupted for three weeks at the beginning of the epidemic. It was later announced that the 2020 spring semester will be completed by distance education (The Council of Higher Education (CoHE), 2020).

When the relevant literature is examined, it is seen that there are many studies analyzing the effects of COVID-19 pandemic on health and economy. However, it has been determined that studies in the field of education are limited. For example, in the study of Bao (2020), six basic principles were explained in order for online education to be successful in higher education during the COVID-19 pandemic process. Basilaia and Kvavadze (2020) analyzed the capacities of transition to distance education and usage of platforms during the COVID-19 pandemic process. As a result of the research, it was determined that the transition to distance education was successfully completed in Georgia. In addition, it has been determined that the experiences gained from this process can shed light on the future with laws and regulations (Basilaia & Kvavadze, 2020). Özer (2020), in his research, described the work that Turkey has done in the field of education during the process of the pandemic. Toquero (2020) shared his recommendations for higher education in his study, in order to reduce the impact of the pandemic process on education systems and achieve success. Yamamota and Altun (2020) examined the countries' transitions to online education during the COVID-19 pandemic process. As a result of their research, it was stated that distance education will go beyond being a support platform in the future (Yamamota & Altun, 2020). Zhou, Wu, Zhou and Li (2020) analyzed the "schools are closed" but "classes are open" campaign and practices for online education in China during the pandemic process. In the research, it has been concluded that information investments in education have been successful that China has carried out in the last thirty years.

The effects of disasters that have reached the pandemic dimension on education systems shape both the present and the future of societies because; education systems have a structure that concerns all segments of the society, considering their stakeholders (students, teachers, parents). Therefore, countries have provided continuity in education by rapidly switching to distance education in the COVID-19 pandemic process. Distance education provides an advantage in education because of the opportunity to repeat the classes (Gregory & Lodge, 2015), ease of access (Gök, 2015) and flexibility in learning speed (Özgöl et al., 2017). However, it has disadvantages that caused by lack of social interaction, high establishment cost (Bolliger & Wasilik, 2009) and lack of technological infrastructure.

The most important criteria for successful distance education are being able to understand the expectations of students (Cabı, 2018) and giving them feedback (Richardson et al., 2015). In this context, teachers have a great responsibility. When the distance education carried out during COVID-19 pandemic process is examined, it is seen that teachers have taken active roles in Turkey. One of the groups of teachers that take an active role is biology teachers. Biology science has complex and interconnected systems in its structure. Focusing on didactic learning methods in biology education causes the depth of knowledge to weaken (Tanner and Allen 2005). The teacher is one of the most significant factors of the education (Dikmenli, Kılıç & Çardak, 2018). In order to be successful in biology education, teachers should have strong connections with students and their sources (Erten, 2008). During the process of the COVID-19 pandemic, application-based educations, one of the indispensable elements of biology education, were not carried out. For this reason, determining the views of biology teachers towards distance education is important for eliminating the problems that are experienced in the distance education process. In addition, determining the views of biology teachers will help measures to be taken for similar disasters and the success of the integration process of technology into education. Therefore in this research, it was aimed to determine the views of biology teachers about distance education in the process of COVID-19 pandemic.

Method

Study Design

Of the qualitative research designs, phenomenological study was used in this research. A phenomenological study is the unification of the lived experiences of several people regarding a phenomenon or concept around a common meaning (Creswell, 2013). Phenomenography explores the qualitatively different ways in which people potentially understand certain phenomena or an aspect of the world around them (Montenegro, 2020). In this research, a phenomenological study was used to analyze the views of biology teachers about the distance education applied in the COVID-19 pandemic process.

Study Group

The study group of the research consists of 62 biology teachers who are working in different provinces and institutions in Turkey. 69.4% (f = 43) of biology teachers are females and 30.6% (f = 19) are males. Biology teachers participating in the research have been using the applications of EBA (f = 20), Zoom (f = 40), TeamLink (f = 4), Skype (f = 4) and Whatsapp (f = 9) in the distance education process.

Data collection tool

Semi-structured interview form prepared by the researchers was used to collect the data. For the validity of the semi-structured interview form, views were received from two (2) biology educators and one (1) information and technology expert. It was stated by the experts that some questions did not serve research purposes. They also stated that the two problems were similar and suggested that one of them should be included in the form. The semi-structured interview form consisting of ten (10) questions was prepared as five (5) questions in accordance with the views of the experts. The final form of the form was created by making the necessary language corrections.

Semi-structured interview forms consist of two parts. In the first part, there are questions to determine demographic information. In the second part, there are questions prepared for the purpose of the research. Https://docs.google.com/forms system was used in the data collection process. The prepared link was shared to teachers via e-mail and Whatsapp. In the introduction part of the form, teachers were informed about the purpose of the study. In addition, as required by ethical rules, voluntary consent statements were taken from teachers.

Data Analysis

The answer forms of the teachers who participated in the research were coded and named as (T-1, T-2, T-3…). The data were evaluated by performing content analysis. Content analysis is defined as the systematic coding of quantitative or qualitative data within the framework of certain themes and classifications (Cohen, Manion & Morrison, 2007; Fraenkel, Wallen & Hyun, 2012). Content analysis provides the data to be classified under certain themes to reveal the relationship with each other (Yıldırım & Şimşek, 2011, p.227). In addition, content analysis gives meaningful conclusions by analyzing verbal or written data for a specific purpose (Kaya, Fırın & Nas, 2013). Therefore, the analysis of the data was carried out by inductive content analysis.

Each data was firstly read by two different researchers and a holistic understanding was tried to attempt. The third researcher checked the consistency of the themes obtained and the compatibility of the literature. In order to determine whether there is consistency among the researchers, the formula introduced by Miles and Huberman (2015) was applied, which is Reliability= Consensus/All views. Reliability of two encoders was calculated as = .89. The reliability of the research was obtained by presenting the data obtained from teachers exactly.

Findings

In this part of the study, the views of biology teachers on distance education applied in the COVID-19 pandemic process were analyzed. In the research, the views of the participants regarding the distance education applied during the COVID-19 pandemic were examined firstly. Findings obtained from the research are presented in Table 1.

When Table 1 is examined, it was determined that the participants had positive and negative views about distance education during the COVID-19 pandemic process. Participants expressed positive views in terms of distance education process such as; Independence from time and place (f=21), providing live courses (f=13), providing time management (f=11) and providing rich content and visual material opportunities (f=11). However, their negative views also draw attention in terms of causing inequality of opportunity (f=27), involving technical and technological problems (f=27), providing classroom organization (f=10) and revealing negative affective characteristics (f=10).

Table 1. Views of participants on the distance education process

Category	Theme	Sub-theme	*f*
Positive		Time management	11
		Positive affective properties	10
	Classroom Management	Classroom control and discipline	7
		Classroom environment and group interaction	5
		Classroom organization	5
		Learning process	10
	Competencies and the learning / teaching process	Evaluation and Evaluation	6
		Technology use	4
		Independence from time and place (desire)	21
		Live course schedule	13
	Distance education process	Enriched content and material	11
		Repeatability	7
		Continuity (durability)	6
		Economical	3
	Not positive	Not positive	14
	Total		133
Negative		Classroom organization	10
		Negative affective characteristics	10
	Classroom Management	Lack of communication	5
		Classroom control and discipline	4
		Time management	3
		Learning environment and group interaction	3
	Competencies and the learning / teaching process	Learning/Teaching process	6
		Evaluation and Evaluation	8
		Technology use	2
		Unreadiness	6
	Distance education process	Inequality of opportunity	27
		Technical and technological problems	27
		Live course schedule	9
	Not negative	Not negative	3
	Total		123

Examples of the positive views of the participants regarding the distance education in the COVID-19 pandemic process are given below:

> T-4: There is no transportation. Material and food are from the student. Its positive aspect is that not only the students keep up with the classes, but they also do not fall behind.
>
> T-5: Since there are no working hours, training activities can be carried out at any hour. Both students and teachers learn to follow technology more closely by scanning more resources.
>
> T-9: We do not waste time writing the course notes in a notebook, I take the screen record and send it to the students, and I have them write it as an assignment. With this way, they repeat the course subject.
>
> T-24: Since the courses are live, I ask questions to the students as if we were in the classroom, it is just like the classroom environment. I can even say that they are more careful than the classroom environment.
>
> T-34: You can appeal to more audiences in distance education.
>
> T-44: It enables students to access classes whenever they want and to repeat topics frequently.

Examples of the negative views of the participants regarding the distance education in the COVID-19 pandemic process are given below:

> T-9: We find it difficult to reach students who cannot access the internet. In addition, students who have technical problems and lack of information technologies have difficulty connecting to the classes.

T-20: Internet speed is insufficient. Also, there are deficiencies in the documents.

T-21: There are some problems with the issues of internet connection, feeling discomfort due to other family members' being at home, and adjusting the appropriate time for all students.

T-61: There are some problems due to technological impossibilities.

T-38: Problems with internet speed and time are experienced.

In the study, the views of biology teachers about the methods and techniques used by them in distance education in the COVID-19 pandemic process were examined. Findings obtained from the research are presented in Table 2.

Table 2. Views on methods and techniques used in biology course in distance education process

Category	Theme	Sub-theme	*f*
Learning Through Presentation	Education Through Presentation	Education Through Presentation	2
	Direct Instruction	(Direct) instruction (presentation)	29
		Using course notes (Pdf, Ppt, Word etc.)	21
		Summarizing	2
		Subject repetition	1
	Demonstration	Video usage	15
		Visual (photograph, figure, graphic, animation etc.)	14
		Performance	1
	Concept maps	Concept maps	1
	Question answer	Question-answer	23
		Question, test or problem solving	15
Learning Through Invention	Education Through Invention	Education Through Invention	2
	Case study	Case study	2
		Daily life (exemplification)	2
		Exemplification	1
	Discussion	Discussion	7
	Enriched content and visual materials	EBA	7
		Social Media	4
		Live course schedule (Zoom etc.)	3
		Z-book	1
		3D visuals	1
		e-material (Instagram, Twitter, Whatsapp etc.)	1
		Voice record	1
	Self-study	Homework	5
		Self-study	1
Learning through Research and Analysis	Brain storming	Brain storming	5
	Demonstration	Demonstration	1
		Guidance	1
	Educational Games	Educational Games	1
	Activity based learning	Activity work	1
Constructivism	Constructivist Learning	Constructivism	1
		5E	1
		Research and Questioning-Based Education	1
		Problem-Based Thinking	1
		Project-Based Education	1
		Project-Based Learning	1
		Snowball Technique	1
Other	Other	Arousing curiosity	1
		Reasoning	1
		Student control	1
		All but group activity and laboratory activity	1

When Table 2 is examined, it is noticed that the participants preferred learning through presentation strategies in the distance education process more than other strategies, methods and techniques. The participants also

preferred methods and techniques such as direct instruction method (*f*= 29), question-answer technique (*f*= 23), use of course notes (Power Point, Pdf, Word etc.) (*f*= 21), question, test or problem solving (*f*= 15) use of videos (*f*= 15) and images (*f*= 14) more. The sample view of the participants about the methods and techniques used in biology courses in distance education in the COVID-19 pandemic process are given below:

> T-2: I use brainstorming, question-answer, discussion, direct instruction, concept maps, z-books and visualization techniques.
>
> T-3: I use plenty of visual factors (photos, figures, graphics, animation, videos ...). In addition, I use case study method, question-answer, educational game (on the digital environment), brainstorming.
>
> T-10: I can make lectures with live videos, I use conference meeting program (Zoom). I give assignments via EBA, and share lecture notes via Whatsapp.
>
> T-20: I use video, animation, pdf note, live course, and on Whatsapp, I do problem-solving.
>
> T-42: I prepare ppt-word documents for the students and upload them to the EBA system. In addition, I prepare target-specific tests in EBA academic for the willing students.
>
> T-44: I use lecture instruction, question-answer, discussion, brainstorming, case study, demonstration, problem solving, video, animation, snowball technique etc.
>
> T-52: I use PowerPoint presentations, 3d visuals, video presentations, and I convert my specific notes that I have prepared to pdf and upload them.

In the study, the views of biology teachers on distance education in the COVID-19 pandemic process regarding the measurement and evaluation used in their courses were analyzed. Findings obtained from the research are presented in Table 3.

Table 3. Views on measurement and evaluation methods and techniques used in biology course in distance education process

Category	Theme	Sub-theme	*f*
Summative Evaluation for Success / Level Determination	Objective	Multiple-choice tests, tests, retests	29
		True-False tests	3
		Matching	1
		Gap-filling	1
		Structured Grid	2
		Diagnostic tree	1
	Subjective	Open-ended questions	1
		Oral examination	1
		Short answer exams	1
		Mini quizzes	2
Formative Evaluation	Performance / Process Evaluation	Performance evaluation	3
		Process evaluation	1
		Research -review	1
		Activity applications	1
		Worksheets	1
Online Evaluation	Online Live Broadcasting Programs	Online Exam	11
		Google form and drive	4
		EBA (Academic)	19
		Social media tools (Whatsapp, Instagram etc.)	1
		Live broadcasting programs (Zoom, Microsoft teams etc.)	2
	Web 2.0 tools	Kahoot (Quiz)	2
		Socrative	1
Other	Other	Question-answer, question, test, problem solving etc.	12
		Giving assignments	9
		Multiple intelligence techniques	1
		Constructivism	1
		Inquiry-learning	1
I did not use it	I did not use it	I have not used it yet	8

When the findings in Table 3 are examined, it is noticed that the participants preferred the methods and techniques of summative evaluation for success/level determination and online evaluation methods, techniques and tools for distance education in comparison to others. The most used measurement and evaluation methods and techniques are; multiple-choice tests (f=29) from the category of "summative evaluation"; EBA (Academic) (f=19) from the online evaluation category- digital education platform created by the Ministry of National Education; and question-answer, question, test, problem-solving, etc. (f=12) from the 'other' category. Sample views of the participants on the measurement and evaluation methods and techniques used in biology courses in distance education in the COVID-19 pandemic process are given below:

T-4: I use verbal question and answer, online exams, and tests.

T-8: I utilize from multiple-choice tests, true-false, gap-filling, structured grid.

T-11: I use multiple-choice, true-false, short answer questions on Socrative. Research-review performances via Drive.

T-15: I use Google forms, online exam, EBA exam, Kahoot, Quiziz.

T-18: I use question-and-answer and I check the topic repetition tests on EBA.

T-30: I use the success rates obtained from activities such as homework, study, and test, which I sent through EBA.

T-32: I use question-answer, matching, structured grid, multiple-choice questions, open-ended questions.

T-37: I share assignments from the academic support system and my own sample questions.

T-44: Student-centered learning and teaching techniques, constructivism, multiple intelligence techniques, inquiry-based learning.

T-52: I control of given assignments in teams. I ensure that the presentations given are uploaded to the system and repeated.

In the study, the views of the participants regarding the applicability of distance education for biology courses in the COVID-19 pandemic process were examined. Findings obtained from the research are presented in Table 4.

Table 4. Views of the participants on the applicability of distance education for biology courses

Category	Theme	Sub-theme	*f*
Applicable	Classroom management	Class control and discipline	1
	Nature of the course	Verbally weighted	2
		Theoretical competence	1
		Insufficiency in practice	1
	Distance education process	Necessity	2
		Enriched content and visual material	2
		Supportive (complementarity)	1
	No explanation	No explanation	3
Partly applicable (not enough by itself, not experimentally applicable)	Nature of the course	Verbally weighted	1
		Theoretical competence	3
		Insufficiency in practice	3
	Distance education process	Supportive (complementarity)	1
		Repeatability	1
	No explanation	No explanation	3
Non-applicable	Classroom management	Classroom environment and group interaction	7
		Negative affective features	1
	Nature of the course	Insufficiency in practice	6
		Insufficiency in learning by experiencing	2
	Distance education process	Inequality of opportunity	1
	No explanation	No explanation	3

When Table 4 is examined, it was determined that the participants had view about the applicability of distance education for biology courses as it is applicable (*f*= 13), partially applicable (*f* = 8) and non-applicable (*f*=17). Some participants (*f*= 24) did not express their view about the applicability of distance education for biology course.

Sample views of the participants about the applicability of distance education for biology courses in the COVID-19 pandemic process are given below:

> T-3: Distance education is applicable for biology courses but I think it will not be good in the long term, because student control is more difficult and takes more time in this system.
>
> T-4: I think it is theoretically applicable but since biology needs practice, it will be difficult. Laboratory applications will not be possible.
>
> T-8: I think that distance education is applicable to the theoretical topics of biology courses but it is not applicable for the experimental part of the course.
>
> T-9: Biology is a course containing animation, visual and video due to its content. For this reason, I think distance education is applicable to it.
>
> T-19: Since it is verbally weighted, it is more applicable than many courses.
>
> T-27: It is never applicable.
>
> T-37: No. It is not applicable for biology course acquirements.
>
> T-41: I think it is not applicable.
>
> T-47: Partially yes. It can be used as a complementary education.
>
> T-50: It is not very convenient because biology is learned by experience.

In the study, the views of biology teachers about that distance education in biology courses' continues in the future were examined. Findings obtained from the research are given in Table 5.

Table 5. Views on the application of the distance education process in biology courses in the future

Category	Theme	Sub-theme	*f*
I want	Classroom management	Learning environment and group interaction	1
	Distant education process	Necessity	3
		Enriched content and visual material	1
		Economics	1
		Supportive (complementarity)	7
	No explanation	No explanation	1
I partially want	Nature of the course	Verbally weighted	1
		Insufficiency in practice	2
	Distant education process	Necessity	1
		Supportive (complementarity)	6
		Unreadiness	2
I do not want	Classroom management	Learning environment and group interaction	9
		Classroom control and discipline	1
		Time management	1
	Competencies and the learning / teaching process	Learning / teaching process	1
	Nature of the course	Insufficiency in practice	4
	Distant education process	Inequality of opportunity	1
	Other	Another system request	1
		Similarity with the technology used	1
	No explanation	No explanation	2

When Table 5 is examined, the participants stated that I want (f = 13), I partially want (f = 10) and I do not want (f= 17) regarding the application of distance education applied in the COVID-19 pandemic process in future biology courses. On the other hand, some participants (f= 22) did not comment on the application of distance education in biology courses in the future.

The sample views of the participants regarding the application of distance education applied in the COVID-19 pandemic process in the biology courses in the future are given below:

> T-1: I don't want it, because the classroom atmosphere and face-to-face education are more efficient and friendly.
>
> T-2: No. No matter how much it is described, there are shortcomings. Courses would be more beneficial if they are taught in the same environment with the student.
>
> T-6: Distance education should continue as an aid to formal education.
>
> T-10: It can happen at certain intervals.
>
> T-12: Yes. Participation of students in education from the comfort of their homes, away from the day's tiredness and transportation etc. would be nice and they would not waste time with these.
>
> T-13: In the future, distance education should continue, but it should be arranged to complement the shortcomings of face-to-face education.
>
> T-51: It is applicable. Distance education will continue and should be.
>
> T-61: I want distance education to continue with formal education because I think it will be useful in the form of supportive education.

Results and Discussion

The aim of the study is to determine the views of biology teachers about distance education in the COVID-19 pandemic process. The teachers evaluated the distance education process in COVID-19 pandemic in terms of process, methods and techniques used in biology courses, the applicability of distance education for biology course and the possibility of future application. As a result of the research, it has been determined that biology teachers have positive views about distance education conducted in the COVID-19 pandemic process in terms of classroom management, competencies, and application processes. The teachers stated that distance education, which is carried out in the pandemic process, provides advantages due to time management, organization of the learning process, use of technology and being independent of place. When the literature on the subject is examined, it is seen that there are studies supporting the findings of the research. For example, as a result of the research conducted by Özgöl et al. (2017), it has been determined that distance education is beneficial in terms of providing extra time to students, being independent of the place and enabling repetition of courses. Cabı (2018), in his study, determined that distance education is beneficial for students (access to course materials, opportunities for repetition, being independent of place and time) and teachers (classroom management, enriched course contents and reduced workload). According to Gregory and Lodge (2015), one of the most important advantages of distance education is the possibility to watch the courses again. In addition, it was found in the research that distance education was found positive for teachers due to its providing enriched content and visual course materials. It can be said that the existence of a lot of visual education materials prepared in the field of biology is effective in this result. One of the factors that increase the quality of education is the availability of materials (Chao, Saj & Tessier, 2006). According to the results of the research, it was determined that the teachers also had negative views about distance education in the pandemic process. The teachers stated that they had negative views on distance education due to the disruption of classroom organization, lack of technological infrastructure and inequality of opportunity. Face-to-face education strengthens students' sense of belonging to the learning environment and process (Luo, Zhang & Qi, 2017). The transactional distance perception weakens the communication between the student and the teacher in different environments and causes psychological gap (Moore & Kearsley, 2012). These results support the findings of the research.

In the research, it has been determined that biology teachers conduct the education process by using teaching methods and techniques such as direct instruction, sharing of course notes, demonstration, enriched content and visual materials through online platforms. According to these results, it can be said that biology teachers use different teaching methods and techniques in distance education applied during the COVID-19 pandemic process. In the distance education process, the use of different activities, methods and techniques by the educators will enable them to build bridges with their students (Moore & Kearsley, 2012). Can (2020) determined that higher education faculty members use different methods and techniques in distance education depending on the COVID-19 pandemic. According to Bao (2020), the use of sound is important for successful distance education in the COVID-19 pandemic process. For this reason, teachers can increase success by using audio-content techniques such as direct instruction, use of visual materials or animations. In addition, the use of technology-assisted teaching techniques will enable students to improve their knowledge and skills. In the research, it has been determined that biology teachers use the methods and techniques of summative evaluation for success/level determination such as multiple-choice tests, true-false tests, matching, in the distance education process; and they use formative evaluation methods and techniques such as project, activity, research; and online evaluation methods and techniques such as online exams and EBA applications in parallel with technological developments. Based on these results, it can be said that biology teachers evaluate students' knowledge-skills and competencies by using different measurement and evaluation methods and techniques. Similar to the categories created for this research, in the literature, it is stated that there are two different measurement-evaluation methods and techniques: the summative evaluation which is measurement-evaluation for determining success and level and the formative evaluation (Gikandi, Morrow, & Davis, 2011). While measurement-evaluation for success and level determination refers to the comparison of students with each other and their meeting certain standards (Shute, & Kim, 2014); formative measurement-evaluation is called evaluation for learning. Formative measurement-evaluation is used to increase students' learning and to improve their organizing learning practices by themselves (Nicol, & Macfarlane-Dick, 2006). Although formative measurement-evaluation has been stated as the most effective methods for learning (Shute, & Kim, 2014), this method and technique are less preferred due to reasons such as crowded classes etc. (Broadbent, Panadero, & Boud, 2018). In this context, the main reason for less usage of formative measurement-and-evaluation methods and techniques in distance education compared to others may be crowded classes. With the face-to-face education was not possible in the COVID-19 process, face-to-face evaluation tools were replaced by online measurement-evaluation tools which use technology (Burgess, & Sievertsen, 2020). This situation has emerged in the research results. Zhou, Huang, Cheng, and Xiao (2020), in their studies, investigated the use of the micro-video Massive Open Online Course (MOOC) distance learning method in the COVID-19 pandemic for the training of emergency service interns and determined that the effect of this evaluation approach was similar with the traditional method. Online evaluation methods and techniques are of vital importance in the process of COVID-19. However, according to Teclehaimanot and Marshall (2016), measurement-evaluation should be compatible with the objectives of the courses. The teaching materials used in online courses should be based on the most convenient practices, be up-to-date and appropriate. These courses should include audio-visual equivalents, and various online educations should be provided to ensure teachers' adaptation to this process.

In the research, some teachers think that distance education is not applicable for biology courses due to the lack of laboratory courses, the lack of some practical applications, the lack of field trips and observations, and the absence of face-to-face interaction in the classroom environment. In addition, these teachers stated that they do not want to apply distance education in biology classes in the future. Practices (experiments) in scientific process-based courses such as biology are necessary for instructional development (Mattheis, Ingram, Jensen, & Jackson, 2015). However, some teachers stated that due to its features of nature of the course and the necessities of the process, distance education is applicable for biology courses and can be applied in the future. Additionally, biology teachers stated that due to its complementarity feature, distance education can be applied in the biology courses in the future. Li, Zhou and Fan (2014) stated that equal opportunities have been provided to students through distance education. Distance education is especially useful for providing simultaneous and same quality education to more than one classroom branch (Cabı, 2018). As a result of the research conducted by Özgöl et al. (2017), it was determined that distance education provides advantages to students because it provides course repetition and easy access.

Suggestions

According to the results of this research, the following suggestions can be proposed:

- It was determined that some teachers did not express positive or negative views about the various aspects of distance education. This situation suggests that some of the teachers do not have information about

distance education and they are in contradictions about its implementation. For this reason, it would be very convenient to provide teachers with education about what distance education is and in what cases and how it should be applied.

- In this process, some of the teachers discovered that distance education is not enough presenting the course content to the student in the classical sense at the specified time by only uploading them onto the system. From this point of view; It will be convenient to equip the course contents with the most up-to-date information suitable for the age level that will attract the attention of the student sitting in front of the screen.
- Course contents should be organized to appeal to the students' affective perceptions (enjoyable animations, videos, knowledge contests that they can actively participate in). Although students are provided with standard education programs by their schools, the content should be updated by the course teachers by taking students' levels and interest levels into account.
- Teachers should be told that situations similar to this global problem experienced in the context of the COVID-19 pandemic can be experienced at other times and therefore, they should be prepared in all circumstances. It should be noted that preventive medicine is very closely related to raising awareness of teachers as much as developments in medicine and pharmacy in the prevention of epidemics. For this reason, platforms can be created where teachers can transfer their experiences about situations that they find themselves successful or unsuccessful during their daily work.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

References

Bao, W. (2020). COVID- 19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies, 2*(2), 113-115. https://doi.org/10.1002/hbe2.191

Basilaia, G., & Kvavadze, D. (2020). Transition to online education in schools during a SARS-CoV-2 Coronavirus (COVID-19) pandemic in Georgia. *Pedagogical Research, 5*(4), em0060. https://doi.org/10.29333/pr/7937

Bolliger, D. U. & Wasilik, O. (2009). Factors influencing faculty satisfaction with online teaching and learning in higher education. *Distance Education, 30*(1), 103-116. https://doi.org/10.1080/01587910902845949

Broadbent, J., Panadero, E., & Boud, D. (2018). Implementing summative assessment with a formative flavour: A case study in a large class. *Assessment & Evaluation in Higher Education, 43*(2), 307-322. https://doi.org/10.1080/02602938.2017.1343455

Burgess, S., & Sievertsen, H. H. (2020). Schools, skills, and learning: The impact of COVID-19 on education. Retrived from: https://voxeu.org/article/impact-covid-19-education

Cabı, E. (2018). Teaching computer literacy via distance education: Experiences of the instructors. *Başkent University Journal of Education, 5*(1), 61-68. Retrieved from: http://buje.baskent.edu.tr/index.php/buje/article/view/93

Can, E. (2020). Coronavirus (Covıd-19) pandemic and pedagogical reflections: Open and distance education applications in Turkey. *AUAd, 6*(2), 11-53. Retrieved from: http://auad.anadolu.edu.tr/yonetim/icerik/makaleler/515-published.pdf

Chao, T., Saj, T., & Tessier, F. (2006). Establishing a quality review for online courses. *Educause Quarterly, 29*(3), 32-38. Retrieved from: https://er.educause.edu/-/media/files/article-downloads/eqm0635.pdf

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (5th Ed.). London and New York: Routledge Falmer.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (2. Baskı). USA: SAGE Publications.

Dikmenli, M., Kılıç, S., & Çardak, O. (2018). High school students' images of "biology teacher". *Journal of Education and Practice, 9*(4), 29-35. Retrieved from: https://www.iiste.org/Journals/index.php/JEP/article/view/41116/42277

Erten, S. (2008). Interests of 5th throuhg 10th grade students toward human biology. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 35*(35), 135-147. Retrieved from https://dergipark.org.tr/en/pub/hunefd/issue/7803/102281

Fraenkel, J. R., Wallen, N. E. & Hyun, H. H. (2012). *How to design and evaluate research in education* (7. ed). New York: McGraw-Hill.

Gikandi, J.W., Morrow, D., & Davis, N.E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education, 57*(4), 2333-2351. https://doi.org/10.1016/j.compedu.2011.06.004.

Gök, T. (2015). The evaluations of the college students' perceptions on distance education from the point of the technical and educational factors. *The Turkish Online Journal of Distance Education, 16*(2), 84-93. https://doi.org/10.17718/tojde.19025

Gregory, M. S. J. & Lodge, J. M. (2015). Academic workload: the silent barrier to the implementation of technology-enhanced learning strategies in higher education. *Distance Education, 36*(2), 210-230. https://doi.org/10.1080/01587919.2015.1055056

Kaya, A.Y., Fışkın, R., & Nas, S. (2013). The content analysis of the articles published in "safety science" journal between 2006-2010. *Dokuz Eylül Üniversitesi, Denizcilik Fakültesi Dergisi, 5*(1), 121-139.

Li, F., Zhou, M., & Fan, B. (2014). Can distance education increase educational equality? Evidence from the expansion of Chinese higher education. *Studies in Higher Education, 39*(10), 1811-1822. https://doi.org/10.1080/03075079.2013.806462

Luo, N.,Zhang, M. ve Qi, D. (2017). Effects of different interactions on students' sense of community in e-learning environment. *Computers & Education,* 115, 153-160. https://doi.org/10.1016/j.compedu.2017.08.006

Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W. M., & Stahl, D.A. (2019). *Brock biology of microorganisms*. Pearson Education Limited, USA.

Mattheis, A., Ingram, D., Jensen, M. S., & Jackson, J. (2015). Examining high school anatomy and physiology teacher experience in a cadaver dissection laboratory and impacts on practice. *International Journal of Science and Mathematics Education, 13*(3), 535-559. https://doi.org/10.1007/s10763-013-9507-8

Merriam, S. B. (2013). *Nitel araştırma: Desen ve uygulama için bir rehber* (3. Baskıdan Çeviri, Çeviri Editörü: S. Turan). Ankara: Nobel Yayın Dağıtım.

Montenegro, H. (2020). Teacher educators' conceptions of modeling: A phenomenographic study. *Teaching and Teacher Education*, 94, 103097. https://doi.org/10.1016/j.tate.2020.103097

Moore, M. G., & Kearsley, G. (2012). *Distance education: A systems view of online learning* (3th ed.). Belmont, CA: Wadsworth Cengage Learning.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education, 31*(2), 199-218. https://doi.org/10.1080/03075070600572090

Özer, M . (2020). Educational policy actions by the ministry of national education in the times of COVID-19 pandemic in Turkey. *Kastamonu Eğitim Dergisi, 28*(3), Retrieved from https://dergipark.org.tr/tr/pub/kefdergi/issue/54020/722280

Özgöl, M., Sarikaya, İ., & Öztürk, M. (2017). Students' and teaching staff's assessments regarding distance education applications in formal education. *Journal of Higher Education and Science*, *7*(2), 294-304. http://doi.org/10.5961/jhes.2017.208

Rasmussen, S.A., Smulian, J.C., Lednicky, J.A., Wen, T.S., & Jamieson, D.J. (2020). Coronavirus disease 2019 (COVID-19) and pregnancy: What obstetricians need to know. *American journal of obstetrics and gynecology*, 222(5),415-426. https://doi.org/10.1016/j.ajog.2020.02.017

Reece, J.B, Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. & Jackson, R.B. (2017). *Campbell biology* (Eleventh Edition). USA: Pearson Education.

Richardson, J.C., Koehler, A., Besser, E., Caskurlu, S. Lim, J., & Mueller, C. (2015). Conceptualizing and investigating instructor presence in online learning environments. *International Review of Research in Open and Distributed Learning, 16*(3), 256-297. https://doi.org/10.19173/irrodl.v16i3.2123

Shute, V. J., & Kim, Y. J. (2014). Formative and stealth assessment. In J. M. Spector, M. D. Merrill, J. Elen, M. J. Bishop (Eds.). *Handbook of Research on Educational Communications and Technology* (pp. 311-321). New York, NY, US: Springer. https://doi.org/10.1007/978-1-4614-3185-5

Tanner, K., & Allen, D. (2005). Approaches to biology teaching and learning: understanding the wrong answers—teaching toward conceptual change. *Cell Biology Education, 4*(2), 112-117. https://doi.org/10.1187/cbe.05-02-0068

Teclehaimanot, B., & Marshall, H. (2020). Faculty members' best practice standarts in the design of higher education online courses. *39th annual Proceedings*, 1, 125-135. Retrieved from: https://www.tresystems.com/proceedings/documents/2016_lasvegas_volume1.pdf#page=133

The Council of Higher Education (YÖK) (2020, 03 29). Press briefing. Retrieved from: www.yok.gov.tr/Sayfalar/Haberler/2020/universitelerde-uygulanacak-uzaktan-egitime-iliskin-aciklama.aspx.

Toquero, C. M. (2020). Challenges and opportunities for higher education amid the COVID-19 Pandemic: The Philippine Context. *Pedagogical Research, 5*(4), em0063. https://doi.org/10.29333/pr/7947

Velavan, T.P., & Meyer, C.G. (2020). The COVID-19 epidemic. *Tropical medicine & international health: TM & IH*, *25*(3), 278–280. https://doi.org/10.1111/tmi.13383

Yamamoto, G.T., & Altun, D. (2020). The Coronavirus and the rising of online education. *Journal of University Research*, *3*(1), 25-34. Retrieved from: https://dergipark.org.tr/tr/pub/uad/issue/53721/702735

Yildirim, A., & Şimşek, H. (2011*). Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin Yayıncılık.

Zhou, L., Wu, S., Zhou, M., & Li, F. (2020). 'School's out, but class' on', the largest online education in the world today: Taking China's practical exploration during the COVID-19 epidemic prevention and control as an example. *Best Evid Chin Edu 2020, 4*(2), 501-519. https://doi.org/10.15354/bece.20.ar023

Zhou, T., Huang, S., Cheng, J., & Xiao, Y. (2020). The distance teaching practice of combined mode of massive open online course micro-video for interns in emergency department during the COVID-19 epidemic period. *Telemedicine and e-Health.* 1-5. https://doi.org/10.1089/tmj.2020.0079

Author Information

Ferhat Karakaya
Yozgat Bozok University
Yozgat, Turkey
Contact e-mail: *ferhatk26@gmail.com*
ORCID iD: https://orcid.org/0000-0001-5448-2226

Selçuk Arık
Tokat Gaziosmanpaşa University
Tokat, Turkey
ORCID iD: https://orcid.org/0000-0003-4496-8104

Osman Çimen
Gazi University
Ankara, Turkey
ORCID iD: https://orcid.org/0000-0002-6651-6849

Mehmet Yılmaz
Gazi University
Ankara, Turkey
ORCID iD: https://orcid.org/0000-0001-6700-6579

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.751023

The Effect of the Augmented Reality Applications in Science Class on Students' Cognitive and Affective Learning

Fatih Serdar Yildirim

Article Info

Article History

Received:
10 January 2020

Accepted:
01 August 2020

Keywords

Augmented reality
Science education
STEM education

Abstract

This study aims to determine how effective science teaching with augmented reality-based teaching material (science cards) is compared to the science curriculum prescribed methods on students' academic achievement and their views on augmented reality application. As a study group, 63 students who were studying in a 7th grade in a secondary school in Antalya in the 2019-2020 academic years were selected. Mixed research design was used in the research. In the quantitative side of the research, the control group and the experimental group who are taught using the augmented reality (science cards) were compared in terms of achievement. In the qualitative side on the other hand, interview and observation data were used. The results of the research have shown that while Augmented Reality (AR) applications increase students' achievement, contribute to the meaningful learning of abstract subjects, AR applications also increase the students' interest and motivation towards science lesson.

Introduction

Augmented Reality, or AR for short, is a form of real-time and interactive experience created by enriching real-world environmental elements using data such as computer-generated graphics, video, GPS, etc. A brand new type of experience is created by the adding of virtual images and graphics to real world images without leaving reality but instead, enriching it with the help of various software and hardware. In augmented reality applications, it is aimed to give the individual a virtual experience as if it were real in physical environment and in real time. A new environment is created by placing various virtual objects on the snapshot of the environment where the individual is located. The real environment is enriched by images, sounds, graphics and GPS data created in digital environment. This method can even be used to make the individuals in the environment be able to talk to objects (Aslan, 2017). The image created with augmented reality basically has three features. These features are as follows; merging of the real world with the virtual image, real time interaction of real and virtual objects and location of the image obtained in the three dimensional environment (Azuma, 1997; Wu, Lee, Chang, & Liang, 2013). Augmented reality provides information that is not normally detectable by the senses and cognitive process of humans to strengthen and enrich the reality (Azuma, 1999). Augmented reality, in its simplest definition, is "presenting computer produced digital objects together with real objects" (Uluyol & Eryilmaz, 2014). Learning environments supported by augmented reality, allow students to see 2D objects in 3D and to examine these objects from various perspectives, and to learn by doing-living. (Arvanitis, Petrou, Knight, Savas, Sotiriou, Gargalakos, & Gialouri , 2007; Wu, Lee, Chang, & Liang, 2013). AR technology attracts educators' attention with its ability to interact with virtual and real objects, providing learning by living and increasing attention and motivation (Singhal, Bagga, Goyal, & Saxena, 2012). Due to such advantages, studies on AR are increasing day by day.

In their study, Çetinkaya and Akçay (2013) discussed the concept of augmented reality, its use in education and application examples. İbili and Şahin (2013) stated that the augmented reality-supported geometry teaching using their 3D geometry book software they created helped improving students' cognitive and affective skills. The teachers who participated in the study stated that the application increased their thinking skills such as making assumptions, generalizing and drawing conclusions and positively affected their interests and motivations. Avcı and Taşdemir (2019) have designed a visual and educational virtual and augmented reality (mixed) game for the periodic table subject with the Unity 3D game engine. With the application, students learned the elements in the periodic table in an audible, visual and entertaining environment by experimenting as if they were in an experimental environment. On the other hand, thanks to the application, students who do not have a science laboratory in their schools have the opportunity to do activities. In addition, with the application, students experienced more impressive understanding processes in an interactive environment without being affected by the risks caused by the chemicals in the experimental environment.

Analyzing the use of augmented reality in education, it is seen that these applications contribute positively to the academic performance of students (Abdüsselam & Karal, 2012; Buluş Kırıkkaya, & Şentürk 2019; Chen & Wang, 2015; Farias & Dantas, 2011; Patirupanusara, 2012), increase students' motivation for the class (Chiang, Yang, & Hwang, 2014; Di Serio, Ibáñez, & Kloos, 2012; İbili & Şahin, 2013; Sırakaya & Alsancak Sırakaya, 2018) and make the learning process remarkable and effective (Avcı & Taşdemir, 2019; Farias & Dantas, 2011).

The purpose and importance of the research

In today's world, educational technologies are developing very rapidly and getting integrated into classroom environments. With each passing day, the interaction of students enrolling into the education system with technology increases compared to the previous generations. In order to meet the expectations of these students, their schools need to adapt to these technologies and meet the needs of the new generations. Traditional lessons, which are taught through the method of direct expression, weaken students' connection with the school and reduce their motivation. However, when the teaching process include course materials utilizing augmented reality technology, it is easier for students to obtain correct information, achieve better inferences and understand abstract concepts that are difficult to learn (Abdüsselam & Karal, 2012).

In this research, in order to increase the value of students' learning and increase their interest and motivation towards science learning, AR application was implemented in the science class. Teaching a science subject with AR increases the importance of working in terms of science education. In this study, it is aimed for students to discover the structure and organelles of the cell in three dimensions by the augmented reality application. In line with this purpose, educational activities supported by AR technology (science cards) are designed for the subject of "Comparison of Plant and Animal Cells and Tasks of Cell Organelles" contained by the Cells and Divisions unit of the Science Class and it is aimed to reveal whether the AR technology increases the students motivation towards learning. For this purpose, the following questions are discussed:

1. Is there a significant difference between the pretest scores of the experimental group to which augmented reality (AR) method is applied and the control group where the science curriculum prescribed method is applied?
2. Is there a significant difference between the posttest scores of the experimental group to which the augmented reality (AR) method is applied and the control group to which the science curriculum prescribed method is applied?
3. What are the opinions of students in the experimental group about the application of augmented reality (AR) method?

Method

Research Model

This research was carried out with the mixed method. Mixed method research provides an alternative approach to the researcher in achieving the "depth and detail" where quantitative research methods lack and "generalization and prediction" where qualitative research methods lack (Yıldırım & Şimşek, 2013). Mixed research allows researchers to use both qualitative and quantitative approaches / methods in a single study (Cresswell and PlanoClark, 2014). In this study; convergent parallel design, which converges from mixed research designs is used. Qualitative and quantitative data, which are equally important in this research design, are collected together and analyzed separately (Creswell, 2011). In the last step, similarities and differences between quantitative and qualitative findings are compared and interpreted. Thus, it is aimed to have better results (Creswell & Piano Clark, 2011). In order to compare the academic achievement of the experimental group, in which the augmented reality (AR) application was applied in science education, and the preferred control group students of the science curriculum prescribed methods, an experimental with pretest-posttest control group was chosen.

Table 1. Pattern of the study

Group	Before Application	Method of Application	After Application
Experimental	Pretest (Test1)	Augmented Reality	Posttest (Test1) Inteview
Control	Pretest (Test1)	The science curriculum prescribed methods	Posttest (Test1)

In order to support quantitative data, the opinions of students in the experimental group about the application were taken and the qualitative documents created during the application were used. The study group of the study consists of 7th grade students studying in a secondary school in Antalya in the 2019-2020 academic years. A total of 63 students, 31 in the experimental group and 32 in the control group, participated in the study. The groups were appointed through impartial selections.

Table 2. Number of students participating in the research

Group	Girls	Boys	Total
Experimental Group	16	15	31
Control Group	15	17	32
Total	31	32	63

Process of conducting experimental processes

This research was carried out with 7th grade students in a secondary school in Antalya. After determining the subject to be used in the experimental process of the research (Structure of Plant and Animal Cell, Cell Organelles), the AR application to be used on the subject was determined and the material (Science Cards) to be used during Augmented Reality application was provided on the internet. Experimental group students were informed about the application before the application. The application was conducted on both the experimental and the control groups by the same teacher. Three prospective science teachers participated in the applications as observers. While the subjects in the experimental group were taught using AR-based material, the same subjects in the control group were taught in two dimensions based on textbooks. During the four-week unit, AR applications are used in appropriate times for the experimental group. Photographs taken during the augmented reality application to the experimental group are shown in Figure 1.

Figure 1. Examples of applications made by the experiment group students

Reliability and Validity of Data Collection Tools

As data collection tools, an achievement test prepared for the science class, for "Cells and Divisions" unit, a semi-structured student interview form containing student views about the application and observer diaries were used.

Achievement Test: A multiple-choice test of 20 questions is prepared in order to be taken by the experimental and control groups to measure the achievements concerning the 7th grade unit of Cells and Divisions. The test was prepared to cover all the achievements of the unit. Thus, the content validity of the test was ensured. A total of seven experts, two science education academics and five experienced science teachers, were consulted on subjects such as whether the test was sufficient to measure the achievements of the unit, there was any errors and the questions were expressed clearly. The questions were revised in line with the opinions of the experts. The final version of the test was solved by two 7th grade students and feedback was received from the students on whether they understood the questions. In line with the feedback received from the students regarding the final version of the test, very minor revisions were made and the test was finalized. The final version of the test was applied to an 8th grade student group of 200 students in another school. KR-20 reliability coefficient of the achievement test was measured to be 0.82.

Interview Form: During the process of preparation of the student interview form, as a result of review of the relevant literature, open-ended questions were asked in order to get the opinions of the experimental group students. This prepared form was revised in line with the feedback received from 2 field experts. In order to determine whether the questions in the form were clearly understood, they were asked to two 7th grade students before taking their final forms. These questions were directed to the students in the experimental group.

Observation Form: An observation form that draws attention to the main points of the application has been prepared for prospective science teachers who go to schools for observation. Prospective teachers were asked to learn the concepts of the AR application by considering the items in this form, to observe the students' interest in the course and the main topics of the teacher's process of performing the AR application, and to write their observations in each lesson under the item in the form.

Data Collection Process:

Before the application started, an achievement test was prepared in accordance with the student levels and achievements. The prepared achievement test was applied to both experimental and control group students as a pretest before the research. After completing the lessons with the AR applications in the experimental group and with the science curriculum prescribed method for the control group, the achievement test prepared was applied as a post-test. In order to reinforce the quantitative data, while the opinions of the teacher and the experimental group students about AR application were taken, the observations of the teacher candidates were used during the process.

Data Analysis

Analysis of quantitative data

In this research, quantitative data were obtained with the achievement test prepared for the subject. The data of the research were analyzed with the t test.

Analysis of qualitative data

Descriptive analysis and content analysis techniques were used in the analysis of qualitative findings. For the qualitative data to be collected in descriptive analysis, the main framework was determined depending on the research problem, and after making the relevant inferences from the data, direct quotations from the interview and observation data were made. The inference made from the data collected during the descriptive analysis phase is reinforced with direct quotations. At the content analysis stage, the qualitative data collected were merged under certain categories. At this stage, the main themes determined based on the categories for qualitative analysis are included. Analyzes were made under these main themes, and were supported by quotations from the descriptive analysis (Yıldırım and Şimşek, 2013).

Findings

In this section, quantitative and qualitative findings are given under separate topics.

Quantitative Findings

When Table3 is analyzed, it is seen that the average score of the students in the experimental group of the research is 36.12 as the control group students' is 34.06. The statistical significance of the difference between the mean scores of the groups was calculated with the independent t test. In the pretest application of the achievement test of both groups, the difference between the scores of the groups were seemed not to be statistically significant (p> 0.05).

Table 3. Results of pretest mean scores of the groups with independent t test

Groups	*N*	*Mean*	*S.D.*	*t*	*p*
Experimental	31	36.12	15.36	,587	0.559
Control	32	34.06	12.47		

After the application, the academic achievement test was re-applied as a post-test to the control and experimental groups. Analysis results related to the post-test results of the groups are given in Table4. When Table4 is analyzed, it is seen that the average score of the students in the experimental group of the research is 77.41 as the control group students' is 64.21. The statistical significance of the difference between the mean scores of the control and experimental groups was calculated with the independent t test. In the posttest application of the achievement test of both experimental and control groups, the difference between the scores of the groups were seemed to be statistically significant and in favor of the experimental group (p< 0.05).

Table 4. Results of posttest mean scores of the groups with independent t test

Groups	*N*	*Mean*	*S.D.*	*t*	*p*
Experimental	31	77.41	21.71	2,131	0.037
Control	32	64.21	27.06		

Qualitative findings

After analyzing the qualitative data through content analysis, two main themes were determined. These themes are: the effect of augmented reality teaching material on the cognitive domain and the effect of augmented reality teaching material on the affective domain. These two main themes are categorized as:

1- Cognitive domain, and 2-Affective domain. Other sub-themes identified are presented in paragraphs within these main themes.

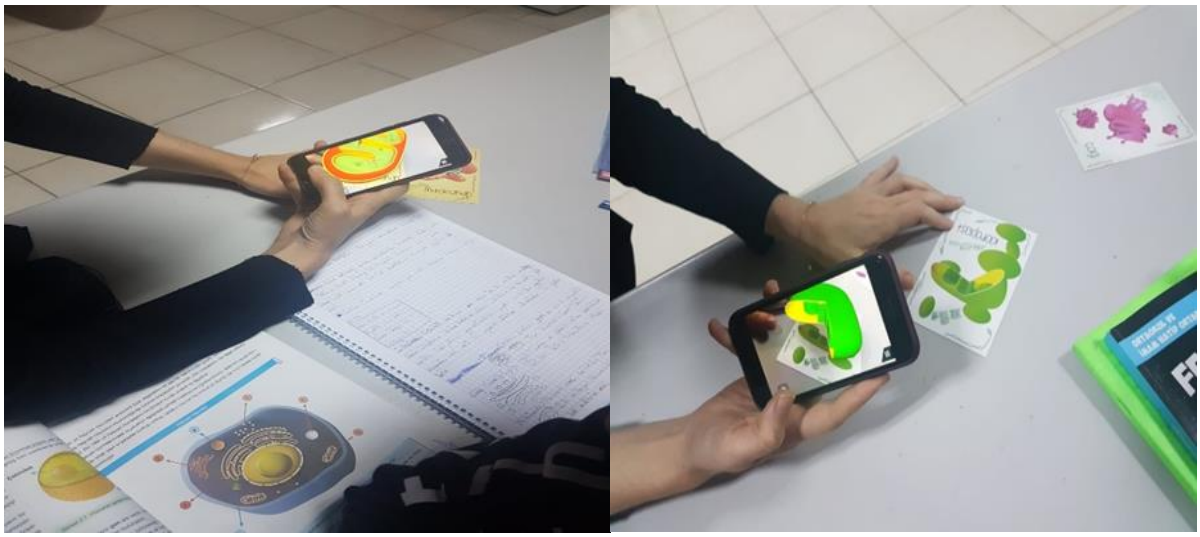


Figure 2. Examples of AR applications where two dimensional images appear in three dimensions

Cognitive Domain

The Cognitive Domain theme contains findings that support the quantitative findings of the research. Findings of quantitative dimension show that AR application positively affects students' learning on the cognitive domain. The qualitative findings collected in the research also support this result. The data collected in this section demonstrates AR application; 1-objectifies abstract subjects, 2-provides meaningful learning.

Abstract-Concrete

Students included in the AR application had the opportunity to view the cell and its organelles that they had previously seen from the books in the two dimensional form in a three dimensional form using their cell phones. According to the development stages of Piaget, it is more convenient for the 7th grade students, who are at the border of the concrete and abstract processes, to comprehend the concrete learning more easily in accordance with their development levels. Seeing the cells and their organelles in three dimensions instead of two dimensions made it possible for students to see that an abstract concept has become concrete and made it easier to learn. Figure 2 shows students observing two dimensional drawings in a three dimensional form. Student A's opinion on this matter is as follows:

> Student A: ...Seeing two dimensional pictures on the book, I had never thought about organelles positions within the cell. I thought I was supposed to learn them as they were shown in the book. But when I displayed the cards with my cellphone, I saw the organelles come to life. They could move in 3D just like they were real. Now I think I understand the organelles much better. I can still see their images as I saw them on my cell phone. They were beautiful.

The notes of Observer A on this subject also support this finding.

> Observer A:...Students looked really excited when we moved on to the AR application previous week. It completely changed the vibe during the class. Everyone checked the cell and its organelles using their cell phones. Everyone checked all the cards one by one without the teacher having to tell them to do so. In this class, the teacher asked questions that measure whether cells and organelles are learned. Almost all of the students who spoke gave correct answers. There were students trying to describe and visualize organelles in a three dimensional form (09.10.2019).

Meaningful learning

It is seen that the students' participation in the learning activity with AR provides them to learn the abstract of cells and organelles, which is an abstract subject. Students have found themselves successful in solving questions about cells and organelles not only in post-test but also in other exams. They were able to adapt what they learned to other problematic situations. Student B's opinion on this matter is as follows:

> Student B:...Seeing the three-dimensional image of organelles and examining them allowed me to do questions about organelle forms in exams easily.

> Student C: … I think I have learned the subject thoroughly. It was much better than reading from the book or just listening to the teacher talking about the subject.

Observation notes of Observer B also support these findings.

> Observer B: ... After the implementation of AR, students were very successful in solving the end of unit tests. It is understood that the activity helped students learn meaningfully. Students can solve different tests. They can solve different questions based on what they have learned (10.10.2019).

Affective Domain

Augmented reality practices have increased the motivation of the students towards the lesson and caused them to be interested in the lesson. The views of students A, B and C in this regard are given below.

Figure 3. Examples showing students' interest in AR implementation

> Student A:...I wish we used augmented reality applications in our new subjects, the lesson was very enjoyable.
>
> Student B:... It was a nice activity, I had a lot of fun and followed the lessons without getting bored.
>
> Student C: A remarkable and pleasant application that I have encountered for the first time. It helped me follow the lesson better.

Observation notes of Observers A and B also support these findings.

> Observer A: ...Students seem very lively even before the teacher came to the class. They are excitedly waiting to use their phones. They are waiting for the class to start all motivated after experiencing the previous lesson (17.10.2019).
>
> Observer B: ...Students are very happy during the course. The classroom is a bit noisy, obviously. Those who see the image on the phone are extremely happy (23.10.2019).

Discussion

In this research, it has been revealed that AR applications increase the academic achievement of students. This result of the study coincides with the conclusion that the augmented reality applications applied in the experimental group in teaching the subject of Solar System and beyond in the 7th grade science course of Kırıkkaya and Şentürk (2019) positively affect the academic success. It also coincides the results of studies conducted by Akçayır & Akçayır (2017), Buluş, Kırıkkaya & Şentürk (2019), Perez-Lopez & Contero (2013), students gain better learning outcomes about the subject in the learning environment supported by AR applications.

In the study, it is observed that AR applications contribute to students learning by objectifying abstract subjects. Perez-Lopez and Contero (2013) stated that in their research with primary school students, augmented reality practices enable more effective learning compared to traditional environments in subjects of digestion and circulatory systems. The conclusion of Perez-Lopez and Contero (2013) is similar to the conclusion of this study that AR practices contribute to the meaningful learning of abstract subjects.

Another result revealed in the research is that AR applications increase students' interest and motivation towards science classes. In recent years, virtual and augmented reality practices are seen as effective course material used in learning environments (Akçayır & Akçayır, 2017; Buluş, Kırıkkaya & Şentürk, 2019; Billinghurst, 2002; Chiang, Yang & Hwang, 2014; Korucu, Usta & Yavuzaslan, 2016; Yalçın Çelik, 2019). Researches, similar to this research result, indicate that students are more willing, happy and excited during the lesson in learning environments supported by AR applications (Avcı & Taşdemir 2019; Chiang et al., 2014; Delello, 2014; Furió et al., 2015) and actively participate in the classes (Delello, 2014; Estapa abd Nadolyn, 2015; Gopalan, Zulkifli & Bakar, 2016).

Conclusion and Recommendations

When the quantitative and qualitative data of the research are combined, it is observed that AR application positively affects students' achievement. In addition to the statistical results, qualitative findings show that education with AG contributes to students learning abstract subjects even though they are in the concrete operations period. At the same time, students were able to adapt what they learned to other situations. This shows that students can learn an abstract subject meaningfully with AR. Another conclusion that can be drawn from the qualitative findings of the research is that AR application has increased students' interest and motivation towards the classes.

Considering the results obtained from the study, the suggestions to be given for future research can be sorted as follows; Moving from the result that AR has a positive effect on students' motivation to learn science, studies can be conducted to develop learning materials prepared with AR technology for science education. It is a good idea to encourage teachers for using such methods in order to make the AR technology more commonly-used. In-service trainings can be organized for teachers to prepare and use these applications. The results to be obtained by repeating this research conducted with secondary school students at different educational levels can be compared. Studies can be done on the effective planning of the integration of AG technology into the training process.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

References

Abdüsselam, M. S. & Karal, H. (2012). The effect of mixed reality environments on the students' academic achievement in physics education: 11th grade magnetısm topic example. *Journal of Research in Education and Teaching*, *1* (4*)*, 170-181.

Akçayır, M. & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20*, 1-11.

Aslan, R. (2017). International competitive new possibilities: Virtual reality, increased reality and hologram. *Journal Detail, 5*(49*)*, 21-26.

Arvanitis, T. N., Petrou, A., Knight, J. F., Savas, S., Sotiriou, S., Gargalakos, M. and Gialouri, E. (2007). Human factors and qualitative pedagogical evaluation of a mobile augmented reality system for science education used by learners with physical disabilities. *Personal and Ubiquitous Computing*, *13*(3), 243-250

Avcı, A.F., Taşdemir. Ş. (2019). Periodic table teaching with augmented and virtual reality. *Journal of Selcuk-Technic. Volume 18*, Number:2

Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators & Virtual Environments, 6* (4), 355-385.

Azuma, R. T. (1999). The challenge of making augmented reality work outdoors. *Mixed reality: Merging real and virtual worlds, 1*, 379-390.

Billinghurst, M. (2002). Augmented reality in education. *New Horizons for Learning, 12(5*), 1-5.

Buluş Kırıkkaya, E., & Şentürk, M. (2018). The impact of using augmented reality technology in the solar system and beyond unit on the academic achievement of the students. *Kastamonu Education Journal, 26* (1), 181-189.

Chiang, T.-H.-C., Yang, S.-J.-H., & Hwang, G.-J. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. *Educational Technology & Society, 17* (4), 352–365.

Chen, C. & Wang, C.-H. (2015). Employing augmented-reality-embedded instruction to disperse the imparities of individual differences in earth science learning. *Journal of Science Education and Technology, 24*(6), 835–847.

Çetinkaya, H. H. & Akçay, M. (2013). Augmented reality applications in educational environments. *Academic Informatics Conference, 23-25 Ocak 2013*, Antalya: Akdeniz Üniversitesi.

Cresswell, J.W & Plano Clark, V.L. (2014). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications, Inc.

Delello, J. A. (2014). Insights from pre-service teachers using science-based augmented reality. *Journal of Computers in Education, 1*(4), 295–311.

Di Serio, Á., Ibáñez, M. B., & Kloos, C. D. (2012). Impact of an augmented reality system on students' motivation for a visual art course. *Computers & Education, 68*, 586–596.

Estapa, A., & Nadolny, L. (2015). The effect of an augmented reality enhanced mathematics lesson on student achievement and motivation. *Journal of STEM Education: Innovations and Research, 16*(3), 40-48.

Farias, L., Dantas, R., & Burlamaqui, A. (2011, September). Educ-AR: A tool for assist the creation of augmented reality content for education. *In Virtual Environments Human-Computer Interfaces and Measurement Systems (VECIMS), 2011 IEEE International Conference* on (pp. 1-5). IEEE.

Furió, D., Juan, M.-C., Segui, I. & Vivó, R. (2015). Mobile learning vs. traditional classroom lessons: A comparative study. *Journal of Computer Assisted Learning, 31*(3), 189–201.

Gopalan, V., Zulkifli, A. N., & Bakar, J. A. A. (2016). *A study of students' motivation using the augmented reality science textbook*. In F. A. A. Nifa, M. N. M. Nawi, & A. Hussain (Eds.), Proceedings of AIP Conference,1761(1), AIP Publishing.

İbili, E. & Şahin, S. (2013). Software design and development of an interactive 3D geometry book using augmented reality:ARGE3D. *Afyon Kocatepe University Journal of Science and Engineering, 1*-8.

Karasar, N. (2016). *Scientific research method: Concepts principles techniques*. Ankara: Nobel Academic Publishing

Korucu, A.T., Usta, E. & Yavuzaslan, İ.F. (2016). Using augmented reality in education: A content analysis of the studies in 2007-2016 period. *Journal of Subject Teaching Research, 2*(2), 84-95.

Patirupanusara, P. (2012). Marker-based augmented reality magic book for anatomical education. *International Conference on Computer and Communication Technologies (ICCCT'2012),* (s. 136-138). Phuket

Perez-Lopez, D. & Contero, M. (2013). Delivering educational multimedia contents through an augmented reality application: A case study on its impact on knowledge acquisition and retention. *Turkish Online Journal of Educational Technology - TOJET, 12*(4), 19–28.

Sırakaya, M., & Alsancak Sırakaya, M. (2018). The effect of augmented reality use in science education on attitude and motivation. *Kastamonu Education Journal, 26*(3), 887-896.

Singhal, S., Bagga, S., Goyal, P. & Saxena, V. (2012). Augmented chemistry: Interactive education system. *International Journal of Computer Applications, 49*(15), 1-5.

Uluyol, Ç, & Eryilmaz, S. (2014). Examining pre-service teachers' opinions regarding to augmented reality learning. GEFAD *Gazi University Journal of Gazi Education Faculty, 34*(3).

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y. & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers ve Education, 62*, 41–49.

Yalçın Çelik, A. (2019). Preservice biology and chemistry teachers' experience of augmented reality materials. *Karaelmas Journal of Educational Sciences 7* (2019) 123-132

Yıldız, Ş. & Beşoluk, Ş. (2019). The investigation of the effect of problem based teaching approach on students' problem solving skills and academic achievements in science course, *Journal of Individual Differences İn Education, 1*(1), 50-68.

Yıldırım, A. & Şimşek, H. (2013). *In social sciences qualitative research methods (9. printing).* Ankara: Seçkin Publishing.

Wu, H.K., Lee, S. W. Y., Chang, H. Y. & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education, *Computers and Education, 62*, 41-49.

Author Information

Fatih Serdar Yildirim
Akdeniz University Faculty of Education, Science
Education Department, Antalya,Turkey
Contact e-mail: fsyildirim@akdeniz.edu.tr
ORCID iD:0000 0003 4080 8488

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.749847

Pre-service Science Teachers' Views towards Socio-scientific Issues and Socio-scientific Issue-based Instruction

Okan Sibic, Mustafa Sami Topcu

Article Info

Article History

Received:
28 January 2020

Accepted:
02 August 2020

Keywords

Socio-scientific issues
Socio-scientific issue-based instruction
Pre-service science teachers

Abstract

Today, many countries have revised their science curricula to ensure an effective science-learning environment and Turkey is one of such countries. Thanks to the revisions within this scope, socio-scientific issues were integrated into the curriculum. Their presence has brought about the requirement of knowing what socio-scientific issues are and how to integrate them into lessons. The aim of this study is to explore pre-service science teachers' views towards socio-scientific issues and socio-scientific issue-based instruction in Turkey. To this end, it utilized qualitative research method. The qualitative data were collected from thirty pre-service science teachers through semi-structured interviews and they were analyzed through content analysis technique. The study revealed that while some participants were aware of socio-scientific issues, some were not. In addition, some did not know those issues existing in science education curricula, and how to deal with them during lessons. Besides, participants did not have sufficient self-efficacy beliefs towards dealing with socio-scientific issues in real classroom settings. These results suggest that socio-scientific issues should be integrated into science education programs of universities and more teaching opportunities should be provided for pre-service teachers to practice SSI-based instruction.

Introduction

Socio-scientific issues (SSIs) are ill-structured issues with open-ended, complicated, and argumentative features which have scientific and social dimensions at the same time (Ratcliffe & Grace, 2003; Sadler, 2004; Sadler & Zeidler, 2005; Sadler, Barab & Scott, 2007; Topçu, Sadler & Yılmaz-Tüzün, 2010; Gardner & Jones, 2011; Klosterman, Sadler & Brown, 2012). As Eastwood et al. (2012) point out, there are some main criteria to introduce a topic as an SSI, which are: First, the issue must be related to science and second, it should have significant effect on the society. Nuclear energy, global warming, genetically modified foods (GMOs), take home foods, and embryonic stem cell can be given as examples of SSIs (Lee, Abd-el-Khalick & Choi, 2006; Levinson, 2006; Morris, 2014; Topçu, 2017). It is possible to notice that different parts of the society can handle and interpret SSIs differently by considering them from different perspectives. Ratcliffe and Grace (2003) summarize the nature and the features of SSIs as follows: SSIs have multidimensional structure with moral and ethical dimensions and risk and benefit analysis, additionally, those issues are up-to-date issues and found in the media frequently.

After SSIs were developed as a follow-up of science-technology-society (STS) approach (Topçu, 2017), a variety of studies were conducted by science educators to examine their effect and find out how to integrate them into science education. One of the most important findings was that SSI can come in useful in bringing up scientifically literate people (Kolstø 2001; Sadler & Zeidler, 2005; Zeidler & Nichols, 2009). In addition, SSIs can increase students' science content knowledge (Dawson & Venville, 2013), motivation and interest towards science and science learning (Parchmann, Gräsel, Baer, Nentwig, Demuth & Ralle, 2006; Albe, 2008). Moreover, the literature suggests that incorporating SSIs into science lessons might affect students' argumentation abilities (Dawson & Venville, 2013; Zohar & Nemet, 2002), communication abilities (Chung, Yoo, Kim, Lee, and Zeidler, 2016), and nature of science comprehension and decision making skills (Eastwood et al., 2012; Walker & Zeidler, 2007) positively.

By virtue of such significant contributions of SSIs, their inclusion into science education curriculum in Turkey occurred in 2013 under the scope of the subject called science-technology-society. With the recent revisions on national science education curriculum undertaken in 2018, SSIs retain their place in the curriculum. Therefore, for science teachers or pre-service science teachers (PSTs), i.e. teachers of the future, being knowledgeable in

SSIs and integrating them into science lessons have become crucial. Thus, the present study reports the views of PSTs towards SSIs and SSI-based instruction in depth.

Literature Review

After detailed literature review, we found out that pre-service teachers', teachers' and students' views towards SSIs are examined in some studies. In the following, we reported the studies in which pre-service teachers' views towards SSIs are evaluated.

Lee et al. (2006) conducted a study with secondary school science teachers in order to get their views towards SSIs, how to integrate them into lessons and their place in the curricula. They reported that teachers regard SSIs as dangerous and destructive topics and a natural consequence of nature of science (NOS). Despite positive feelings towards SSIs in lessons, teachers emphasized the need for more time and class materials for SSI integration. One of the most important findings of the study was that teachers have low self-efficacy beliefs towards bringing SSIs into lessons. Kara (2012) also found that pre-service biology teachers (PBTs) perceived SSIs as negative issues resulted from humankind. In a similar vein with Lee et al.'s (2006) results, Kara also found that PBTs have positive opinions about the integration of SSIs into lessons despite the presence and need for more time, classroom management skills, materials and in-depth knowledge about the presented issues. The participants of Alaçam-Akşit's (2011) study pointed out that more pedagogical knowledge is required for successful inclusion of SSIs into lessons as emphasized in the studies of Lee et al. (2006) and Kara (2012). Yapıcıoğlu (2016) examined PSTs' views towards SSIs. She found that participants consider organ donation, GMOs, environmental topics, founding base stations, and cloning as SSIs. In addition, the participants discussed how to teach SSIs effectively and emphasized that it is possible through using argumentation, problem-based learning methods.

Özden (2015) conducted a study with pre-service elementary school teachers and found that the participants perceive SSIs as open-ended, current and mediatic topics which have risk and probability analysis, moral and ethical dimension and affect individuals. The participants of the study emphasized that bringing SSIs into lessons can increase students' higher-order thinking skills and they emphasized that teachers should act as a guide while integrating SSIs into lessons. One of the important findings of this study was that when the students are mature enough, their interest in SSIs increases. Alaçam-Akşit (2011) also found that their participants (pre-service elementary school teachers) emphasized that SSIs are mediatic issues that are sources of social and science lessons. They also were willing to learn more about SSIs.

Espeja and Lagaron (2015) are other researchers who collaborated with pre-service teachers and found that after the participants are taught through SSIs and SSI teaching, their understanding and ability in SSIs and SSI teaching increase. Muğaloğlu, Küçük, and Güven (2016) also found that if teacher candidates are trained about the integration of SSIs into classrooms, their understandings of SSIs and SSI-teaching and their self-efficacy beliefs towards bringing such issues into lessons increase.

The Framework of the Study

In accordance with the purpose of the present study, we specified the study by Presley et al. (2013) as the frame by considering the definition and explanation of Ratcliffe and Grace (2003) about SSIs. As stated earlier, Ratcliffe and Grace (2003) defined SSIs as issues which have some important features such as having multidimensional structure, having risk and cost analysis; being up-to-date, and easy to encounter in daily lives. Accordingly, Presley et al. (2013) developed an instructional strategy to incorporate SSIs into classroom settings. They emphasized that in order to deal with SSIs in the classroom successfully, three core aspects – '*design elements*, *learner experience* and *teacher attributes*', which are surrounded by '*classroom environment* and *several peripheral influences such as curricula*' must be considered by teachers:

(1) *Design elements:* The lesson must be built around a tough topic and a compelling question. The topic should not be complicated, and the questions should not be very difficult for students to brainstorm and discuss on the issues presented. Besides, the lesson should permit students to engage in higher order thinking skills and require using technology and media.
(2) *Learner experience:* Students should engage in higher order thinking skills and participate in discussions. They should consider all the claims and arguments produced by other students about the issues and create their own claims. Students should consider different stakeholders' position towards the issues while

producing arguments and claims and conceive of different dimensions such as morality, politics and economy.

(3) *Teacher Attributes:* Teachers should know the different dimensions of the issues and associate the issue with those dimensions. They should be open to all ideas produced by students and behave as a learner. Additionally, teachers should not act as the only authority in the classroom, rather should be a guide during lessons.

(4) *Classroom Environment* and *Peripheral Influences:* There should be an interactive classroom environment in which students easily express their ideas and respect others', work collaboratively during lesson, and use several interactive materials such as the internet. In addition to the impact of classroom environment, different peripheral influences have significant effects on SSI-based instruction. For instance, science curriculum should be flexible to include SSIs and different stakeholders should participate during lessons. Lastly, school administrations should provide the required permissions for SSI teaching.

Study Rationale

As we stated earlier, there are some studies in which the views of teacher candidates, students, and teachers from different majors such as biology, science, and elementary school teaching etc. towards SSIs were examined from various perspectives. Alaçam-Akşit (2011), Kara (2012), Lee et al. (2006), Özden (2015), Yapıcoğlu (2016), and Sadler et al. (2006) can be given as examples of such studies. Due to the crucial importance of SSIs for teaching and learning, their integration in classrooms has become one of the most attractive topics in science education. We discovered that general opinions of the participants towards SSIs were examined in the literature, but their views towards how to use and integrate SSIs in science classrooms were not directly examined. In other words, there were no studies in which PSTs' views towards SSI-based instruction were examined. Additionally, we did not find any study in which PSTs' awareness towards the place of SSIs in national science education curricula and their self-efficacy beliefs for SSI-based instruction were examined. This study examines the views of PSTs, as teachers of the future, towards SSIs, SSI-based instruction and their self-efficacy beliefs for integrating SSIs in science lessons. Therefore, the present study will contribute to the literature in these aspects. After acquiring knowledge about those aspects in consequence of the study, it might be decided whether a revision is needed in science education programs of universities towards integrating new courses in which SSIs and SSI-based instruction are lectured in detail, and also the need of in-service trainings about SSIs can be discussed.

Research Questions

Based on the rationale and the aim of the study, this study is shaped by the following two research questions:

(1) What are the views of pre-service service science teachers towards socio-scientific issues?

(2) What are the views of pre-service science teachers towards socio-scientific issue-based instruction?

Method

Research Design

In the present study, we aim to reveal the views of PSTs towards SSIs and SSI-based instruction in depth. We desire to reveal the views from different perspectives by considering all the aspects of SSIs and SSI-based instruction. By using qualitative research method, one can deeply examines the questions of their research (Merriam, 1998) and accordingly, to deeply examine the views of PSTs towards SSIs and SSI-based instruction, we used qualitative research method in the study. Additionally, we decided that the qualitative research method is consistent with the nature and the philosophical stance of the presented research.

Participants

The data were collected during Spring Semester in 2018. Thirty PSTs studying at science education department participated in the study. The participants were selected from two state universities (fifteen PSTs from each) located in Istanbul, Turkey. In the study, we collaborated only with those who volunteered to participate in the study. While eight of the participants were male, twenty-two of them were female. On the other hand, while sixteen participants of the study were 3rd grade students, the others (fourteen participants) were 4th graders. The

PSTs' age ranged between 21 and 23; except for one who was 27 when the study was conducted. The participants' GPA were between 2.5-3.7 and therefore we could state that the participants were from between middle and high achiever groups. While the 4th grader in the study finished 'School Experience' course and took 'Practice in Teaching Science' course in which they had experienced real classroom settings; the 3rd grade participants did not experience real classroom settings but were aware of different science teaching strategies. During 'School Experience' course, it is highly possible that PSTs might encounter with one of the SSIs in real classroom settings and might observe how teachers deal with those issues. Therefore, in the 'Results' section we also emphasize participants' teaching experience.

Data Collection

In the present study, we used interview method to get the views of PSTs towards SSIs and SSI-based instruction. A semi-structured interview was conducted with the all participants and each lasted on average 30 minutes (ranging from 25 and 45 minutes). The use of an interview helped the participants of the study to easily express their views and ideas in their own words, provided them opportunities to garner new ways to see and understand the topic at hand, and helped researchers to ensure the collection of valid, reliable and comparable qualitative data (Cohen & Crabtree, 2016). All the interviews were conducted either in the first or the second researcher's office in which participants expressed positive attitudes stating that they were feeling comfortable. All the participants were also informed about the confidentiality of the interviews. After all semi-structured interviews were conducted, the researchers transcribed the audio-recordings verbatim in order to analyze the data in detail.

Instrument

As the data collection instrument, we used an interview tool consisting of semi-structured questions. To create the instrument, first, we made detailed literature review and created seventeen semi-structured questions. Next, we conducted interviews with 3rd grade PSTs, who were not included in the main sample of the study, to check whether the questions were consisted with our aims. Additionally, three experts, two of them were experts in science education and qualitative research and one of them was an expert in science education with different quantitative studies, examined the interview questions independently from the perspectives of validity and applicability. Considering the reviewers' feedback and conducted interviews, we made some major revisions on the instrument. First, we divided the instrument into two parts. In the first part, we aimed to reveal PSTs' views towards SSIs and, in the second part; we aimed to reveal PSTs' views towards SSI-based instruction. Second, we reduced the number of the questions. The final version of the instrument consists eleven questions: In the first part, there are six questions which reveal PSTs' views and understanding towards SSIs, the place of SSIs in national science education curricula, and their examples of SSIs and in the second part, there are five questions which reveal PSTs' views and understanding towards SSI-based instruction and their self-efficacy beliefs towards bringing SSIs into lessons. Sample questions of the instrument and related research questions of those questions can be seen in Table 1. As a result of the revisions, we built consensus between researchers and experts for the final version of the instrument.

Table 1. Sample interview questions

Research Question	Sample Interview Question
What are the views of pre-service service science teachers towards socio-scientific issues?	How can you define SSIs in science education context? Could you give any examples to SSIs? -
What are the views of pre-service service science teachers towards socio-scientific issues?	What kind of teaching strategies would you prefer if you were dealing with SSI-based instruction?

Data Analysis

All the interviews were transcribed verbatim by the researchers to analyze the data by following content analysis technique. In the present study, we followed Harris's content analysis technique (Harris, 2001). In this technique, researchers pursue the following steps: (1) Determining the research questions of the study, (2) Determining the text(s) which is examined, (3) Deciding 'unit of analysis', (4) Detecting 'the categories', (5) Making coding, and, (6) Evaluating reliability and validity. In accordance with these, we, first, transcribed all

the data verbatim. Second, we determined 'sentences' as our 'unit of analysis'. Then, we examined the data and created categories (e.g. 'biotechnology' and 'teacher-centered'). Afterwards, we started 'coding' (e.g. 'argumentation' and 'GMO') and presented the findings in terms of their frequencies. We also presented some excerpts from the interviews to emphasize important points. We followed the same above-mentioned steps for each research question. The calculated inter-coder reliability was 80%, which means the data were valid and reliable.

Results

PSTs' Views towards SSI

In the present study, we, first, examined the views of PSTs towards SSIs. In accordance with this aim, we revealed their awareness towards SSIs and the place of SSIs in the national science education curricula of Turkey, their understanding towards the nature of SSIs, and the topics/issues which they considered as SSIs. First, we found that more than half of the participants (n=19) were aware of SSIs before the present study. Whereas a few participants had encountered SSIs through their own effort by researching (n=4), other participants emphasized that they had encountered SSIs during such courses as 'Special Issues in Biology', 'Special Issues in Chemistry' and an elective course which was designed for teaching SSIs. For instance, while STD8 pointed out that he enrolled in a course which was related to SSIs, STD13 mentioned that he came across SSIs in 'Special issues in Biology' course.

> Interviewer: Have you ever encountered SSIs before?
> STD8: Yes, I have. I have encountered during a lesson.
> Interviewer: What was the lesson about, could you please explain?
> STD8: It was done as an adaption of an SSI to science program in its (the lesson) content, I mean we had a lesson whose aim was to show how to adapt SSI that we encounter in our daily lives to science education…
> Interviewer: Have you ever encountered SSIs before?
> STD13: Socio-scientific issues… we had a lesson, 'Special Issues in Biology', I encountered there, not in the previous week but two weeks ago […]

Next, we examined the awareness of the participants who had encountered SSIs (n=19) towards the place of such issues in the national science education curricula (published in 2005 and 2013). We discovered that all participants were aware of the both curricula since they had examined the curricula in their regular lessons and the participants pointed out the presence of SSIs in the 2013 curriculum and the absence of them in the 2005 one.

Table 2. Features and characteristics of SSIs

Category	Code (f)
Multidimensional structure	Social and scientific (16)
	Scientific (13)
	Social (8)
	Multidimensional (4)
	Ethical and moral (3)
General Features	Interesting and riveting (11)
	Argumentative (7)
	Real life (5)
	Reliable (4)
Specific Features	Ill-structured (with not solution) (7)
	Up to date (5)
	Risk and benefit analysis (2)
Other	Science branches related with structure of society (1)

In the following excerpts, STD1 emphasized the presence of SSIs in the 2013 curriculum by providing some details and additionally, STD17 emphasized the absence of SSIs in the 2005 curriculum.

> Interviewer: Have you examined the Science Education curriculum published in 2013 by the Ministry of National Education?
> STD1: Yes. We've examined it in the lesson.
> Interviewer: Have socio-scientific issues been included into this curriculum?

STD1: Yes, socio-scientific issues have been examined under a separate heading there (2013 curriculum). Objectives have been regulated based on that. Additionally, the abilities used for constructing arguments have been gained with the opportunities presented with socio-scientific issues. I remember this way.
Interviewer: Have you examined the Science and Technology curriculum published in 2005 by the Ministry of National Education?
STD17: A little. Socio-scientific issues have not been given under a separate heading. There are perception and motivation kinds of things but it did not separate socio-scientific issues. The word "socio-scientific issues" was not used.

After revealing the awareness of participants towards SSI, we examined their understanding of SSIs and the issues they consider as SSIs. In Table 2, we present general perspectives about understanding of SSI. As presented in Table 2, the participants mostly emphasized the social and scientific dimension of SSIs whereas other dimensions were emphasized less frequently. For instance, only few participants emphasized ethical and moral dimension of SSIs. In the following excerpts, STD2 and STD10 pointed ethical and moral dimension of SSIs.

STD2: Socio-scientific issues are issues which have both scientific content and social content. They are argumentative, do not have exact solutions, then, our teacher emphasized the need for the presence of ethical and moral elements. So, that's it.
STD10: Socio-scientific issues, as the name suggests, are social, scientific, quotidian, interesting, argumentative, and argumentative in ethical and moral dimensions.

In the study, participants specified wide range of examples of SSIs. According to their responses, we constituted six different categories and represented each category in Table 3 with examples and frequencies.

Table 3. Examples of SSIs

Category	Code (f)
Environment	Global Warming (7)
	Environmental Pollution (7)
	Acid Rain (3)
	Zoo (3)
	Greenhouse Effect (1)
	Migration (1)
Biotechnology	Genetically Modified Organisms (11)
	Cloning (2)
	Experimental Animals (2)
	Organ Donation (1)
	Stem Cells (1)
	Genetics (1)
Technology	Base Station (3)
	Electricity (3)
	Technology (1)
	Technological Weapons (1)
	Cyber Attacks (1)
Energy	Nuclear Power Plant (5)
	Nuclear Energy (2)
	Energy (2)
	Nuclear Weapons (1)
	Energy Plants (1)
Health	Health (3)
	Nutrition (3)
	Antibiotic usage (3)
	Vaccination (2)
	Puberty (1)
	Cancer (1)
	Consanguineous marriage (1)
	Smoking (1)
Other	Anatomy (1)
	Light (1)
	Viruses (1)

The examples were generally related to up-date-date issues such as global warming, nuclear issues and GMOs. Our findings showed that participants mostly stated GMOs and global warming as SSIs. Some of the participants pointed out general areas such as technology and health as SSIs instead of giving specific examples.

> STD18: For example, GMO is a socio-scientific issue […] or for example, nuclear power plants, energy types, I mean those kinds of topics can be included. […]
> STD8: […] we can talk about zoo from this point such as taking animals from their natural environments and placing them into artificial environments. Besides, it might be the benefits of GMOs or normal foods that we use in our daily lives.
> Interviewer: Could you tell me why those examples are SSIs?
> STD8: Those examples are not actually the topics which need to be explained in lessons, but we encounter them in our daily lives, and we might encounter some of them in our lessons. So, since we might encounter them in the lessons.

Some of the participants also pointed anatomy, health, light and viruses which we did not categorize them as SSIs.

PSTs' Views towards SSI-based Instruction

In the present study, we examined the views of PSTs about how to deal with SSIs when confronted with them in science classes and how they design the lessons to integrate SSIs successfully. Additionally, we examined PSTs' views towards the role of different stakeholders such as teachers, students, school administration and more for SSI-based instruction. Lastly, we aimed to examine the self-efficacy beliefs of PSTs for the integration of SSIs into their lessons and the reasons behind their beliefs. In the following, we present our findings in detail. First of all, we asked our participants about how to design a lesson which is related to SSIs. The findings are presented in Table 4.

Table 4. Proposed Instructional Approaches for SSI-based Instruction

Instructional approaches for SSI-based instruction	f
Catching attention about the SSI provided – arousing curiosity by presenting video, news etc. – discussing the SSI – doing related activities	9
Informing students about the SSI provided – discussing on the SSI – showing and sharing different sources	6
Grouping students – distributing essays related to the SSI assigned to groups – discussions on essays between groups – discussion in class about the SSI	1
Real setting observation – discussions	1

Table 4 illustrates that, except two participants, all the participants pointed similar approach for SSI-based instruction and most of them concentrated on two different approaches. In the first approach, the participants expressed that they firstly caught students' attention by presenting different materials related to the issue. Then, they continued the lesson by making discussions and activities related to the lesson and the SSI presented. For instance, STD12 pointed this approach.

> STD12: I think, it is started with socio-scientific issues, I mean because of the fact that they are already issues from everyday life, by starting with them students' attention should be caught and this should be explained this way […]
> Interviewer: How do you continue the lesson?
> STD12: Some videos could be watched related to the lessons. Besides, news examples could be shown, they are already usually exposed to them.

In the second approach, participants expressed that they present all the information about an SSI and continued the lesson by discussing it. STD2 emphasized the importance of presentation of the materials related to the issue and the need of diversifying the materials.

> STD2: First of all, no matter which topic is discussed, the concepts related to it should be provided to students […] then, because of the fact that I teach students I have to have a lot of sources […]

We also examined which teaching method the participants preferred to use in their lessons while dealing with SSIs. We found that our participants mostly preferred student-centered teaching methods. 5E, argumentation

and investigation methods were mostly emphasized methods by the participants (Table 5). In the excerpts presented below, STD13 pointed out the importance of discussion and usage of cartoon map and cartoon web; and STD7 laid emphasis on the usage of 5E and 4E as instructional methods for SSI teaching in science lessons.

> STD13: There are discussion environment, brainstorming, concept map and concept webs kind of things, I mean I put a bait in the middle and try to make students active. […]
> STD7: […] I would prefer 5E, but apart from that the methods that we saw, 4E method or any method, method of Gagne… […]

Table 5. Teaching Methods for SSI-based Instruction

Category	Teaching Methods
Student-centered	4E-5E-7E Methods (7)
	Argumentation (6)
	Investigation (5)
	Brainstorming (3)
	Gagne's teaching method (2)
	Researching-questioning (1)
	Gaming (1)
	Concept maps-Concept web (1)
Teacher-centered	Presentation (5)
	Question-Answer (2)
	Precedent (2)
	Demonstration (1)
	Experts' Presentations (1)

Although most of the participants were willing to use student-centered teaching methods for SSI-based instructions, some participants still pointed out their preferences towards using teacher-centered teaching methods such as presentation and question-answer methods (Table 5).

> STD1: I wanted to say investigation method, but I do not know how to use investigation method, I mean what I want students to discover about socio-scientific issues, thus I would use presentation method more and more I mean by showing something to them.

At that point, we examined the views of PSTs towards possible factors which facilitate or impede the integration of SSIs into lessons. In Table 6, we present our results.

Table 6. Facilitating and impeding factors for SSI-based Instruction

Category	Factors
Impeding Factors	Planning/Preparing (13)
	Finding appropriate materials (12)
	Classroom Management (10)
	Classroom participation (5)
	Time-consuming (5)
	Cost (4)
Facilitating Factors	Expressing idea (8)
	Learning and comprehension of topics (7)
	Connecting issues with everyday life (7)
	Focusing (2)
	Developing argumentation skills (2)
	Being economic (1)
	Planning (1)
	Developing curiosity (1)
	Developing research skill (1)

Frequently, the participants pointed out that the process of planning, finding appropriate materials and preparation for instruction with classroom management are among the top impeding factors for SSI-based instruction.

> STD4: Once, we said that there is no exact answer of SSIs, in-class discussions should be used, and this makes classroom management difficulties definitely. […] and also, I think while preparing materials, we can confront with difficulties. […] Additionally, for example, making students active could be difficult […]
> STD28: So, for instance, the impeding factors might be that it could create chaos environment in the class. […] that discussion might turn into to quarrels. […]
> STD10: First, application process might take too much time.

The participants emphasized that with the integration of SSIs into science lessons, students can easily express their ideas and the learning might be easier. Moreover, they stated that by bringing SSIs into lessons, real life topics such as GMOs could be integrated in lessons more.

> STD6: In the end, you could make whatever comment you want, you are free after all.
> STD19: Facilitating factors… because of the fact that the topic that we explain is intriguing, I think it would be easier to explain and understand that.

In the wake of examining the views of participants towards how to deal with SSIs during their lessons in terms of instructional approach and teaching methods and also examining their views towards the possible impeding and facilitating factors for SSI-based instruction, we examined participants' views towards the role different stakeholders such as teachers, students, school administrations and more. In Table 7, we present all the findings in detail.

> First, participants emphasized different roles of teachers. Among them, the most emphasized roles of teachers were 'being a guide during lessons' and 'entering the lessons after good preparation and planning'.
> STD11: I think teachers should not directly explain the topics. They should direct students to discover. I want teachers to have guidance role more and more. I think this way. So, as a guide, that's it.

Additionally, they also emphasized that teachers should 'have good classroom management skills, be knowledgeable about issues and impartial during classroom debates' (Table 7).

Table 7. Different stakeholders' roles for SSI-based instruction

Category	Roles
Teachers	Guidance (11)
	Good planning/preparation (9)
	Being knowledgeable about issues (8)
	Having good classroom management skills (6)
	Being knowledgeable (6)
	Being impartial (4)
Students	Active participation (12)
	Expressing his/her ideas (8)
	Researching/preparing (8)
	Being willing towards lessons (5)
	Respectful towards each other (4)
Program Developers	Making revisions on the available curricula for integration of SSIs (8)
	Producing materials (4)
Researchers	Giving information about SSIs and SSI topics (8)
	Making continuous research about SSIs (2)
Parents & Society	Researching with open mindedness (4)
	Providing easiness (1)
School Administration	Providing resources and opportunities (3)
Others	Dealing with exam anxiety problems (1)

About students' roles, participants emphasized 'active participation, expression of idea frequently, making research about the topic which will be handled or already discussed, being willing towards lessons and participation and also being respectful towards each other in the class during lessons' (Table 7).

> STD10: Students should be willing active, and think about that topic.
> STD4: […] I expect students to volunteer for researching too. Active participation and making research. Of course, I create a discussion platform and I want them to generate ideas. My main aim is

> that. During generating ideas, they should continue by listening and understanding each other's idea with mutual respect. […]

In the present study, the participants also noticed that some other stakeholders such as school administration and program developers have some crucial roles for SSI-based instruction. We found that our participants generally had consensus on two important roles (see Table 7). One was producing a more flexible curriculum to which SSIs could be integrated more easily and the other was informing every part of the society about SSIs (about what they are and what kind of examples they have). Below, we shared two excerpts from the interviews about these points.

> STD15: […] I think while in the process of regulating curricula, they might leave open doors for them (SSIs). […]
> STD3: […] in their (teachers) holiday they go in-service training. During in-service trainings, they could be given information about them (SSIs). […]

In the final phase, we desired to confirm participants' self-efficacy beliefs towards SSI-based instruction. In other words, we desired to learn whether they perceived themselves enough to deal with SSIs in their future science classes and the underlying reasons for their beliefs. In Table 8, we present our findings. Among nineteen participants, only four of them stated that 'Yes, I am competent enough to deal with SSIs in my future class' while 6 of them noticed 'partially yes' and 9 of them noticed 'no'. When the responses were analyzed, it is possible to specify that there were several reasons for different self-efficacy beliefs towards SSI teaching and SSI-based instruction. The most frequent ones were 'lack of teaching experience' and 'lack of content knowledge'. Besides, teacher candidates emphasized the fact that SSIs are relatively new topics and more research need to be conducted on them affect their self-efficacy beliefs negatively.

> STD21: I am. I like to form different views; I like searching scientific magazines. […] and I could use that method.
> STD20: No, of course I am not, at the moment I can not even make normal presentation and so at that moment it is more difficult. […] You could see lack of self-confidence maybe, but when I enter the class I just know A+B=C, I just learned that. I have not educated myself about those, my training is not enough […]
> STD8: I could not say directly that I apply, I could apply SSI-based instruction in my lessons because I think that I am not still ready for that […]
> STD3: So, I think it is not possible to see completely enough; of course, we took lessons of that but this is something open-ended so I could not say I am competent enough.

Table 8. Reasons of lack of self-efficacy towards SSI-based instruction

Category	Code
Personal Characteristics	Lack of experience (5)
	Lack of content knowledge (4)
Characteristics of SSI-based Instruction	Requirement of research (6)
	Requirement of being up to date (2)

Discussion

The inclusion of SSIs into national science education curriculum was made in 2013 and with recent revisions (made in 2018), SSIs preserve their place on the curriculum (MONE, 2013; MONE, 2018). As we stated in the very beginning of the article, SSIs can contribute to students from various aspects such as increasing higher-order-thinking abilities, scientific literacy level, science content knowledge and more. When bearing these factors in mind, being aware of SSIs and understanding how to deal with them in science classes arise its importance for teachers. Thus, in the present study, we examined the views of PSTs, teachers of the future, towards SSIs and SSI-based instruction.

In this study, we found that while some of the participants had encountered SSIs through the compulsory or elective courses which they attended during their university education and some encountered them through their own efforts, there were still some other participants who did not encounter SSIs. Due to the fact that some participants were aware of SSIs through the courses that they had attended during university education, we examined the structure of corresponding courses in detail and realized that in compulsory courses e.g. 'Special Issues in Biology', instructors only indicated some issues as SSIs, but did not explain what SSIs are and how

those issues are classified as SSIs in detail. In the elective course, participants noticed that the focus of the lesson was on teaching what SSIs are and how SSI-based instruction can be carried out. They also emphasized that they are composed of different activities related to the SSIs within that course. Nonetheless, whether they encountered SSIs through courses, compulsory or elective, or through their own efforts, we found that the participants did not define SSIs and specify their features effectively. The most emphasized feature of SSIs was having both social and scientific dimension. Kara (2012) and Lee et al. (2006), in their studies, obtained the same results. Although in those studies, the participants strongly emphasized the multidimensionality of SSIs, especially the moral and ethical dimension; in our study, only a few participants emphasized the multidimensional structure of the SSIs. In her study, Özden (2015) found that the participants emphasized SSIs as ill-structured and open-ended issues. The present study's participants also stated those points as the features of SSIs.

In the present study, PSTs noticed environmental issues, for instance global warming, greenhouse effect etc., as SSIs. On the other hand, the most frequent proffered example was GMOs. Yapıcıoğlu (2015), in her study, also found the same results. In her study, environmental issues, GMOs, organ and blood donation etc. were given as examples to SSIs. In the present study, on the other hand, no participants specified organ and blood donation as examples of SSIs. In a study, Kolstø (2001) stated that SSIs are the issues which we encounter through our daily life activities. In line with that, we noticed, the participants mostly provided examples of SSIs among which they encountered through media (such as TV and social media) and through their lessons.

In the present study, next, we examined participants' ideas towards SSI-based instruction; how to design the instruction, what kind of teaching approaches can be used during such instructions and what different stakeholders' roles can be within SSI-based instruction. First, we found that PSTs were generally willing to use student-centered teaching methods such as 5E teaching method, argumentation and etc. for SSI-based instruction rather than to use teacher-centered teaching methods. Alaçam-Akşit (2011) found that prospective elementary teachers stated that SSI-based instruction could be more effective if student-centered teaching methods were used in the classrooms. Yapıcıoğlu (2016) also explored that participants of her study were willing to use student-centered teaching methods. On the other hand, in this study, some participants were willing to use teacher-centered teaching methods such as presentation and question and answers methods.

Friedrichsen et al. (2016), in their study, developed an instructional model for SSI-based instruction. Their model was based on 5E teaching method combined with argumentation. We realized that some of the participants stated a similar instructional model for SSI-based instruction with that instructional model. In the present study, we also examined the views of PSTs towards the easiness and difficulties of applying SSI-based instruction. Lee et al. (2006) and Kara (2012) stated time problems for planning and preparation, presence of less educational materials, and requirement of advance classroom management skills as some difficulties for SSI-based instruction. Similarly, the present study's participants pointed out planning and preparation, requirement of good classroom management skills and requirement of great amount of time for planning and preparation for lessons as the most significant difficulties of SSI-based instruction. On the other hand, as an advantage of SSI-based instruction, participants mostly emphasized that in class interaction could be more easily developed and the handled issues could be easily associated with real life.

Heretofore, we discussed the idea of PSTs towards successful integration of SSI in science lessons and possible impeding and facilitating factors of SSI-based instruction. At that point, we discuss what PSTs think about the roles of different stakeholders such as teachers, students, school administrations and etc. to conduct SSI-based instruction. As the role of teachers, our participants strongly emphasized that teachers should act as a guide during lessons and be knowledgeable about SSIs from both content and pedagogical perspectives. Özden (2015), in his study, obtained the same results and in the study of Presley et al. (2013), the importance of acting as a guide during lessons was shown as one of the most significant roles of teachers. Additionally, having adequate pedagogical knowledge and science content knowledge to teach SSIs were also emphasized as important teachers' roles which they should have for satisfactory SSI-based instruction (Alaçam-Akşit, 2011; Presley et al., 2013; Özden, 2015). As students' roles, PSTs emphasized that students should be active during lessons and be willing to participate actively in discussions, activities etc. Similarly, Kara (2012) found that students should be willing to learn the presented issues and participate actively in lessons. The present study also examined the views of PSTs towards different stakeholders' roles for SSI-based instruction. As we stated earlier in this article, Presley et al. (2013) emphasized that for SSI-based instruction, in addition to teachers and students, some other stakeholders such as school administration and program developers have some roles such as developing appropriate curriculum to integrate SSIs, providing materials and so on. In the present study, some of the participants also emphasized revising science curriculum and creating a more flexible program in

order to integrate SSI to science lessons and providing materials for successful lessons as the roles of stakeholders.

It came into prominence that the participants generally did not have sufficient self-efficacy beliefs. In their studies, Muğaoğlu et al. (2016), Sönmez and Kılınç (2012), Alaçam-Akşit (2011) and Lee et al. (2006) also pointed out that the participants did not have sufficient self-efficacy beliefs. The present study found that lack of experience, teaching practice in real settings, and content knowledge were top reasons for such findings. Similarly, Alaçam-Akşit (2011) found that lack of content knowledge and pedagogical knowledge about appropriate teaching method were reasons for less self-efficacy beliefs while Lee et al. (2006) found lack pedagogical expertise and content knowledge the reasons of less self-efficacy beliefs.

To conclude, we found that although some participants were aware of SSIs and through an elective course that they had a chance to practice teaching through those issues while others did not have such opportunities, most of the participants did not have adequate knowledge about SSIs and SSI-based instruction and did not have enough self-efficacy beliefs towards their skills to integrate SSIs into real classroom settings. Therefore, we suggest that during university education, courses in which PSTs can learn more about SSIs and have more teaching opportunities in microteachings and real teaching practices should be added by revising the science education programs of universities. As Muğaloğlu et al. (2016) stated that by providing PSTs opportunities towards integrating SSIs in different teaching settings, they might develop positive self-efficacy beliefs towards integrating SSIs into their future classes. Additionally, for science and elementary education teachers, in-service training opportunities for teaching SSIs should be provided. In future research, with the same participants, new interviews might be conducted to get their ideas towards SSIs after gaining more teaching experiences. In addition, self-efficacy beliefs of PSTs and science teachers towards SSIs and SSI-based instruction might be examined in detail and the reasons of low self-efficacy might be investigated.

Disclosure Statement

No potential conflict of interest was reported by the author.

References

Alaçam Akşit, A. C. (2011). *The views of primary education pre-service teachers on socioscientific issues and their perspectives on the teaching of these issues*. Master thesis, Dokuz Eylül University.

Albe, V. (2008). When scientific knowledge, daily life experience, epistemological and social considerations intersect: Students' argumentation in group discussions on a socio-scientific issue. *Research in Science Education, 38*(1), 67-90. Doi: 10.1007/s11165-007-9040-2.

Chung, Y., J. Yoo, S. W. Kim, H. Lee, and D. L. Zeidler. (2016). Enhancing students' communication skills in the science classroom through socioscientific issues. *International Journal of Science and Mathematics Education, 14*(1),1-27.

Dawson, V. & G. Venville. (2013). Introducing high school biology students to argumentation about socioscientific issues. *Canadian Journal of Science, Mathematics and Technology Education,13*(4), 356-372. doi: 10.1080/14926156.2013.845322.

Eastwood, J. L., T. D. Sadler, D. L. Zeidler, A. Lewis, L. Amiri & S. Applebaum. (2012). Contextualizing nature of science instruction in socioscientific issues. *International Journal of Science Education, 34*(15), 2289-2315. doi: 10.1080/09500693.2012.667582.

Espeja, A. G. & D. C. Lagarón. (2015). Socio-scientific issues (SSI) in initial training of primary school teachers: Pre-service teachers' conceptualization of SSI and appreciation of the value of teaching SSI. *Procedia-Social and Behavioral Sciences, 196*, 80-88. doi: j.sbspro.2015.07.015.

Friedrichsen, P. J., T. D. Sadler, K. Graham & P. Brown. (2016). Design of a socio-scientific issue curriculum unit: Antibiotic resistance, natural selection, and modeling. *International Journal of Designs for Learning, 7*(1), 1-18. doi: 10.14434/ijdl.v7i1.19325.

Garder, G. & G. Jones. (2011). Perceptions and practices: biology graduate teaching assistants' framing of a controversial socioscientific issue. *International Journal of Science Education, 33*(8), 1031-1054. doi: 10.1080/09500691003743244.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Technology Research and Development, 29*(2), 75-91.

Harris, H. (2001). Content analysis of secondary data: A study of courage in managerial decision making. *Journal of Business Ethics, 34*(3), 191-208.

Kara, Y. (2012). Pre-service biology teachers' perceptions on the instruction of socio-scientific issues in the curriculum. *European Journal of Teacher Education, 35*(1), 111-129. doi: 10.1080/02619768.2011.633999.

Klosterman, M. L., T. D. Sadler & J. Brown. (2012). Science teachers' use of mass media to address socio-scientific and sustainability issues. *Research in Science Education, 42*(1), 51-74. doi:10.1007/s11165-011-9256-z.

Kolstø, S. D. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education, 85*(3), 291-310. doi: 10.1002/sce.1011.

Lee, H., F. Abd-El-Khalick & K. Choi. (2006). Korean science teachers' perceptions of the introduction of socio-scientific issues into the science curriculum. *Canadian Journal of Math, Science & Technology Education, 6*(2), 97-117. doi: 10.1080/14926150609556691.

Levinson, R. (2006). Towards a theoretical framework for teaching controversial socio-scientific issues. *International Journal of Science Education, 28*(10), 1201-1224. doi:10.1080/09500690600560753.

Lincoln, Y. S. & E. G. Guba. (1985). *Naturalistic inquiry* (Vol. 75). Sage.

Merriam, S. B. (1998). *Qualitative research and case study applications in education. Revised and expanded from" Case study research in education."*. San Francisco: Jossey-Bass Publishers.

Ministry of National Education (MONE). (2005). *İlköğretim fen ve teknoloji dersi (6,7 ve 8. Sınıflar) öğretim programı*. Ankara.

Ministry of National Education (MONE). (2013). *İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. sınıflar) öğretim programı*. Ankara.

Ministry of National Education (MONE). (2018). *Fen bilimleri dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7 ve 8. sınıflar)*. Ankara.

Morris, H. (2014). Socioscientific issues and multidiciplinarity in school science textbooks. *International Journal of Science Education, 36*(7), 1137-1158. doi: 10.1080/09500693.2013.848493.

Muğaloğlu, E. Z., Z. D. Küçük & D. Güven. (2016). Pre-service science teachers' self-efficacy beliefs to teach socio-scientific issues. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 29*(1), 95-110. doi:10.19171/uuefd.69568.

Özden, M. (2015). Prospective elementary school teachers' views about socioscientific issues: A concurrent parallel design study. *International Electronic Journal of Elementary Education, 7*(3), 333-354.

Parchmann, I., C. Gräsel, A. Baer, P. Nentwig, R. Demuth & B. Ralle. 2006. "Chemie im Kontext": A symbiotic implementation of a context-based teaching and learning approach. *International Journal of Science Education, 28*(9),1041-1062. doi: 10.1080/09500690600702512.

Presley, M. L., A. J. Sickel, N. Muslu, D. Merle-Johnson, S. B. Witzig, K. Izci & T. D. Sadler. 2013. A framework for socio-scientific issues based education. *Science Educator, 22*(1), 26-32.

Ratcliffe, M. & M. Grace. (2003). *Science education for citizenship: Teaching socio-scientific issues*. UK: McGraw-Hill Education.

Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research In Science Teaching, 41*(5), 513-536. doi: 10.1002/tea.20009.

Sadler, T. D. & D. L. Zeidler. (2005). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research In Science Teaching, 42*(1), 112-138. doi: 10.1002/tea.20042.

Sadler, T. D., A. Amirshokoohi, M. Kazempour & K. M. Allspaw. (2006). Socioscience and ethics in science classrooms: Teacher perspectives and strategies. *Journal of Research in Science Teaching, 43*(4), 353-376. doi: 10.1002/tea.20142.

Sadler, T. D., S. A. Barab & B. Scott. (2007). What do students gain by engaging in socioscientific inquiry?. *Research in Science Education, 37*(4): 371-391. doi: 10.1007/s11165-006-9030-9.

Savin-Baden, M. & C. H. Major. (2013). *Qualitative research: The essential guide to theory and practice*. Routledge.

Sönmez, A. & A. Kılınç. (2012). Preservice science teachers' self-efficacy beliefs about teaching GM foods: the potential effects of some psychometric factors.*Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 6*(2): 49-76.

Topçu, M. S., T. D. Sadler & Ö. Yılmaz-Tüzün. (2010). Preservice science teachers' informal reasoning about socioscientific issues: the influence of issue context.*International Journal of Science Education, 32*(18), 2475-2495. doi: 10.1080/09500690903524779.

Topçu, M. S. (2017). *Sosyobilimsel konular ve öğretimi*. Ankara: Pegem Akademi.

Walker, K. A. & D. L. Zeidler. (2007). Promoting discourse about socioscientific issues through scaffolded inquiry. *International Journal of Science Education, 29*(11), 1387-1410. doi:10.1080/09500690601068095.

Yapıcıoğlu, A. E. (2016). Fen bilimleri öğretmen adaylarının sosyobilimsel durum temelli öğretim yaklaşımı uygulamalarına yönelik görüşleri ve çalışmalarına ansıtmaları. *HU GSES The Journal of Educational Research, 2*(2), 132-151.

Zeidler, D. L., & B. H. Nichols. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education, 21*(2), 49-58.

Zohar, A., & F. Nemet. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching, 39*(1), 35-62. doi: 10.1002/tea.10008.

Author Information

Okan Sıbıç
İstanbul University-Cerrahpaşa, Hasan Ali Yücel Faculty of Education
Büyükçekmece, İstanbul, Turkey
Contact e-mail: *okansibic@istanbul.edu.tr*
ORCID iD: 0000-0001-7241-274X

Mustafa Sami Topçu
Yıldız Technical University, Faculty of Education
Davutpaşa-Esenler, İstanbul, Turkey
Contact e-mail: *mstopcu@yildiz.edu.tr*
ORCID iD: 0000-0001-5068-8796

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.795980

The Relationship between Physical Activity and Smart Phone Use in University Students

Muhammet Demirbilek, Mert Minaz

Article Info

Article History

Received:
11 February 2020

Accepted:
25 September 2020

Keywords

Smartphone addiction,
Physical activity
Health, Sedentary life

Abstract

Smartphone addiction and physical inactivity are often a major public health problem across the world. This research was aimed to determine the smartphone addiction status, physical activity levels and related factors of university students. Using convenience sampling, university students in Isparta/Turkey completed two questionnaires in Spring semester assessing smartphone addiction and physical activity levels. A total of 147 participants attended in this study. The participants included in the scope of the research; the questionnaire including the International Physical Activity Questionnaire and the Smartphone Addiction Questionnaire, which were considered to be related to socio-demographic characteristics, smartphone use and physical activity habits were applied under direct observation. The physical activity for males was higher than females. There was a significant relationship between age and smart phone use. Whereas the age of the participants increased, a decrease in the number of smartphone usage was observed. The differences of between educational groups are related to the lower level of smartphone addiction of the graduate students compared to the associate degree students. Finally, there was no significant difference between the level of physical activity and the score of smartphone usage as the main aim of this study.

Introduction

Smartphones have brought dramatic changes to individuals' daily lives. They are one of the important technological developments and become an integral part of our daily lives. When used effectively, smart phones are useful technology. However, they may cause serious adverse effects especially in young people if they are not used properly. Smartphone usage is almost out of control among the young people (Choudhary, 2014). Therefore, many new health problems have started to appear with the use of uncontrolled smartphones. Todays' smartphones have many new interaction features with the internet connection. Smart phones, which we can call new generation mobile phones, have more extraordinary functions compared to the traditional mobile devices such as information sharing, message service applications, image sharing, video conferencing as well as communication use. With these features' smartphones have become the high-tech tool for individuals who spend most of their time with them.

Physical activity is the activities that involve the consumption of energy by using our muscles and joints in our daily life, increasing the heart and respiratory rate, and can be performed at different intensities, resulting in fatigue (Bayrakci, 2008). However, with the developing technological products, many technological developments negatively affect physical activity such as devices used in homes or workplaces, elevators and escalators, vehicles used in agriculture and industry. Even though they have free time, young people do not prefer to allocate time for physical activity instead they spend most of their time with smartphones.

Usage of Smartphone

Phone's shapes and features have changed dramatically since it was invented. The first phone was with cable with no interaction features. It only transfers the sound between two speakers. In the 1900s, the concept of mobility was introduced to human life and caused dramatic changes the way we live and interact with the people. Many services offered on smartphones make people's lives easier and the use of these devices is becoming more and more common.

The mobile phones are portable and convenient, making it easier to access the internet. For this reason, internet access via mobile phone is preferred by people. The use of smart phones has brought a different dimension to communication today. Mobile phones, which were the communication tools of the first time, are now used for more complex purposes such as connecting to the internet under the name of smart phones, social media, playing games, listening to music, paying, banking and shopping (Meral, 2017). In addition to advantages of smartphones, there are also pitfalls of using smartphones.

In the case of addiction, the person spends all his time and physical energy on the object or behavior to which he is highly dependent, except for the work he has to do and the relationships he has to establish. There is no clearly definition for smartphone addiction. However smartphone addiction can be defined that a form of addiction that does not have chemical substances but reveals a psychologically negative situation when it is not used (Minaz & Bozkurt, 2017). This is especially true for young people who spend excessive time with their smart phones than older people.

Today, some of the individuals have not been able to use their smart phones according to their needs and therefore they have started to experience some problems. So much so that for some individuals, smart phones have become an integral part of life and the phrase "nomophobia", namely "no mobile phone phobia/mobile phone addiction" has been introduced. Nomophobia is defined as the accompanying feelings such as discomfort and anxiety, irritability caused by not contacting the mobile phone (Griffiths, 2003; King et al., 2010).

It has been reported in positive results for the treatment of chronic diseases such as diabetes, alcoholism, as well as problems with excessive smartphone use (Arsand et al., 2015; Gustafson et al., 2014). In the literature, the problems caused by the excessive use of smart phones were mentioned as "problematic mobile phone use" (Bianchi & Phillips, 2005)," mobile phone addiction "(mobile phone dependency; mobile phone addiction) (Toda et al., 2008)," smartphone addiction "(smartphone addiction) (Kwon et al., 2013).

Nomo phobic people show constant control of messages or calls, excessive anxiety and tension when they are out of range, constant access to the phone and dealing with a smartphone in the bed, and behaviors that can be increased further (Meral, 2017).

Physical Activity

Physical activity is defined as body movements caused by contraction of skeletal muscles that increase energy expenditure above basal level (Baranowski et al., 1992; Pate et al., 1995). All activities that increase energy expenditure can be called physical activity. Therefore, physical daily life activity can also be evaluated as "the sum of voluntary movements that occur through skeletal muscles during everyday functions" (Steele et al., 2003).

Physical activity is a complex reaction of the body in terms of health and performance, biochemically, biomechanically. Physical activity in daily life can be classified as housework, work, school, sports or other activities. If exercise is; it is a subset of physical activity that is structured, planned and performed to achieve, develop or maintain physical condition (Haskell & Kiernan, 2000). The effect of physical activity on an individual's daily energy need varies from person to person and age (Pekcan, 2008). There is no evidence that physical activity is more or less in adulthood than in children or youth periods (Li et al., 2010). However, there is often a study showing that there is a significant decrease in physical activity during adolescence (Budd et al., 2018). However, there are also studies showing that physical activity decreased during the adolescent period (Bauer et al., 2008; Li et al., 2010). In studies related to gender, it has been reported that female students are less active than male students (Hallal et al., 2012; HBSC, 2010). It has been reported that it is recommended to make social and physical conditions enjoyable to increase the level of physical activity in this period (Budd et al., 2018). It increases the risk of chronic disease (obesity, metabolic syndrome, diabetes, cardiovascular diseases, etc.) in adulthood (childhood and adolescence) and a lifestyle away from physical activity (Poti et al., 2014).

In order to increase the quality of life of individuals, it is necessary to adopt a healthy lifestyle and increase the level of physical activity in a more conscious way (Bozkus et al., 2013). Although young people benefit their health by doing physical activity, these activities may become a habit over time. This situation will have a positive impact on public health in the long term and will also have a positive effect on individual health (Malina, 2001). Transition processes that people encounter by their ages may affect their physical activities. Regular physical activity at a young age will bring similar activity in life in the future (Malina, 2001). Physically active children have less fat body mass than passive children (Muratli, 2007). Regular physical

activities of young people and children are important in terms of being a barrier to possible health problems that may occur in the future (Garibagaoglu et al., 2006; Mazicioglu & Ozturk, 2003). Regular physical activity is essential for the healthy growth and development of children and young people. Physical activity provides young people with social, behavioral and mental benefits. Having fun and being with friends are among the main reasons for dealing with physical activity and sports for children and young people (Peggy & Tsouros, 2006).

The Relationship between Smartphone Usage and Physical Activity

Whereas smartphones have made life more helpful, it has too brought numerous side-effects. Although there is insufficient evidence that the use of technological devices changes physical activity, it is investigated whether the use of excessive technological devices replaces sleep, especially at night. While sedentary behavior increases in children with insufficient sleep habits, their level of participation in physical activity decreases (Strasburger et al., 2010). In one study, 37% of 4-11 year-old children have low levels of active gaming, 65% have high screen-watching time (television, computer, smartphone etc.) and 26% have both behaviors together has been reported (Anderson & Whitaker, 2010). In another study, it was reported that only 4 out of 10 children between the ages of 6 and 11 match both the physical activity and the time of use of the technological device. In addition, it was found that physical inactivity levels increased with the increase in the age of the children (Fakhouri et al., 2013).

In a recently published study, it was reported that during playing games with a smartphone or tablet, children require more head, trunk and upper arm angles than watching television and playing with toys. However, compared to games played with toys, children playing with smartphones have been shown to exhibit less body, upper arm and elbow posture variation, less trapezius muscle activity, more sitting, and less physical activity behaviors. Therefore, it has been reported that instead of using technological devices, playing with toys should be encouraged to minimize potential musculoskeletal disorders and sedentary lifestyle in children. It has been suggested that conscious manuals of smartphones and other technological devices should be created for parents and caregivers (Howie et al., 2017).

Concerns have been expressed that as time spent on digital technology increases, time spent on physical activity decreases and may be a factor contributing to child and adolescent obesity and physical health problems (Kautiainen et al., 2005). In a study on children aged 6-17, it was found that those who have low physical activity level and who use technological devices (watching television or video and using smart phones) for a long time are 2 times more likely to be obese than those who do not use (Sisson et al., 2010). A large-scale national survey on survey data from 200,000 adolescents aged 11-15 revealed that the relationship between time spent using digital technology and leisure physical activity varied depending on age, gender and nationality (Melkevik et al., 2010). Also, the relationship between obesity and screen time seen in some studies may result from nutritional behavior rather than lack of physical activity. This claim was supported by a systematic review of studies on immobile behavior and nutrition for children, adolescents, and adults (Pearson & Biddle, 2011). Therefore, although the relationship between physical activity and smartphone use is the main research topic, the relationship between calculated body mass indices, principle obesity, and physical activity and smartphone use will be examined.

Method

Population and Sampling Procedure

This study was conducted on a total of 147 students in higher education. The samples, which are considered as university education, are composed of students who have received undergraduate, graduate and postgraduate education at Süleyman Demirel University. The students participating in the study are 64 (45.6%) male and 80 (54.4%) are female. Participants who are in associate degree (N=36) age average was 20.94, in undergraduate degree age average was 22.74, and in graduate degree age average was 25.60. Smartphone addiction and physical activity levels were determined in line with the survey study. However, in order to examine the correlation between personal characteristics and smartphone addiction and physical activity levels presented in the surveys, a section containing demographic features was presented in the survey study. Thus, the survey study consists of three main sections (demographic characteristics, physical activity scale and smartphone addiction scale).

Smartphone Addiction Scale

The scale used to determine smartphone addiction (Smartphone Addiction Scale: SAS) contains 33 Likert-type questions. The scale developed by Kwon et al. (2013) was developed based on Young's Internet addiction scale and smartphone features. Translation into Turkish Demirci et al. (2014), it was first translated by 2 linguists and then the Turkish version was translated to English and prepared by 5 linguists in line with the similarity of the two English scales. For the reliability study of the scale, the original Cronbach Alpha value was found to be 0.98 and 0.93 for the adaptation study. The scale consists of one dimension. Participants are asked to choose the one that suits them from "I strongly disagree", "I disagree", "I have no idea", "I agree", "I strongly agree". Answers are evaluated between 1-6. The lowest answer score is 33, the highest answer score is 165. Higher scores indicate higher risks of smartphone addiction.

Physical Activity Scale

The International Physical Activity Questionnaire (IPAQ) was used to determine physical activity levels of the participants. The first pilot study for IPAQ was carried out in 1998-1999. The survey has a total of eight versions. IPAQ, which is developed to be four short and four long, has a telephone, bilateral call or self-applicable method. In addition, there are different question types such as 'last 7 days' and 'any week'. For this study, the 'last 7 days' short form, which can be applied on its own, was used (Sjostrom et al., 2005). International validity and reliability of Craig et al. (2003) the validity and reliability study in Turkey for this survey made by Ozturk (2005) was conducted by university students.

IPAQ short form; walking gives information about the time spent in moderate and severe activities. The time spent in sitting is considered as a separate question. The calculation of the total score of the short form includes the sum of walking, moderate activity and duration (minutes) and frequency (days) of the intense activity. It is a criterion that physical activities in IPAQ are performed for at least 10 minutes at a time.

In the last 7 days with the survey;

• Duration of severe physical activity (football, basketball, aerobics, fast cycling, lifting weights, carrying loads, etc.) (min).
• Moderate physical activity (light load carrying, normal speed cycling, folk dances, dance, bowling, table tennis, etc.) duration (min).
• Walking and one-day sitting times (min) were questioned.
The total physical activity score (MET-min/week) was calculated by converting severe, moderate activity and walking times to MET, which corresponds to the basal metabolic rate, by the following calculations Craig et al., (2003).

From these calculations, a score in MET-minutes is obtained. A MET-minute is calculated from the product of the activity performed and the MET score. MET-minute scores were determined according to the kilocalorie values of a 60 kilogram person. Kilocalories can be calculated from the following equation:
MET-min x (person's body weight kg/60 kilograms).

The following values are used for the analysis of IPAQ data:
Walking = 3.3 MET
• Moderate to severe physical activity = 4.0 MET
• Severe physical activity = 8.0 MET.

For example, a person walking 30 minutes 3 days a week has a walking MET-min/week score; it is calculated as 3.3 x 30 x 3 = 297 MET-min/week. In addition to this continuous scoring, categorical scoring is done with the numerical data obtained from it.

There are three levels of physical activity identified when categorizing populations - 'active', 'minimally active' and 'very active (physical activity that improves well-being'). The criteria for these levels were established by calculating the continuous scoring values obtained above.

Total Physical Activity Score (MET-min/hf) = Walking + Moderate activity + Severe activity scores

While the physical activity levels of the participants were classified as "low, medium and high" according to the total physical activity score;
Physical Activity Levels:
• Inactive (Low Intensity) Level: 599 MET-min/week and below,
• Minimal Active (Moderate Intensive) Level: 600-2999 MET-min/week,
• Very Active (Severe) Level: It is classified as 3000 MET-min/week and above (Ozturk, 2005).

Statistical Analysis

All statistical studies were analyzed using IBM SPSS Statistic 24 version. Depending on the nature of the variables, percentage, mean, t test, Pearson correlation analysis and ANOVA test between the single factor groups, post hoc Tukey HSD test were applied. While the age, height, weight, BMI and smartphone addiction score variables of the participants show normal distribution, their physical activity score is not normal distribution. Therefore, parametric tests were applied in the analysis of variables with normal distribution. Spearman correlation, Mann-Whitney test and Kruskal Wallis test as non-parametric analysis and square root physical activity score as normalized parametric analysis were applied in the analyzes including the physical activity variable. Averages are given with standard deviation, $p < 0.05$ is considered significant.

Results and Discussion

Descriptive Statistics Results of the Participants

The relationship between smartphone use and physical activity severity was examined on 147 university students. Pearson correlation analysis was performed to examine the relationship between age, height, weight and BMI. While there was a significant relationship between age and height and weight according to Pearson correlation coefficient ($r = 0.17$, $p < 0.05$ and $r = 0.19$, $p < 0.05$), there was no significant relationship between BMI variable and age ($p > 0.05$). A positive increase was observed in height and weight variables with increasing age. This increase was found low in both variables. In addition, the age variable explains 2% of the total variance in the height variable and 3% of the variance in the weight variable.

In addition, it is aimed to participate in the study from institutes, faculties and colleges. Cross-tabulation and chi-square analysis were performed to examine the relationship between the groups. The results of the profound chi-square analysis reveal a significant difference between the groups. While 36 (24.5%) of the participants are in associate degree education, 81 (55.1%) continue their undergraduate education and 30 (20.4%) continue their graduate education. The proportion of female students attending associate education is 2.6 times more intense than male students and this situation reveals the difference with chi-square analysis. In addition, 14.9% of male students are associate degree students, while 24.5% of female students continue their associate degree education. The main reason for the difference between the groups is due to the density of female students who continue their associate degree education.

Weight and height information were obtained to describe the body mass characteristics of the participants. The average height of the participants was 172.46 cm, the arithmetic average of 68.21 kg and the average body mass index (BMI) was 22.75 kg/m2. Body mass index classes of adult individuals are defined if BMI (kg/m2) ≤18,49 as slim, if it is between 18,5 and 24,99 as normal, if it is between 25 and 29,99 slightly fat and if it is ≥30 as fat.

Independent samples t-test was applied to compare the BMI, height and weight values of the participants by gender. Accordingly, there was a significant difference between all groups [BMI ($t(145) = 1.335$, $\eta 2 = 0.19$, $p < 0.01$), Length ($t(145) = 1.187$, $\eta 2 = 0.5$, $p < 0, 01$) and Weight ($t(145) = 4.365$, $\eta 2 = 0.47$, $p < 0.01$)]. Females' BMI, height and weight averages are lower than male participants.

A significant difference was sought between the BMI, height and weight variables of the participants and their educational status by applying the ANOVA test between the single factor groups. The results show that the BMI, height and weight values of the participants did not make a significant difference with their educational status [$p > 0.05$]. This is supported by the fact that the BMI, height and weight arithmetic averages are close to each other for each learning group as associate degree (N=36), 22.27, undergraduate (N=81) 22.80, graduate (N=30) 23.20. In addition, when cross tabulation categorically between BMI values and education levels, it is seen that the BMI values of all learning groups contain normal levels of BMI (Table 1).

Table 1. Cross-tabulation between participants' educational status and BMI means

			BMI Groups				
			Weak	Normal	Slightly Fat	Obese	Total
Degree	Associate Degree	Number	5	23	7	1	36
		%	13,9%	63,9%	19,4%	2,8%	100,0%
	Undergraduate	Number	8	53	16	4	81
		%	9,9%	65,4%	19,8%	4,9%	100,0%
	Graduate	Number	2	21	4	3	30
		%	6,7%	70,0%	13,3%	10,0%	100,0%
Total		Number	15	97	27	8	147
		%	10,2%	66,0%	18,4%	5,4%	100,0%

Statistical Results of Physical Activity Scale

The physical activity levels of the participants are important variables of the study and the average and classification of the participants' physical activity (PA) level mean (MET-min/week) is 2753.78 (Sd:2690.99) and (PA_Cat) values are love level frequency: 26 (17.7%), intermediate frequency: 70 (47.6%) and severe level frequency:51 (34,7%). Considering the standard deviation values, there is no homogeneous distribution in physical activity levels and it can be said that there is a wide range between PA levels and arithmetic means. Considering the PA categorical variables, the highest frequency was observed for the intermediate level PA class (47.6%). In addition, when the box chart is examined for the normality distribution of PA levels, the fact that the PA level of the participant number 114 is approximately 6.5 times higher than the average level affects the normality of the PA levels (skew coefficient: 2.07).

It is necessary to regulate the distribution of normality for the PA variable in order to prevent statistical errors and perform statistical analysis. Therefore, since there is a positive distortion in the PA variable, first of all, normalization is performed by applying the square root procedure to the PA variable belonging to all participants. For the PA variable with square root operation, the new normality analysis was performed by naming PA_Sqr and the results showed the normality of the new variable (Skewness coefficient: 0.789). The new arithmetic average for the PA_Sqr variable is 46.16 MET-min/week and the standard deviation is 23.08.

Pearson correlation coefficient was calculated to examine the relationship between the ages of the participants and PA_Sqr. Since the normality of the PA variable is not observed, the PA_Sqr variable is used. As a result of the analysis, no significant relationship was found between the ages of the participants and their physical activity levels ($p > 0.05$). It is not possible to comment on the increase or decrease tendency for age-related physical activity levels. Independent samples t-test was conducted to examine a significant difference between gender difference and physical activity levels. No normal distribution was observed in PA for each gender variable and in PA_Sqr for females. Therefore, the logarithm of the PA variable belonging to each participant was taken as two degree normalization. As a result, statistical analysis of physical activity levels by gender was performed.

Independent samples t-test was applied to compare participants' physical activity levels by gender (Table 2). Accordingly, a significant difference was observed in the levels of physical activity towards gender [$t(141.90) = 2.42$, $\eta 2 = 0.04$, $p < 0.05$]. Male participants ($X = 3.33$, $SS = 0.42$) were found to have higher levels of physical activity compared to female participants ($X = 3.16$, $SS = 0.44$). Physical activity levels have a minor effect on males and explain 4% of the total variance. When analyzed categorically, chi-square analysis was conducted between gender and PA_Cat. It has been observed that the majority of males have severe physical activity levels, and for females, mostly moderate to severe physical activity levels (Table 3). In addition, 65.4% of those who do low physical activity are females, while males make up 34.6%. On the other hand, 62.7% of those who do violent activities are males, while females make up 37.3%. In general terms, males have higher activity than females in terms of physical activity levels.

Table 1. Physical activity levels by gender (MET-min/week)

Variable	Group	N	$\bar{x}$	Ss	t	η^2
PA_Sqr	Male	67	3,3357	0,4266	2,428	0,04
	Female	80	3,1616	0,4408		

*p<0,05

Table 2. Cross tabulation between gender and physical activity classes

Gender * PA_Cat Crosstabulation						
			PA_Categories			
			Low Level	Intermediate	Severe Level	Total
Gender	Male	Number	9	26	32	67
		% Gender	13,4%	38,8%	47,8%	100,0%
		% PA_Cat	34,6%	37,1%	62,7%	45,6%
	Female	Number	17	44	19	80
		% Gender	21,3%	55,0%	23,8%	100,0%
		% PA_Cat	65,4%	62,9%	37,3%	54,4%
Total		Number	26	70	51	147
		% Gender	17,7%	47,6%	34,7%	100,0%
		% PA_Cat	100,0%	100,0%	100,0%	100,0%

*p<0,01

ANOVA analysis was conducted between the single-factor groups to investigate a significant difference in participants' physical activity levels for different BMI classes. Descriptive statistics of the participants' physical activity levels are given in Table 4. Table 5 presents the ANOVA results between single factor groups. The PA_Sqr variable gave appropriate normality results for ANOVA analysis. The results did not reveal a significant difference in physical activity levels with different BMI values [F (3,143) = 0.155, p> 0.05].

Table 3. Descriptive statistics of participants' physical activity levels for different BMI classes

PA_Sqr (MET-min/week)	N	Mean	Ss
Weak	15	44,3446	24,37199
Normal	97	46,9968	22,72328
Slightly Fat	27	49,3621	22,12019
Obese	8	47,0359	31,55714
Total	147	47,1627	23,08867

Table 4. ANOVA test for different BMI classes of participants' physical activity levels

PA_Sqr (MET- min/week)					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	252,536	3	84,179		
Within Groups	77578,098	143	542,504	,155	,926
Total	77830,634	146			

*p>0,05

In order to investigate the effect of physical activity on the educational status of the participants and to find a statistically significant difference, ANOVA analysis was performed between the single factor groups. In order to ensure normality, PA_Sqr was used as a physical activity variable. The results showed that there was no significant difference between educational status and physical activity levels (Table 6).

Table 5. Physical activity impact on participants' educational status

Education Level	N	Mean (MET- min/week)	Ss	F	p
Associate Degree	36	48,87	22,13	0,389	0,679
Undergraduate	81	45,64	21,64		
Graduate	30	49,20	28,02		
Total	147	47,16	23,08		

*p>0,05

When the intersection between educational status and classification as a result of classification of physical activity levels is examined, the superiority of medium level physical activity for all education levels is remarkable (Table 7). According to the chi-square analysis, no significant difference was observed between the groups.

Table 6. Cross-tabulation between participants' education and physical activity classes

			PA_Cat			
			Low Level	Intermediate	Severe Level	Total
Education Level	Associate Degree	Number	3	20	13	36
		%	8,3%	55,6%	36,1%	100,0%
	Undergraduate	Number	17	38	26	81
		%	21,0%	46,9%	32,1%	100,0%
	Graduate	Number	6	12	12	30
		%	20,0%	40,0%	40,0%	100,0%
Total		Number	26	70	51	147
		%	17,7%	47,6%	34,7%	100,0%

*p>0,05

Statistical Results about Using Smartphone

The smartphone addiction scale used to analyze the smartphone usage of the participants was used. According to the scale of smartphone addiction, answers to 33 questions were sought and 5-level Likert answers were prepared for each question. Accordingly, the measurement of the answers for the research findings provides a minimum of 33 and a maximum of 165 points. Within the scope of our study, an average of 76.85 ± 22.13 points was observed in line with the answers of the participants. The distribution of normality, which is the dominant assumption of statistical analysis related to the use of smart phones, was examined. Normality was observed in the box chart and Q-Q chart (Skewness coefficient: 0,208).

Pearson correlation coefficient was calculated to determine the relationship between the ages of the participants and their smartphone use (Table 8). As a result of the preliminary examination, it was observed that the variables of age and smartphone use provide normality and linearity assumptions. There is a low-level negative relationship between the two variables ($r = -0.21$, $p < 0.01$). As the ages of the participants increase, there is a decrease in the use of smartphones. Age explains 4.4% of the total variance in smartphone use.

Table 7. Correlation between age and smartphone use

		Age	Smartphone Addiction
Age	Pearson Correlation	1	-,212*
	p		,010
	N	147	147

*p<0,01

Independent samples t-test was carried out to examine the statistical difference in smartphone usage depending on gender. Smartphone use was normally distributed for both sex groups. No significant difference was found between smartphone use and gender (Table 9).

Table 8. Smartphone use by gender

Gender	N	Mean	Ss	F	p
Male	67	76,16	23,04	1,202	0,730
Female	81	77,43	21,47		

*p>0,05

The difference between BMI and smartphone usage has been examined. First of all, smartphone usage shows normal distribution for all BMI groups. ANOVA analysis was performed between single factor groups between BMI and smartphone usage. Since the Levene test is significant ($p < 0.05$), it can be said that group variances are not homogeneous. Accordingly, in the ANOVA analysis, the significance levels of Welch or Brown-Forsythe results were examined and the results showed that there was no significant difference between the participants' BMI classes and their smartphone use (Table 10).

Table 9. ANOVA test of smartphone use belonging to different BMI classes

BMI	N	Mean	Ss	F (Welch)/p	F (Brown-Forsythe)/p
Weak	15	79,06	20,03	1,932/0,147	0,805/0,496
Normal	97	77,15	23,51		
Slightly Fat	27	77,37	20,83		
Obese	8	67,37	10,37		

*p>0,05

When the smartphone usage levels of the participants with different education levels were examined, the normal distribution assumption of the smartphone use was checked for all groups. ANOVA results between the single factor groups made according to the education level are presented in Table 11. Since the Levene test results are not significant, the variances of the group are homogeneous.

Table 10. ANOVA test of smartphone use for different educational situations

Usage of Smartphone						
	Sum of Squares	df	Mean Square	F	η^2	p
Between Groups	3692,164	2	1846,082			
Within Groups	67831,836	144	471,054	3,919	0,0516	0,022
Total	71524,000	146				

*p<0,05

Accordingly, a significant difference was found in the ANOVA results examined [F (2,144) = 3,919, η2 = 0.0516, p <0.05]. Tukey HSD post hoc test was applied to determine which groups the differences were between (Table 12). According to the Tukey HSD test, the difference between associate students and graduate students was observed. Considering the arithmetic averages, it was found that graduate students had a lower smartphone habit than associate students.

Table 11. Tukey HSD post hoc analysis of smartphone use for different educational situations

			Mean Difference			95% Confidence Interval	
	(I) Education Level	(J) Education Level	(I-J)	Std. Error	p	Lower Bound	Upper Bound
Tukey HSD	Associate Degree	Undergraduate	8,04938	4,34745	,157	-2,2462	18,3450
		Graduate	14,90000*	5,36532	,017	2,1939	27,6061
	Undergraduate	Associate Degree	-8,04938	4,34745	,157	-18,3450	2,2462
		Graduate	6,85062	4,63867	,305	-4,1347	17,8359
	Graduate	Associate Degree	-14,90000*	5,36532	,017	-27,6061	-2,1939
		Undergraduate	-6,85062	4,63867	,305	-17,8359	4,1347

*p<0,05

The statistical study between the use of the smartphone belonging to the participants and the PA_Cat was analyzed with the single factor intergroup ANOVA test (Table 13). It provided normal distribution for all physical activity classes of smartphone use. The results show that smartphone use does not have a significant difference in physical activity levels [F (2,144) = 2,042, p = 0,134].

Table 12. Statistical analysis between participants' smartphone use and PA_Cat

	N	Mean	Ss	F	p
Low Level	26	70,84	17,51	2,042	0,134
Intermediate	70	80,38	23,28		
Severe Level	51	75,07	22,13		

*p>0,05

The questions on the scale of smartphone addiction conducted by the students of Süleyman Demirel University were evaluated individually. Accordingly, the column graph obtained with the arithmetic means of the answers from the participants for each question is shown in Figure 1. In particular, the answers given to the 32th (3,32),

29th (3,2), 27th (3,15) and 25th (3,13) options have a positive effect on smartphone addiction. When these 4 options are examined, the question with the highest average number 32 is "I always think that I should shorten my smartphone usage period" option. The second question of questionnaire to the highest average by the participants is "I use my smartphone more than I planned" option. These two options can be considered as complementary questions and show that users are not able to overcome these habits even though they are aware that their smartphone use affects them negatively. The other two high averages are "I prefer to research from my smartphone rather than asking other people" and "I check social networks such as Twitter, Instagram, Whatsapp or Facebook as soon as I wake up" options. Compared to other options, the high observation of these two options reveals the telephone usage purposes of the participants using smart phones. Participants generally control social networks with their smart phones and research with their phones using internet access, which we can consider as an innovative research method.

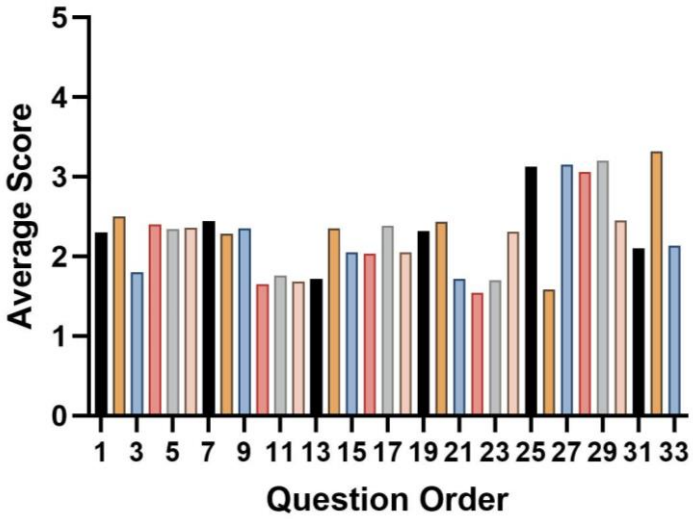


Figure 1. Arithmetic mean of the answers given to individual questions about smartphone addiction questionnaire

Conclusion

Within the scope of the present study, the relationship between physical activity and smartphone addiction was examined on 147 students studying at Süleyman Demirel University with an average age of 22.88. In similar studies, the average age is between 20-25 years (Cengiz, 2007; Kurt, 2018; Ozturk, 2005). Similar to the population, 54.4% of the students participating in the survey study are women and 45.6% are men. In the literature, there are studies in which female and men participants are distributed in a balanced way (Alacam, 2012; Kargul et al., 2016; Reyhanoglu, 2015; Tohumcu, 2018). In addition, 24.5% of the participants study at associate degree, 55.1% at undergraduate and 20.4% at graduate. According to the actual statistics of Süleyman Demirel University, 71.9% of current students study undergraduate, 15.9% graduate and 9% associate degree. Undergraduate student density in this study is proportional to the rate of undergraduate students studying at the university.

According to the Pearson correlation analysis, a low and positive correlation was found between increasing height and weight and the age of the participants. Based on the BMI classification calculated according to the height and weight stated by the adult population aged 15 and over, 16.9% are obese and 33.0% are overweight in Turkey (TSI, 2010). According to OECD (2012), the prevalence of overweight (including obesity) boys between the ages of 5-17 in Turkey is 11.3% and that of girls is 10.3%. A significant difference was observed between the gender and the variables of height, weight and BMI. Height, weight and BMI values of female participants were found to be lower compared to males with similar to a study (Ayhan, 2014). It is striking that female students participating in the study are more fit and healthier than male students.

International physical activity scale was used to determine the PA levels of the participants. Accordingly, the PA levels of the participants were examined for two different scenarios as continuous and categorical variables. The average PA levels of the participants were found to be 2753.78±2690.99 MET-min/week. The standard

deviation value indicates that the PA level will not provide a normal distribution for the participants. Results for categorical physical activity levels were observed as 17.7%, 34.7% and 47.6% for low, severe, and moderate FA, respectively. Weekly energy consumption point averages calculated according to the IPAQ are 1618.10±1934.30 in the study of Akova & Koçoğlu (2018), 1838.5±2452.6 in the study of Bayram (2017), 1916.30±1368.46 for Yıldırım et al. (2015) and 1958±1588 for Savcı et al. (2006). On the other hands, In a study conducted with 2125 university students in Ukraine, the average IPAQ scores were found 3560 MET min/week (Bergier et al., 2014). This variation in the level of physical activity between countries stems from the differences in socioeconomic development, technology and urbanization levels (Haase et al., 2004). The results of many studies on physical activity levels in the literature are intermediate (Cengiz, 2007; El-Gilany et al., 2011; Genc et al., 2011; Koksal, 2016; Yarasır, 2018). Male participants were found to have higher PA levels compared to female participants. Physical activity levels have a small effect on men and explain 4% of the total variance. Categorically, a chi-square analysis was performed between gender and PA_Cat. It was remarked that the majority of men had a severe physical activity level, and for women, mostly a moderate physical activity level was observed. In addition, women constitute 65.4% of participants who do low physical activity, while men make up 34.6%. On the other hand, 62.7% of those who do severe activity are men, while women make up 37.3%. In general, men have severe activity than women in terms of physical activity levels. It has been found that women live more sedentary than men. This can be explained by the tendency of women to spend time at home in our traditional culture, and the tendency of men to spend more time outside the home for sports activities and exercise at different times of the day. In Turkey, men moves more freely than women, and can do many exercises at different times of the day. On the contrary, female students have more limited sport areas, activities and time due to family and social pressure (Sayer, 2011). In many studies, male total physical activity mean scores were found to be significantly higher than female students (Akova & Koçoğlu, 2018; Alricsson et al., 2006; Cengiz, 2007; Kargul et al., 2016; Oztürk, 2005; Quadros et al., 2009; Yarasır, 2018; Yıldırım et al., 2015)

The smartphone addiction scale was used to examine the impact of smartphone use. In the smartphone addiction scale with a minimum score of 33 and a maximum of 195, the average of the smartphone addiction scores for the participants was found to be 76.85. In a study in which the short form of smartphone addiction with the lowest 6 and the highest 60 points was analyzed, the average smartphone addiction was found to be 27.00 ± 10.24 (Kurt, 2018). If the average value in this study is normalized in accordance with our study, the average value is 74.25 points and it is compatible with our study. A low negative relationship was observed between smartphone addiction and age. It has been observed that the use of smartphones decreases with increasing age. This situation is associated with increasing age and increased responsibilities and awareness of users. As the age range decreases, addiction to smartphone use increases. This is related to the age of having a mobile phone for the first time, and as this age decreases, it is normal that smartphone addiction increases. Similarly, in the studies conducted by Demirci et al. (2014) and Heo et al. (2014), an negative correlation was observed between increasing age and smartphone addiction score. There was no significant difference between smartphone use and gender. The fact that current smartphone types include various functions that appeal to both genders (such as social networks for girls, video games for boys) seems to be effective in closing the difference between the genders in terms of smartphone addiction reported by previous study (Kurt, 2018). A significant difference was observed between smartphone addiction and education levels. According to this difference, associate degree students spend more time with smartphones than graduate students. This difference shows the decrease in smartphone addiction score due to increasing education level. In a similar study, a significant difference was found between the smartphone addiction scores of the students and their education level (Tohumcu, 2018).

Finally, there was no significant difference between smartphone use and PA. When the Pearson Correlation Coefficient analysis between PA_Cat and smartphone use was examined, no significant relationship was observed. Since there are no studies in the literature regarding the relationship between smartphone addiction and physical activity level, supporting studies for smartphones can be considered by examining the internet addiction scale, which is a similar measurement.

Recommendations

Today, technology has become an important criterion in determining the living standards for nations. With the development of technology, changes have occurred in many areas. Among these, smart phones have been developed very rapidly in a short time after the invention of the phone that enables communication between people. However, with the integration of many technologies, smartphones have become a threat especially for young children. Technological developments on smart phones lead to sedentary life. For this reason, smartphones can be a risk factor that may affect the development of obesity and that obese individuals may

become addicted to smartphones or online games. Especially for the z generation, where physical activity is very low, smartphone addiction pushes societies to an unhealthy life. Therefore, families should prevent or restrict the use of smartphones in the process of raising their children. In order to protect school-age children against addiction, the use of smart phones under family supervision should be provided. In addition, lessons that will increase students' physical activities and define the negative impacts of using wrong technology should be added to the school curriculum. People look for elevators instead of stairs, and instead of cooking, they order unhealthy meals with the smartphone app. Despite all these negativities, there is a gap in the literature for smartphone use and physical activity levels. This study is an example of further studies that will raise awareness to reduce sedentary life.

References

Akova, İ., & Kocoglu, G. (2018). 20 Yaş üstü erişkinlerde uyku süresi, kalitesi, fiziksel aktivite düzeyi ve bazı antropometrik ölçümler arasındaki ilişkiler. *Ahi Evran Tıp Dergisi*, *2*(3), 67–73. https://dergipark.org.tr/tr/pub/aemj/issue/41876/384581

Alacam, H. (2012). *Denizli bölgesi üniversite öğrencilerinde internet bağımlılığının görülme sıklığı ve yetişkin dikkat eksikliği, hiperaktivite bozukluğu ile ilişkisi* [Pamukkale University]. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Alricsson, M., Landstad, B. J., Romild, U., & Werner, S. (2006). Self-related health, physical activity and complaints in Swedish high school students. *TheScientificWorldJournal*, *6*, 816–826. https://doi.org/10.1100/tsw.2006.164

Anderson, S. E., & Whitaker, R. C. (2010). Household routines and obesity in US preschool-aged children. *Pediatrics*, *125*(3), 420–428. https://doi.org/10.1542/peds.2009-0417

Arsand, E., Muzny, M., Bradway, M., Muzik, J., & Hartvigsen, G. (2015). Performance of the first combined smartwatch and smartphone diabetes diary application study. *Journal of Diabetes Science and Technology*, *9*(3), 556–563. https://doi.org/10.1177/1932296814567708

Ayhan, Y. F. (2014). *Çocukluk ve ergenlik dönemindeki fiziksel aktivite deneyimleri ile yetişkinlikteki fiziksel aktivite düzeyleri ve beden kompozisyonlarının incelenmesi* [Muğla Sıtkı Koçman University]. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Baranowski, T., Bouchard, C., Bar-Or, O., Bricker, T., Heath, G., Kimm, S. Y. S., Malina, R., Obarzanek, E. ., Pate, R., Strong, W. B., Truman, B., & Washington R. (1992). Assessment, prevalence, and cardiovascular benefits of physical activity and fitness in youth. *Med. Sci. Sport. Exerc*, *24*, 237–246. https://pubmed.ncbi.nlm.nih.gov/1625549/

Bauer, K. W., Nelson, M. C., Boutelle, K. N., & Neumark-Sztainer, D. (2008). Parental influences on adolescents' physical activity and sedentary behavior: Longitudinal findings from Project EAT-II. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 12. https://doi.org/10.1186/1479-5868-5-12

Bayrakcı, V. T. (2008). *Yetişkinlerde Fiziksel Aktivite* (1. edn). Klasmat matbaacılık. www.klasmat.web.tr

Bayram, S. (2017). *Sağlık bilimleri öğrencilerinde fiziksel aktivitenin akademik başarıya etkisi* [Medipol University]. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Bergier, B., Tsos, A., & Bergier, J. (2014). Factors determining physical activity of Ukrainian students. *Annals of Agricultural and Environmental Medicine*, *21*(3), 613–616. https://doi.org/10.5604/12321966.1120612

Bianchi, A., & Phillips, J. G. (2005). Psychological predictors of problem mobile phone use. *Cyberpsychology and Behavior*, *8*(1), 39–51. https://doi.org/10.1089/cpb.2005.8.39

Bozkus, T., Turkmen, M., Kul, M., Ozkan, A., Oz, Ü., & Cengiz, C. (2013). Beden eğitimi ve spor yüksekokulu'nda öğrenim gören öğrencilerin fiziksel aktivite düzeyleri ile sağlikli yaşam biçimi davranişlarinin belirlenmesi ve ilişkilendirilmesi. *International Journal of Science Culture and Sport*, *1*(3), 49–65. https://dergipark.org.tr/tr/pub/intjscs/108013

Budd, E. L., McQueen, A., Eyler, A. A., Haire-Joshu, D., Auslander, W. F., & Brownson, R. C. (2018). The role of physical activity enjoyment in the pathways from the social and physical environments to physical activity of early adolescent girls. *Preventive Medicine*, *111*, 6–13. https://doi.org/10.1016/j.ypmed.2018.02.015

Cengiz, C. (2007). *Physical activity and exercise stages of change levels of middle east technical university students* [Middle East Technical University]. https://etd.lib.metu.edu.tr/upload/12608524/index.pdf

Choudhary, A. (2014). Smartphones and their impact on net income per employee for selected u.s. firms. *Review of Business & Finance Studies*, *5*(2), 9–17. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2456470

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-Country

reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Demirci, K., Orhan, H., Demirdas, A., Akpinar, A., & Sert, H. (2014). Validity and reliability of the Turkish version of the smartphone addiction scale in a younger population. *Klinik Psikofarmakoloji Bulteni*, *24*(3), 226–234. https://doi.org/10.5455/bcp.20140710040824

El-Gilany, A. H., Badawi, K., El-Khawaga, G., & Awadalla, N. (2011). Physical activity profile of students in Mansoura University, Egypt. *Eastern Mediterranean Health Journal*, *17*(8), 694–702. https://doi.org/10.26719/2011.17.8.694

Fakhouri, T. H. I., Hughes, J. P., Brody, D. J., Kit, B. K., & Ogden, C. L. (2013). Physical activity and screen-time viewing among elementary school-aged children in the United States from 2009 to 2010. *JAMA Pediatrics*, *167*(3), 223–229. https://doi.org/10.1001/2013.jamapediatrics.122

Garibagaoglu, M., Budak, N., Oner, N., Saglam, O., & Nisli, K. (2006).). Üç farklı üniversitede eğitim gören kız öğrencilerin beslenme durumları ve vücut ağırlıklarının değerlendirmesi. *Journal of Health Sciences*, *15*(3), 173–180. https://dergipark.org.tr/tr/pub/eujhs/issue/44518/552046

Genc, A., Umit, S., Karabacak, H., & Ucok, K. (2011). Kadın ve erkek genç erişkinler arasında fiziksel aktivite ve yaşam kalitesi farklılıklarının araştırılması. *Kocatepe Tıp Dergisi*, *12*(3), 145–150. https://doi.org/10.18229/ktd.34902

Griffiths, T. (2003). Diving and other headfirst entries. In *In Griffiths, Tom |a Penn State University (ed.), The complete swimming pool reference. 2nd ed, Champaign, Ill., Segamore Publishing, c2003, p.279-280;288-300.*

Gustafson, D. H., McTavish, F. M., Chih, M. Y., Atwood, A. K., Johnson, R. A., Boyle, M. G., Levy, M. S., Driscoll, H., Chisholm, S. M., Dillenburg, L., Isham, A., & Shah, D. (2014). A smartphone application to support recovery from alcoholism a randomized clinical trial. *JAMA Psychiatry*, *71*(5), 566–572. https://doi.org/10.1001/jamapsychiatry.2013.4642

Haase, A., Steptoe, A., Sallis, J. F., & Wardle, J. (2004). Leisure-time physical activity in university students from 23 countries: Associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*, *39*(1), 182–190. https://doi.org/10.1016/j.ypmed.2004.01.028

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U., Alkandari, J. R., Bauman, A. E., Blair, S. N., Brownson, R. C., Craig, C. L., Goenka, S., Heath, G. W., Inoue, S., Kahlmeier, S., Katzmarzyk, P. T., Kohl, H. W., Lambert, E. V., Lee, I. M., … Wells, J. C. (2012). Global physical activity levels: Surveillance progress, pitfalls, and prospects. In *The Lancet* (Vol. 380, Issue 9838, pp. 247–257). Lancet Publishing Group. https://doi.org/10.1016/S0140-6736(12)60646-1

Haskell, W. L., & Kiernan, M. (2000). Methodologic issues in measuring physical activity and physical fitness when evaluating the role of dietary supplements for physically active people. *American Journal of Clinical Nutrition*, *72*(2 SUPPL.). https://doi.org/10.1093/ajcn/72.2.541s

HBSC. (2010). *Social determinants of health and well-being among young people.* World Health Organization. https://www.euro.who.int/en/publications/abstracts/social-determinants-of-health-and-well-being-among-young-people.-health-behaviour-in-school-aged-children-hbsc-study

Heo, J., Oh, J., Subramanian, S. V., Kim, Y., & Kawachi, I. (2014). Addictive internet use among Korean adolescents: A national survey. *PLoS ONE*, *9*(2). https://doi.org/10.1371/journal.pone.0087819

Howie, E. K., Coenen, P., Campbell, A. C., Ranelli, S., & Straker, L. M. (2017). Head, trunk and arm posture amplitude and variation, muscle activity, sedentariness and physical activity of 3 to 5 year-old children during tablet computer use compared to television watching and toy play. *Applied Ergonomics*, *65*, 41–50. https://doi.org/10.1016/j.apergo.2017.05.011

Kargul, M., Togo, O. T., Biner, M., Pala, A., & Kizar, O. (2016). Üniversite öğrencilerinin fiziksel aktivite düzeylerinin incelenmesi. *Spor Bilimleri Dergisi*, *1*(1), 61–61. https://doi.org/10.22396/sbd.2016.6

Kautiainen, S., Koivusilta, L., Lintonen, T., Virtanen, S. M., & Rimpelä, A. (2005). Use of information and communication technology and prevalence of overweight and obesity among adolescents. In *International Journal of Obesity* (Vol. 29, Issue 8, pp. 925–933). Int J Obes (Lond). https://doi.org/10.1038/sj.ijo.0802994

King, A. L. S., Valença, A. M., & Nardi, A. E. (2010). Nomophobia: The mobile phone in panic disorder with agoraphobia. *Cognitive and Behavioral Neurology*, *23*(1), 52–54. https://doi.org/10.1097/WNN.0b013e3181b7eabc

Koksal, O. (2016). *Sağlık bilimlerinde öğrenim gören üniversite öğrencilerinin fiziksel aktivite düzeyleri ile yaşam kalitesi arasındaki ilişkinin diğer bölümlerde öğrenim gören üniversite öğrencileriyle karşılaştırılması* [Haliç University]. http://earsiv.halic.edu.tr/xmlui/handle/20.500.12473/491

Kurt, F. (2018). *Üniversite öğrencilerinde akıllı telefon kullanım bozukluğu ile dürtüsel davranış ve çocukluk çağı travması arasındaki ilişkisi* [Üsküdar University]. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Kwon, M., Lee, J.-Y., Won, W.-Y., Park, J.-W., Min, J.-A., Hahn, C., Gu, X., Choi, J.-H., & Kim, D.-J. (2013).

Development and validation of a smartphone addiction scale (SAS). *PLoS ONE*, *8*(2), e56936. https://doi.org/10.1371/journal.pone.0056936

Li, S., Treuth, M. S., & Wang, Y. (2010). How active are American adolescents and have they become less active? In *Obesity Reviews* (Vol. 11, Issue 12, pp. 847–862). Obes Rev. https://doi.org/10.1111/j.1467-789X.2009.00685.x

Malina, R. M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology*, *13*(2), 162–172. https://doi.org/10.1002/1520-6300(200102/03)13:2<162::AID-AJHB1025>3.0.CO;2-T

Mazıcıoğlu, M. M., & Ozturk, A. (2003). Üniversite 3 ve 4. sınıf öğrencilerinde beslenme alışkanlıkları ve bunu etkileyen faktörler. *Erciyes Medical Journal*, *25*(4), 172–178. https://dergipark.org.tr/tr/pub/omuspd/issue/20459/217881

Melkevik, O., Torsheim, T., Iannotti, R. J., & Wold, B. (2010). Is spending time in screen-based sedentary behaviors associated with less physical activity: A cross national investigation. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 46. https://doi.org/10.1186/1479-5868-7-46

Meral, D. (2017). Orta öğretim öğrencilerinde akıllı telefon bağımlılığının yalnızlık, yaşam doyumu ve bazı kişisel özellikler bakımından incelenmesi. In *Erzincan Üniversitesi Sosyal Bilimler Enstitüsü Eğitim Bilimleri Anabilim Dalı, Yüksek Lisans Tezi*.

Minaz, A., & Bozkurt, O. Ç. (2017). Üniversite öğrencilerinin akıllı telefon bağımlılık düzeylerinin ve kullanım amaçlarının farklı değişkenler açısından incelenmesi. *Mehmet Akif Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *2*(9), 268–286. https://doi.org/10.20875/makusobed.306903

Muratlı, S. (2007). Antrenman bilimi yaklaşımıyla çocuk ve spor. *Nobel Yayın Dağıtım*, 23. https://scholar.google.com/scholar?cluster=7178317652999020302&hl=en&oi=scholarr

OECD. (2012). *OBESITY UPDATE*. http://www.oecd.org/health/49716427.pdf

Ozturk, M. (2005). *Üniversitede eğitim-öğretim gören öğrencilerde uluslararası fiziksel aktivite anketinin geçerliliği ve güvenirliği ve fiziksel aktivite düzeylerinin belirlenmesi* [Hacettepe Üniversitesi,]. https://www.ulusaltezmerkezi.net/universitede-egitim-ogretim-goren-ogrencilerde-uluslararasi-fiziksel-aktivite-anketinin-gecerliligi-ve-guvenirligi-ve-fiziksel-aktivite-duzeylerinin-belirlenmesi/

Pate, R. R., Macera, C. A., Pratt, M., Heath, G. W., Blair, S. N., Bouchard, C., Haskell, W. L., King, A. C., Buchner, D., Ettinger, W., Kriska, A., Leon, A. S., Marcus, B. H., Morris, J., Paffenbarger, R. S., Patrick, K., Pollock, M. L., Rippe, J. M., Sallis, J., & Wilmore, J. H. (1995). Physical activity and public health: A recommendation from the centers for disease control and prevention and the American College of Sports Medicine. *JAMA: The Journal of the American Medical Association*, *273*(5), 402–407. https://doi.org/10.1001/jama.1995.03520290054029

Pearson, N., & Biddle, S. J. H. (2011). Sedentary behavior and dietary intake in children, adolescents, and adults: A systematic review. In *American Journal of Preventive Medicine* (Vol. 41, Issue 2, pp. 178–188). Elsevier Inc. https://doi.org/10.1016/j.amepre.2011.05.002

Peggy, E., & Tsouros, A. (2006). *Kentsel çevrede fiziksel aktivite ve aktif yaşamın desteklenmesi*. http://www.euro.who.int/pubrequest

Pekcan, G. (2008). *Beslenme durumunun saptanması* (1. edn.). Klasmat Matbaacılık. www.klasmat.web.tr

Poti, J. M., Duffey, K. J., & Popkin, B. M. (2014). The association of fast food consumption with poor dietary outcomes and obesity among children: Is it the fast food or the remainder of the diet? *American Journal of Clinical Nutrition*, *99*(1), 162–171. https://doi.org/10.3945/ajcn.113.071928

Quadros, T. M. B. de, Petroski, E. L., Santos-Silva, D. A., & Pinheiro-Gordia, A. (2009). The prevalence of physical inactivity amongst Brazilian university students: its association with sociodemographic variables. *Revista de Salud Pública*, *11*(5), 724–733. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0124-00642009000500005

Reyhanoglu, E. N. (2015). *Türkiye'deki üniversite öğrencilerinin internete bağımlılık düzeyleri ile sıkıntıya dayanma, başaçıkma stratejileri, kişilik özellikleri ve bazı demografik değişkenler arasındaki ilişki* [Üsküdar University]. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=3v0UhC1Q_4mLCHrgucNoVg&no=_ZsQ9HWOigcum0RD1vzGUA

Savcı, S., Oztürk, M., Arıkan, H., Ince, D. I., & Tokgozoglu, L. (2006). Üniversite öğrencilerinin fiziksel aktivite düzeyleri. *Türk Kardiyoloji Derneği Arşivi*, *34*(3), 166–172. https://www.archivestsc.com/tr/jvi.aspx?un=TKDA-46330&volume=34&issue=3

Sayer, H. (2011). *Toplumsal cinsiyet eşitliğine erkeklerin katılımı*. Kadının Statüsü Genel Müdürlüğü. https://ailevecalisma.gov.tr/media/2533/handansayer.pdf

Sisson, S. B., Broyles, S. T., Baker, B. L., & Katzmarzyk, P. T. (2010). Screen time, physical activity, and overweight in U.S. Youth: National survey of children's health 2003. *Journal of Adolescent Health*, *47*(3), 309–311. https://doi.org/10.1016/j.jadohealth.2010.02.016

Sjostrom, M., Ainsworth, B., Bauman, A., Bull, F., Hamilton-Craig, C., & Sallis J. (2005). *Guidelines for data*

processing analysis of the International Physical Activity Questionnaire (IPAQ) - Short and long forms . https://www.scienceopen.com/document?vid=b223350f-d159-4043-9b48-e2031f210a3c

Steele, B. G., Belza, B., Cain, K., Warms, C., Coppersmith, J., & Howard, J. E. (2003). Bodies in motion: Monitoring daily activity and exercise with motion sensors in people with chronic pulmonary disease. *Journal of Rehabilitation Research and Development*, *40*(5 SUPPL. 2), 45–58. https://doi.org/10.1682/JRRD.2003.10.0045

Strasburger, V. C., Jordan, A. B., & Donnerstein, E. (2010). Health effects of media on children and adolescents. In *Pediatrics* (Vol. 125, Issue 4, pp. 756–767). American Academy of Pediatrics. https://doi.org/10.1542/peds.2009-2563

Toda, M., Ezoe, S., Nishi, A., Mukai, T., Goto, M., & Morimoto, K. (2008). Mobile phone dependence of female students and perceived parental rearing attitudes. *Social Behavior and Personality*, *36*(6), 765–770. https://doi.org/10.2224/sbp.2008.36.6.765

Tohumcu, M. U. (2018). *İnternet ve akıllı telefon bağımlılığı ile benlik saygısı ve yalnızlık arasındaki ilişkinin çeşitli demografik değişkenler açısından incelenmesi* [Haliç University]. http://earsiv.halic.edu.tr/xmlui/handle/20.500.12473/1055

TSI. (2010). *2010 Yılı Türkiye sağlık araştırması sonuçları*. Turkish Statistical Institution. http://tuik.gov.tr/PreTablo.do?alt_id=1095

Yarasır, E. (2018). *Fırat üniversitesi sağlık hizmetleri meslek yüksekokulu öğrencilerinde internet bağımlılığı ve fiziksel aktivite düzeylerinin belirlenmesi* [Fırat University]. https://openaccess.firat.edu.tr/xmlui/handle/11508/12907

Yıldırım, İ., Ozsevik, K., Ozer, S., Canyurt, E., Tortop, Y. (2015). Üniversite öğrencilerinde fiziksel aktivite ile depresyon ilişkisi. *Niğde University Journal of Physical Education And Sport Sciences*, *9*(9), 32–39. https://dergipark.org.tr/tr/pub/bsd/712603

Author Information

Muhammet Demirbilek
Suleyman Demirel University
Isparta, 32260 Turkey
Contact e-mail: muhammetdemirbilek@sdu.edu.tr
ORCID iD: 0000-0001-7448-9206

Mert Minaz
Isparta University of Applied Sciences
Isparta, 32260 Turkey
ORCID iD: 0000-0003-1894-9807

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.769444

Science Amotivation Scale: Validity and Reliability Study

Busra Karaca, Solmaz Aydin

Article Info

Article History

Received:
11 November 2019

Accepted:
16 June 2020

Keywords

Amotivation
Scale development
Science classes
Secondary school

Abstract

The aim of the present study was to develop the Science Amotivation Scale (SAS) in order to determine amotivation levels among demotivated students in science classes as well as examine the reasons causing amotivation. The participants were 533 students (6th, 7th, and 8th grade) studying across secondary schools located in Kars city centre in Turkey. The development of the scale included; *1)* a review of related literature to develop an item pool, *2)* interviews with students in a secondary school who were highly demotivated in science classes, *3)* consultation with subject matter experts for the draft scale, and *4)* exploratory and confirmatory factor analyses. The results suggested that the final scaled included 22 items on a 5-point Likert scale. In addition, the scale had three sub-dimensions: Psychological-Personal Reasons, Family-Environment Related Reasons, and Fear-Anxiety Related Reasons. Exploratory Factor Analysis results showed that factor loadings of items within the scale ranged between .602 and .764. In addition, Confirmatory Factor Analysis results supported the structure of the scale. The reliability coefficient of the scale was calculated as .91. The results also indicated that validity and reliability levels of the scale were high and that the scale, in its current form, can be used to identify the reasons behind students' amotivation in secondary school science classes.

Introduction

Science courses have an abstract and equally complex structure. Therefore, students may experience difficulties in science subjects from time to time. Motivating students becomes an important point of consideration in order to be able to overcome the difficulties that can be faced during science education. Research has shown that motivation affects students' academic success in the classroom (Alvord & Glass, 1974; Bart, 1978, Pintrich & De Groot, 1990; Trumper, 1995). Atay (2014) has found that individuals' purposeful participation in the learning process positively affects learning and students become more successful in learning scientific knowledge. Being motivated will positively affect an individual's learning and allow the learning process to be more effective. In this sense, identifying factor that can affect students' motivation becomes an important point of consideration to increase their motivation. Undoubtedly, the learning outcomes for a motivated student would be different from the learning outcomes for a demotivated student.

Amotivation results from not caring about an activity, feeling the self to be incompetent, or not believing that the self will be able to reach the desired outcome (Deci & Ryan, 2000). An individual's imperceptions or disbelief in his/her skills and efforts are one of the main sources of amotivation (Legault, Green-Demers, & Pelletier, 2006). Amotivation, which is a big problem not only for teachers but also for students, is one of the most frequently experienced sources of failure (Green-Demers, Legault, Pelletier & Pelletier, 2008). More specifically, high levels of student amotivation, in most cases, can put the teacher in a tight spot and cause them to make wrong decisions (Dicke, Lüdtke, Trautwein, Nagy & Nagy, 2012).

Research studies revealed that individuals with high levels of motivation are able to achieve better results compared to those who are less motivated (Green, Nelson, Martin ve Marsh, 2006; Linnenbrink ve Pintrich, 2002; Pintrich ve Schunk, 1996). Motivation is a prequisite for classroom success and school satisfaction (Vallerand et al., 1991). According to self-determination theory, amotivation is the most worrisome state of academic motivation. While motivated students' actions are supported by feelings such as competition and effort, amotivated students have the tendency to not participate in activities, not taking any taks, not comleting a given task, and absenteeism (Vallerand et al., 1991). Demotivated students can experience negative feelings such as anxiety, fear, disappointment, anger, hopelessness, and unhappiness. Therefore, an individual's amotivation can increase incrementally and result in unproductivity at classroom as well as societal levels. In this sense, student amotivation becomes a significant problem that needs to be solved not only in the context of an individual students' academic success but also in the context of the whole class as well as the school

(Legault, Green-Demers & Pelletier, 2006). Therefore, it is considered that the reasons which negatively affect student motivation should be determined. More specifically, if teachers become aware of the factors that cause their students to become amotivated in the classroom then they can shape teaching and learning processes and their behaviour in a way that contributes towards the solution of those problems.

Table 1. Factors that were found to be related to student amotivation

Category
Family
Financial situation (Atay,2014)
Monthly income (Demir, Öztürk & Dökme, 2012; Dembo, 2004)
Education level (Demir, Öztürk & Dökme, 2012; Uzun & Keleş, 2010; Atay, 2014; Yerlikaya, 2014)
Study environment (Demir, Öztürk & Dökme, 2012)
Having a computer and internet connection available for use at home (Atay, 2014)
Family support (Khamis, Dukmak & Elhoweris, 2008)
Family expectations (Dembo, 2004)
School and environment
School's physical appearance (Vatansever-Bayraktar, 2015)
Classroom seating arrangement (Ceylan, 2003)
A classroom environment that supports student autonomy (Orsini, Binnie & Wilson, 2016)
Friends
Friends' attitudes towards learning (Khamis, Dukmak & Elhoweris, 2008)
Collaboration (Uzun & Keleş, 2010)
Personal reasons
Weekly study time (Yenice, Saydam & Telli ,2012)
Individual differences (Arıkıl & Yorgancı, 2012)
Teacher
Teacher guidance (Ceylan, 2003)
Teacher appearance (Uzgören-Gültan, 1999; Vatansever-Bayraktar, 2015)
Teacher behaviour (Akbaba & Aktaş, 2005; Ceylan, 2003; Vatansever-Bayraktar, 2015; Mccombs, 1991; Dembo, 2004)
Teacher-Student interaction (Arıkıl & Yorgancı, 2012; Khamis, Dukmak & Elhoweris, 2008; Mccombs, 1991)
Teacher's Teaching style (Ceylan, 2003; Vatansever-Bayraktar, 2015; Mccombs, 1991; Dembo, 2004)
Teaching materials (Arıkıl & Yorgancı, 2012; Ceylan, 2003)
Teacher's psychological support (Kashef, Mazyari & Ameri, 2012)
Psychological
Passion-enthusiasm (Arıkıl & Yorgancı, 2012; Ceylan, 2003)
Student beliefs (Khamis, Dukmak & Elhoweris, 2008)
Being goal oriented (Gömleksiz & Serhatlıoğlu, 2014; Dembo, 2004; Martin & Tracey, 2002)
Self-confidence (Akbaba & Aktaş, 2005; Vatansever-Bayraktar, 2015
Reward-punishment (Vatansever-Bayraktar, 2015; Khamis, Dukmak & Elhoweris, 2008)
Attitudes towards the course (Yaman & Dede, 2007; Yetim, Demir & Erturan İlker, 2016; Dembo, 2004)
Interest in the subject (Arıkıl & Yorgancı, 2012; Gömleksiz & Serhatlıoğlu, 2014)
Positive thinking (Arıkıl & Yorgancı,2012; Akbaba & Aktaş, 2005)
Students' fear and concerns (Martin & Tracey, 2002)

The review of literature on this subject suggests that most studies have been conducted to measure students' motivation levels and scales have been developed to realize this aim (Aydın, Yerdelen, Gürbüzoğlu-Yalmancı & Göksu, 2014; Azizoğlu & Çetin 2009; Dede & Yaman, 2007; Uzun & Keleş, 2010; Yenice, Saydam & Telli, 2012).. It has been found that various international studies have been conducted on amotivation (i.e. Legault, Green-Demers & Pelletier, 2006; Pelletier, Dion, Tuson & Green-Demers, 1999; Vlachopoulos & Gigoudi, 2008). Nevertheless, there has not been enough research on this subject in the context of Turkey. The only study

that has been conducted in the context of Turkey is İlter's (2019) study which aimed to adapt the "Academic Amotivation Scale" developed by Legault, Green-Demers and Pelletier (2006) into the Turkish culture. No amotivation scale was found that was specifically oriented towards science classes. The aim of the present study is to contribute to the literature by developing a valid and reliable scale which can be used to measure students' amotivation levels and understand the reasons for their amotivation.

Method

The aim of the present study is to develop the Science Amotivation Scale (SAS). Survey research design, a quantitative research approach, was followed to achieve this aim and collect data. The development of the scale included; 1) a review of related literature to develop an item pool, 2) interviews with students in a secondary school who were highly demotivated in science classes, 3) consultation with subject matter experts for the draft scale, and 4) exploratory and confirmatory factor analyses. The universe of the study consisted of 6th, 7th, and 8th grade students studying in secondary schools in Kars city centre in Turkey. A different group of participants (sample) was selected for each phase of the study and analyses were conducted using the collected data. The size of each sample is specified under related sub-headings.

Table 2. Student responses received following the interviews

Reasons affecting amotivation	Number of students mentioning a reason (5 students)
Study environment	2
Use of internet	3
Family support	4
Family expectations	5
School's physical appearance	1
Classroom seating arrangement	3
An environment supporting student autonomy	3
Friends' attitudes towards learning	2
Collaboration	3
Teacher guidance	3
Teacher behaviours	1
Student-Teacher interaction	5
Teacher's teaching style	2
Teacher's teaching materials	3
Teacher's psychological support	5
Being passionate and enthusiastic	3
Student beliefs	1
Students being goal-oriented	3
Student self-confidence	2
Reward and punishment	2
Attitudes towards the course	1
Interest in the subject	5
Positive thinking	4
Students' fears and concerns	3
Weekly study time	2
Individual differences	3

Creation of item pool

In the initial phase, a review of related literature was conducted in order to create the item pool. This review focused on identifying the factors that cause amotivation among students. Those factors are summarized in Table 1. Those factors were transformed into items and included in the item pool. Furthermore, interviews were arranged to be held with demotivated students in order to write further items. Therefore, the Academic Motivation Scale for Learning Science (AMSLS) was administered to 6^{th}, 7^{th}, and 8^{th} grade students in a

secondary school that was not part of the study sample for the main study. The reason for administering this scale was to identify students who were demotivated in science classes.

AMSLS is a scale developed by Aydın, Yerdelen, Gürbüzoğlu-Yalmancı and Göksu (2014) and adapted for science classes by Çekim (2016). It is used to measure students' academic motivation in science classes and consists of 19 items and four sub-dimensions. Those sub-dimensions are; intrinsic motivation, extrinsic motivation-career, extrinsic motivation-social, and amotivation. Due to the focus of the present study, only the results of the *amotivation* sub-dimension were taken into consideration. Five students among those who scored highest in this sub-dimension (indicating highest levels of amotivation) were invited to semi-structured interviews. Students were asked questions linked to the factors identified in the review of literature for amotivation. Those questions were:

- Do you think your family affects your motivation in science classes?
- Do you think that your school's physical appearance affects your motivation in science classes?
- Do you think your friends affect your motivation in science classes?
- Do you think your teacher affects your motivation in science classes?
- Do you think that your psychological mood affects your motivation in science classes?
- Are there any other reasons that you think affect your motivation in science classes?

The content analysis of the responses received from students, the reasons mentioned to affect amotivation are summarized in Table 2. The item pool developed following the above steps were examined by three subject matter experts and the item pool was finalized following the revisions suggested by the experts. The scale consisted of 42 items to be administered on a 5-point Likert scale where "1" represented "Strongly disagree" and "5" represented "Strongly agree".

Results and Discussion

Exploratory Factor Analysis

Initially the scale was administered to 261 secondary school students (6^{th}, 7^{th}, and 8^{th} grade) using simple random sampling procedures and the 42-item scale was factor analysed. Exploratory Factor Analysis (EFA) results indicated that 22 items had a loading value of .518 and over. Next, the factor analysis was run again with those 22 items and the KMO value was calculated as .93. This suggested that the dataset was fit for factor analysis. Moreover, the Bartlett Sphericity test indicated that there was a considerably large relationship among variables to conduct the factor analysis ($\chi 2 = 3027$, p<, 001). The EFA results indicated that there were 3 factors with an eigenvalue higher than 1. Similarly, the analysis of the scree plot suggested that there were three areas above the curve point (Figure 1).

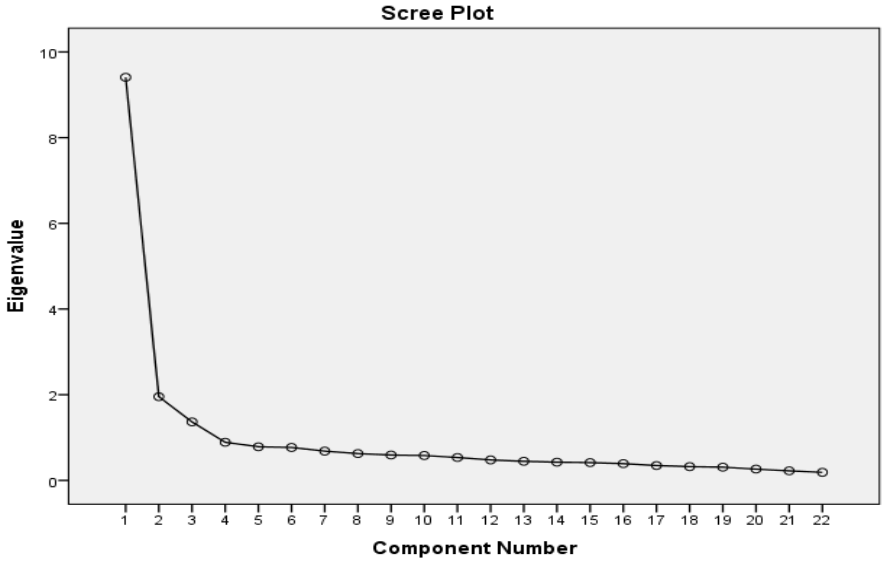


Figure 1. Eigenvalues' distribution graph

Following these results, the dataset was rotated using the Varimax method and it was decided that the scale had a 3-factor structure. The factors were named based on the items that loaded onto them; Psychological-Personal

(PP), Family-Environment (FE), and Fear-Anxiety (FA). The total variance that those three factors explained was 57.85 % (see Table 3).

Table 3. Total variance explained by the factors

Factors	Eigenvalue	Explained variance (%)	Total variance (%)
PP	9,408	32,572	32,572
FE	1,954	13,417	45,988
FA	1,366	11,864	57,852

Each item's factor loadings are summarized in Table 4. According to the Varimax rotation technique in Table 4, the first factor (Family-Environment) consists of items 1, 2, 3, 9 and 26; the second factor (Fear-Anxiety) consist of items 21, 32 and 36; and items 22, 24, 33, 35, 37, 38, 39, 40, 41, 7, 13, 16, 18 and 19 constitute the third factor (Psychological-Personal).

Table 4. SAS factor loadings based on the 3-factor solution using varimax method

Items	Factors		
	FE	FA	PP
1. Because my family's financial situation prevents me from buying materials necessary for science classes	.790		
2. Because I do not have Internet at home to do my science homework	.775		
3. Because my parent's education level is not high enough to support me in science classes.	.764		
9. Because I do not have an opportunity to study for science classes with my friends.	.719		
26. Because I do not have a computer to do my science homework.	.603		
21. Because I fear that I will not be successful in science classes.		.658	
32. Because I abstain from asking questions to my teacher when I do not understand the subject in science classes.		.518	
36. Because the subjects in science classes are difficult for me.		.638	
22. Because I do not like science classes.			.652
24. Because I do not have a goal to learn science.			.648
33. Because I do not like my science teacher.			.798
35. Because my teacher does not believe that I can be successful in science.			.716
37. Because I do not know why I should learn science.			.627
38. Because I do not learn new information in science classes.			.602
39. Because science classes are not important for me.			.763
40. Because my family does not believe that I can be successful in science.			.722
41. Because learning science will not be useful.			.671
7. Because I do not like my school.			.754
13. Because our teacher does not interact with us when teaching science lessons.			.711
16. Because I do not think science classes are necessary.			.708
18. Because I do not want to learn science.			.686
19. Because I do not believe that I can be successful in science.			.684

Note: FE: Family-Environment, FA: Fear-Anxiety, PP: Psychological-Personal

Confirmatory Factor Analysis (3 Factors)

Confirmatory Factor Analysis (CFA) was conducted to establish the construct validity of the Science Amotivation Scale (SAS). The 22-item version of SAS was administered to a new cohort of participants. 272 students (6^{th}, 7^{th}, and 8^{th} grade) from three secondary schools were selected using simple random sampling strategy. Model indices that were achieved following CFA and using the Maximum Likelihood method indicated that the model has a good fit (x^2=531,27; p<,05; x^2/sd= 2,617; RMSEA= ,077; NFI= ,93; CFI= ,96; IFI= ,96; NNFI= ,95). Factor correlations, mean, standard deviation, and reliability coefficients were calculated for the 22-item final version of the scale and the results supported SAS's construct validity. Parameter (λ) estimates for the 22 items are presented in Table 5.

Table 5. Parameter values (λ)

Items	Factors		
	FE (λ)	FA (λ)	PP (λ)
1 Because my family's financial situation prevents me from buying materials necessary for science classes	.58		
2 Because I do not have Internet at home to do my science homework	.69		
3 Because my parent's education level is not high enough to support me in science classes.	.55		
5 Because I do not have an opportunity to study for science classes with my friends.	.61		
13 Because I do not have a computer to do my science homework.	.65		
10 Because I fear that I will not be successful in science classes.		.69	
14 Because I abstain from asking questions to my teacher when I do not understand the subject in science classes.		.72	
17 Because the subjects in science classes are difficult for me.		.68	
11 Because I do not like science classes.			,66
12 Because I do not have a goal to learn science.			.56
15 Because I do not like my science teacher.			.59
16 Because my teacher does not believe that I can be successful in science.			.73
18 Because I do not know why I should learn science.			.72
19 Because I do not learn new information in science classes.			.71
20 Because science classes are not important for me.			.77
21 Because my family does not believe that I can be successful in science.			.65
22 Because learning science will not be useful.			.71
4 Because I do not like my school.			.49
6 Because our teacher does not interact with us when teaching science lessons.			.53
7 Because I do not think science classes are necessary.			.68
8 Because I do not want to learn science.			.72
9 Because I do not believe that I can be successful in science.			.51

Factor correlations of the scale ranged between .55 and .76. All factor correlations were significant at p<.01 level. There were medium-level, positive relationships among factors (Table 6). Mean, standard deviation, and reliability coefficients for each factor are presented in Table 7.

Table 6. Factor correlations coefficient

Factors	FE	FA	PP
FE	1	.76*	.60*
FA		1	.55*
PP			1

Table 7. Mean and standard deviation for SAS's sub-dimensions

Factors	N	Mean	Sd
FE	272	1.81	.91
FA	272	2.19	1.09
PP	272	1.61	0.75

In addition the results of the reliability analysis show that the reliability coefficient of the Family-Environment sub-dimension was .76, reliability coefficient for the Fear-Anxiety sub-dimension was .66, and reliability coefficient for the Psychological-Personal sub-dimension was .90. Moreover, Cronbach's alpha value for the whole scale was calculated as .91.

Confirmatory Factor Analysis (Single Factor)

Another round of CFA for one factor structure was conducted using the data collected from 406 secondary schools in order to decide whether SAS can be used to measure students' amotivation levels in science classes. The fit indices achieved suggested that the scale can also be used in its single factor structure (x^2=698,98; p<,05; x^2/sd= 3,530; RMSEA= ,079; SRMR= ,040; NFI= ,98; CFI= ,99; IFI= ,99; RFI= ,98; GFI= ,86; NNFI= ,99). Those results supported the idea that SAS can measure the factors which it is intended to measure and can be used to identify students' amotivation levels as well as the reasons of amotivation.

Conclusion

The present study aimed to develop the Science Amotivation Scale (SAS) which can be used to measure students' levels of amotivation and reasons behind their amotivation in science classes. Initially, a review of literature was conducted to create an item pool and interviews were held with students who had high levels of amotivation in science classes. The item pool included a number of dimensions such as family, friends, teacher, personal and psychological reasons, school, and environment. The initial item pool included 42 items which decreased to 22 items with a 3-factor structure following Exploratory Factor Analysis (EFA). After analysing the items that loaded onto each factor, the three factors were named as; Family-Environment (FE), Fear-Anxiety (FA), and Psychological-Personal (PP).

Within the Family-Environment factor, it is understood that various factors such as families' financial situation, monthly income, parents' level of education, availability of the Internet at home, having a computer for use, family support, family expectations, and opportunities for students to collaborate with their friends affect students' motivation (Atay, 2014; Demir, Öztürk & Dökme, 2012; Uzun & Keleş, 2010; Yerlikaya, 2014; Khamis, Dukmak & Elhoweris, 2008; Dembo, 2004). Deci and Ryan (1985) noted that social factors such as teachers, family, and friends affect motivation. Similarly, Legault, Green-Demers and Pelletier (2006) underlined that teachers, family, and friends are important social support factors which have effects on students' amotivation.

In addition, investigation of factors related to fear and anxiety which cause amotivation among students indicates that not believing that they could succeed in science classes, abstaining from asking questions to the teacher, and finding the topic to be difficult cause fear and anxiety. Martin and Tracey (2002) highlighted that fear and anxiety affected students' motivation. In their research, Green-Demers, Legault, Pelletier and Pelletier (2008) studied amotivation under four sub-dimensions. Those sub-dimensions are; (a) deficient ability beliefs, (b) deficient effort beliefs, (c) insufficient academic values, and (d) unappealing characteristics of school tasks. Thus, students' fears and anxiety might result from their lack of confidence in their abilities and unappealing school tasks.

The analysis of studies conducted on factors affecting students' motivation suggested that psychological and personal reasons affect students' motivation. These factors included various sub-dimensions such as students being passionate and enthusiastic, their beliefs, their goal orientations, self-confidence, reward and punishment, attitudes towards the course, being interested in the subject, positive thinking, weekly study time and individual differences (Arıkıl & Yorgancı, 2012; Ceylan, 2003; Khamis, Dukmak & Elhoweris, 2008; Gömleksiz & Serhatlıoğlu, 2014; Dembo, 2004;; Akbaba & Aktaş, 2005; Vatansever-Bayraktar, 2015; Yaman & Dede, 2007; Yenice, Saydam & Telli, 2012; Yetim, Demir & İlker, 2016). Zimmerman, Bandura and Martinez-Pons (1992) stated that motivation depends on self-regulation and personal goals. Raffini (1993), on the other hand, underlined that students do not perceive school as an important activity if their basic psychological and academic needs are not met in the school environment. Therefore, it is important for student motivation that teachers create an educational environment in which students feel psychologically safe.

Lastly, the scale's three-factor structure was confirmed using Confirmatory Factor Analysis (CFA) and the scale's construct validity was established. Furthermore, an extra layer of analysis (one-factor CFA) was conducted to test whether the scale can be used as a whole to measure students' amotivation levels and CFA

results indicated that the scale can be used for this purpose. Cronbach Alpha reliability coefficients were calculated as .76 for the Family-Environment factor, .90 for the Psychological-Personal factor, .66 for the Fear-Anxiety factor, .91 for the whole scale. These analyses suggested that the Science Amotivation Scale (SAS) is a valid and reliable scale that can be used to measure secondary school science students' amotivation levels and the reasons behind their amotivation.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

Acknowledgements or Notes

This article was prepared by benefiting from Karaca's (2019) master thesis.

References

Akbaba, S. & Aktaş, A. (2005). İçsel motivasyonun bazı değişkenler açısından incelenmesi [Searching internal motivation according to some variables]. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi*, *21*(21), 19-42.

Alvord, D. J. & Glass, L. W. (1974). Relationships between academic achievement and self-concept. *Science Education*, *58*(2), 175-179.

Arıkıl, G. & Yorgancı, B. (2012). *Öğretmenlerin, öğretmen adaylarının ve öğrencilerin motivasyonu algılama farklılıkları*. X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi. Niğde Üniversitesi Eğitim Fakültesi.

Atay, A. D. (2014). *Ortaokul öğrencilerinin fen öğrenmeye yönelik motivasyon düzeylerinin ve üstbilişsel farkındalıklarının incelenmesi*. (Master thesis). Adnan Menderes University, Fen Bilimleri Enstitüsü, Aydın.

Aydın, S., Yerdelen S., Gürbüzoğlu-Yalmancı S. & Göksu, V. (2014). Academic motivation scale for learning biology: A scale development study. *Education and Science*, *39*(176),425-435.

Azizoğlu, N. & Çetin, G. (2009). 6 ve 7. Sınıf öğrencilerinin öğrenme stilleri, fen dersine yönelik tutumları ve motivasyonları arasındaki ilişki [Six And Seventh Grade Students' Learning Styles, Attitudes Towards Science And Motivations]. *Kastamonu Eğitim Dergisi, 17*(1), 171-182.

Bart, W. M. (1978). Formal operations among high school adolescents from lower and middle socio-economic classes: An investigation of the scholastic import, psychometric structures, and styles of formal reasoning. *Unpublished final report to the Spencer Foundation*, Chicago.

Ceylan, M. (2003). *İki öğretmenin sınıf içinde motivasyon değişkenlerini dikkate alma davranışlarının betimlenmesi.* (Master thesis). Anadolu Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir.

Deci, E. L. & Ryan, R. M. (1985). *Intrinsic motivation and self determination in human in behavior*. New York: Plenum Press.

Deci, E. L. & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268.

Dede, Y. & Yaman, S. (2008). Fen öğrenmeye yönelik motivasyon ölçeği: Geçerlik ve güvenirlik çalışması [A questionnaire for motivation toward science learning: A validity and reliability study]. *Necati Bey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, *2*(1), 19-37.

Dembo, M. H. (2004). *Motivation and learning strategies for college success:A self management approach* (2nd ed.). Mahwah: Lawrence Erlbaum Associates

Demir, R., Öztürk, N. & Dökme, İ. (2012). İlköğretim 7. sınıf öğrencilerinin fen ve teknoloji dersine yönelik motivasyonlarının bazı değişkenler açısından incelenmesi [Investigation of 7th grade primary school students' motivation towards science and technology course in terms of some variables]. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, *12*(23), 1-21.

Dicke, A.-L., Lüdtke, O., Trautwein, U., Nagy, G., & Nagy, N. (2012). Judging students' achievement goal orientations: are teacher ratings accurate?. *Learning and Individual Differences*, 22, 844-849.

Gömleksiz, M. N. & Serhatlıoğlu, B. (2014). Öğretmen adaylarının akademik motivasyon düzeylerine ilişkin görüşleri [Prospective teachers' perceptions of academic motivation levels]. *Türkiye Sosyal Araştırma Dergisi, 17* (3), 99-127.

Green-Demers, I., Legault, L., Pelletier, D. & Pelletier, L. G. (2008). Factorial invariance of the Academic Amotivation Inventory (AAI) across gender and grade in a sample of Canadian high school students. *Educational and Psychological Measurement*, 68(5), 862-880.

Green, J., Nelson, G., Martin, A. J. & Marsh, H. (2006). The causal ordering of self-concept and academic motivation and its effect on academiz achievement. *Internetional Education Journal*, 7(4), 534-546.

İlter, İ. (2019). Akademik motivasyonsuzluk ölçeğinin Türk kültürüne uyarlanması [Adaptation of the Academic Amotivation Scale into Turkish Culture]. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi*, *52*(1), 191-224.

Karaca, B. (2019). *Fen bilimleri dersinde motivasyonsuz olan öğrencilerin motivasyonsuz olmalarına neden olan faktörlerin incelenmesi*. (Master thesis). Kafkas University, Kars.

Kashef , M. M., Mazyari, M. & Ameri, M. H. S., (2012). The relationship between support behaviours of physical education teachers and a motivation of students in physical education activities at schools. *In The Asian Conference on Education*, Osaka, Japan, Oct (pp. 24-28).

Khamis, V., Dukmak, S. & Elhoweris, H., (2008). Factors affecting the motivation to learn among United Arab Emirates middle and high school students. *Educational studies, 34*(3), 191-200.

Linnenbrink, E. A. & Pintrich, P. R. (2002). Motivation as an enabler for academic success. *School Psychology Review*, 31(3), 313-327.

Legault, L., Green-Demers, I. & Pelletier, L. (2006). Why do high school students lack motivation in the classroom? Toward an understanding of academic amotivation and the role of social support. *Journal of Educational Psychology*, *98*(3), 567-582.

McCombs, B. L. (1991). Motivation and lifelong learning. *Educational psychologist*, *26*(2), 117-127.

Martin, A. J. & Tracey, D. (2002). Motivating students to learn. *Learning-Links Publication of Association for Children with Learning Disabilities. 3*, 1-5.

Orsini, C., Binnie, V. I. & Wilson, S. L. (2016). Determinants and outcomes of motivation in health professions education: a systematic review based on self-determination theory. *Journal of educational evaluation for health professions*, *13*, 19.

Pelletier, L. G., Dion, S., Tuson, K. & Green- Demers, I. (1999). Why do people fail to adopt environmental protective behaviors? Toward a taxonomy of environmental amotivation 1. *Journal of Applied Social Psychology*, *29*(12), 2481-2504.

Pintrich, P. R. & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33-40

Pintrich, P. R. & Schunk, D. (1996). Motivation in education: Theory, research, and applications. *Upper Saddle*, NJ: Prentice-Hall, Inc.

Raffini, J. P. (1993). Winners without losers: Structures and strategies for increasing student motivation to learn. Boston: Allyn & Bacon

Trumper, R. (1995). Students' motivational traits in science: A cross-age study. *British Educational Research Journal*, *21*(4), 505-516.

Uzun, N. & Keleş, Ö. (2010) . Fen öğrenemeye yönelik motivasyonun bazı demografik özelliklere göre değerlendirilmesi [Evaluation of the Motivation for Science Learning According to Some Demographic Characteristics]. *Gazi Eğitim Fakültesi Dergisi, 30*(2), 561-584.

Uzun, N. & Keleş, Ö. (2012). İlköğretim öğrencilerinin fen öğrenmeye yönelik motivasyon düzeylerinin değerlendirilmesi [Evaluation of primary school students' motivation levels for science learning]. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *9*(20), 313-327.

Uzgören-Gültan, C. (1999). *İlköğretim okulları ikinci kademe ingilizce öğrencilerinin motivasyonu* [*Secondary school English students motivation*]. (Master thesis). Marmara Üniversity, Sosyal Bilimler Enstitüsü, İstanbul.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C. ve Vallieres, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and psychological measurement*, *52*(4), 1003-1017.

Vatansever-Bayraktar, H. (2015). Sınıf yönetiminde öğrenci motivasyonu ve motivasyonu etkileyen etmenler [Student motivation in classroom management and factors that affect motivation]. *Electronic Turkish Studies*, *10*(3).

Vlachopoulos, S. P. & Gigoudi, M. A. (2008). Why don't you exercise? Development of the amotivation toward exercise scale among older inactive individuals. *Journal of aging and physical activity*, *16*(3), 316-341.

Yaman, S. & Dede, Y. (2007). Öğrencilerin Fen ve Teknoloji ve Matematik dersine yönelik motivasyon düzeylerinin bazı değişkenler açısından incelenmesi [Examination of motivation level of students towards science and mathematics by some variables]. *Kuram ve Uygulamada Eğitim Yönetimi*, *52*(52), 615-638.

Yenice, N., Saydam, G. & Telli, S. (2012). İlköğretim öğrencilerinin fen öğrenmeye yönelik motivasyonlarını etkileyen faktörlerin belirlenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *3*(2), 231-247.

Yerlikaya, İ. (2014). İlkokul ve ortaokul öğrencilerinin eğitime ilişkin motivasyonlarının çeşitli değişkenler açısından incelenmesi. *Tarih Okulu Dergisi (TOD), 7*, 773-795.

Yetim, E., Demir, Y. & Erturan-İlker, G. ve (2016). Beden eğitimi derslerinde motivasyon, tutum ve motivasyonel stratejilerin tahmin edici etkisi. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi*, *12*(2), 139-146.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American educational research journal*, *29*(3), 663-676.

Author Information

Büşra Karaca
Kafkas University, Dedekorkut Education Faculty
Science Education Department, Kars/TURKEY
Contact e-mail:bsrkskn25@gmail.com

Solmaz Aydin
Kafkas University, Dedekorkut Education Faculty
Science Education Department, Kars/TURKEY
ORCID iD: 0000-0003-0153-9545

Appendix 1: Fen Bilimlerinde Motivasyonsuzluk Ölçeği (Turkish Version)

Sevgili öğrenciler;

Bu ölçek Fen Bilimleri dersini öğrenmeyi istememenizin sebeplerini belirlemek amacıyla hazırlanmıştır. Her bir maddeyi dikkatlice okuyarak size uygun gelen ifadeyi 1'den 5'e kadar puanlayınız. Katkılarınızdan dolayı teşekkür ederiz.

Neden fen öğrenmek istemiyorsunuz?	**Kesinlikle katılmıyorum**	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle katılıyorum**
Çünkü ailemin maddi durumu fen dersindeki gerekli malzemeleri almaya yetmiyor.	①	②	③	④	⑤
Çünkü evde fen ödevlerimi yapabilmek için internetim yok.	①	②	③	④	⑤
Çünkü ailemin eğitim durumu fen dersime yardım etmek için yeterli değil.	①	②	③	④	⑤
Çünkü okulumu sevmiyorum.	①	②	③	④	⑤
Çünkü arkadaşlarımla birlikte fen dersini çalışma imkanım olmuyor.	①	②	③	④	⑤
Çünkü öğretmenimiz fen dersini anlatırken bizimle hiç iletişim kurmuyor.	①	②	③	④	⑤
Çünkü fen dersinin gerekli olduğunu düşünmüyorum.	①	②	③	④	⑤
Çünkü fen dersini öğrenmek istemiyorum.	①	②	③	④	⑤
Çünkü fen dersini başarabileceğime inanmıyorum.	①	②	③	④	⑤
Çünkü fen dersini yapamayacağımdan korkuyorum.	①	②	③	④	⑤
Çünkü fen dersini sevmiyorum.	①	②	③	④	⑤
Çünkü fen dersini öğrenmek için bir hedefim yok.	①	②	③	④	⑤
Çünkü fen ödevlerimi yapabilmek için bilgisayarım(tablet-telefon vb.) yok.	①	②	③	④	⑤
Çünkü fen dersinde konuyu anlamadığım zaman öğretmenime soru sormaktan çekiniyorum.	①	②	③	④	⑤
Çünkü fen öğretmenimi sevmiyorum.	①	②	③	④	⑤
Çünkü öğretmenim fen dersini yapabileceğime inanmıyor.	①	②	③	④	⑤
Çünkü fen dersindeki konular bana zor geliyor.	①	②	③	④	⑤
Çünkü neden fen öğrenmem gerektiğini bilmiyorum.	①	②	③	④	⑤
Çünkü fen dersinde yeni bilgiler öğrenmiyorum.	①	②	③	④	⑤
Çünkü fen dersi benim için önemli bir ders değil.	①	②	③	④	⑤
Çünkü ailem fen dersini yapabileceğime inanmıyor.	①	②	③	④	⑤
Çünkü fen dersini öğrenmek işime yaramayacak.	①	②	③	④	⑤

Appendix 2: Science Amotivation Scale

Dear students;
This scale has been prepared in order to determine the reasons for not wanting to learn Science course. Read each item carefully and score the expression that suits you from 1 to 5. Thank you for your contribution.

Why don't you learn science?	**Strongly Disagree**	**Disagree**	**Not sure**	**Agree**	**Strongly Agree**
Because my family's financial situation prevents me from buying materials necessary for science classes.	①	②	③	④	⑤
Because I do not have Internet at home to do my science homework.	①	②	③	④	⑤
Because my parent's education level is not high enough to support me in science classes.	①	②	③	④	⑤
Because I do not like my school.	①	②	③	④	⑤
Because I do not have an opportunity to study for science classes with my friends.	①	②	③	④	⑤
Because our teacher does not interact with us when teaching science lessons.	①	②	③	④	⑤
Because I do not think science classes are necessary.	①	②	③	④	⑤
Because I do not want to learn science.	①	②	③	④	⑤
Because I do not believe that I can be successful in science.	①	②	③	④	⑤
Because I fear that I will not be successful in science classes.	①	②	③	④	⑤
Because I do not like science classes.	①	②	③	④	⑤
Because I do not have a goal to learn science.	①	②	③	④	⑤
Because I do not have a computer to do my science homework.	①	②	③	④	⑤
Because I abstain from asking questions to my teacher when I do not understand the subject in science classes.	①	②	③	④	⑤
Because I do not like my science teacher.	①	②	③	④	⑤
Because my teacher does not believe that I can be successful in science.	①	②	③	④	⑤
Because the subjects in science classes are difficult for me.	①	②	③	④	⑤
Because I do not know why I should learn science.	①	②	③	④	⑤
Because I do not learn new information in science classes.	①	②	③	④	⑤
Because science classes are not important for me.	①	②	③	④	⑤
Because my family does not believe that I can be successful in science.	①	②	③	④	⑤
Because learning science will not be useful.	①	②	③	④	⑤

JESEH
Journal of Education in Science, Environment and Health
Volume 6, Issue 4, 2020
DOI:10.21891/jeseh.705977

A Study to Adapt the "Puppet Interview Scales of Competence in and Enjoyment of Science" to Turkish Culture

Berrin Akman, Erhan Alabay, Mefharet Veziroglu-Celik, Pinar Aksoy, Selahattin Gelbal

Article Info

Article History

Received:
02 November 2019

Accepted:
28 June 2020

Keywords

Early childhood period
Teaching science
Puppet interview scales of competence in and enjoyment of science
Scale adaption

Abstract

Children interact with science from the moment of their birth. By means of the scientific experiences they have as a result of this interaction, children acquire numerous skills related to science at the early ages. These scientific skills and children's orientation towards science such as awareness, attitude, proficiency, inquisitiveness, as well as interest and ability in researching, exploring, problem solving are especially enhanced by effective science education in early childhood. A valid and reliable assessment tool is needed to determine whether children's scientific attitude and orientation are at desirable levels. The aim of this study, which was developed in line with this need, is to examine validity and reliability of Puppet Interview Scales of Competence in and Enjoyment of Science (in original version; Samarapungavan, Mantzicopoulos& Patrick, 2008) in the context of Turkish culture. Data was gathered from 1158 children in 15 provinces in various regions of Turkey. KR-20 was computed to be .96 for the first subscale, .90 for the second subscale, .80 for the third subscale and .87 for the forth subscale. As a result of exploratory factor analysis for validity, the scale was gathered with 41 items and in four sub-dimensions in total. The total variability of all the factors was computed to be 49.35%. The confirmatory factor analysis conducted on another sample revealed that error is within an acceptable range (.63) and adaptation statistics is above .80. The CFI and NFI values -the indicators of the goodness-of-fit index- are above .90. Additionally, IFI value is .98 and the SRMR value is lower than .08. These indicate high model-data conformity. As a result of this study, Puppet Interview Scales of Competence in and Enjoyment of Science were found to be a reliable and valid scale for the Turkish society.

Introduction

Science plays a significant part in individuals' life (Bornstein & Lamb, 2005; Farenga, Joyce & Ness, 2001). Various experiences that preschool children have in their social environment in particular are closely related to science (Akman, 2003; Holt, 1977; Howe & Jones, 1998). Many situations, events and concepts, encountered by the child in his/her environment, such as the characteristics and motions of ordinary observable objects, life cycles of living beings, astronomical objects visible in the sky, slow or fast-paced changes in world, and technological advances are all subjects of science (Aktaş-Arnas, 2002). The National Science Education Standards, which describe the standards, extent, and content of preschool science education, were also created with this fact in mind. According to the National Science Education Standards, preschool science education can be grouped under eight categories. These are unifying scientific concepts and processes, scientific inquiry, physical science, life science, earth and space science, science and technology, science as seen from individual and social perspectives, and the nature and history of science (National Research Council [NRC], 1996; NRC, 2000). As captured by these categories, children start exploring the world of science, asking questions and searching for answers, solving problems and gathering awareness from the moment of their birth through both the formal and informal experiences they have. As they grow older, children become more adept at using their sensory faculties and start to utilize the essential skills involved in scientific processes (Pianta, 2012; Samarapungavan, Mantzicopoulos& Patrick, 2008; Saracho & Spodek, 2007). In this regard, a planned approach to preschool science education is essential to ensure that children acquire basic knowledge and skills related to science, are able to comprehend the objects and events they encounter, and become acquainted with scientific concepts (Akman, Üstün & Güler, 2003; Dubosarsky, 2011; Duschl, Scweingruber & Shouse, 2006; Erden & Sönmez, 2011; French, 2004).

Eshach & Fried (2005) explain the significance of preschool science education in a study on this subject. A well-planned science education program enables children to think about the concepts and events they are curious about and would like to know more about, and helps them develop a positive orientation towards their experiences concerning science. At the same time, such a program is instrumental in supporting the acquisition of scientific literacy, a scientifically meaningful grasp of cause-effect relationships, and the ability to use scientific reasoning skills more effectively (Akman, Üstün & Güler, 2003; Platz, 2004). According to Akman (2010), an effective preschool science education supports the development of children's grasp of scientific concepts and skills and the growth of their scientific knowledge. Science education helps raising children's scientific awareness regarding the experiences they have, improves the skills instrumental for discovery and generally reinforces the skills that are needed to conduct a basic scientific investigation. Akman (2010) also emphasizes the key role of science education in keeping alive the children's sense of wonder and inquisitiveness and in helping them adopt a realistic, objective, and critical attitude towards the concepts and events they encounter in their environment. The children whose developments are supported with a science education that takes the said facts into account tend to develop a positive orientation towards science, and their positive orientation manifests itself in their scientific behavior.

In a study that aims to determine preschool children's motivational beliefs concerning science education, Samarapungavan, Mantzicopoulos & Patrick (2008) also argue that science education from a very early age has remarkable significance regarding the longevity of their interests in science throughout their future careers and their future scientific success. Moreover, the results of the study reveal that the duration of exposure to scientific education and their motivational beliefs related to science (interest in science, scientific self-confidence, scientific curiosity, scientific literacy and scientific competence) are positively correlated. Similarly, Barton (2010) reports that inclusion of science education into early childhood programs would pose a major advantage for the children exposed to it. As inclusion and healthy application of science education in a curriculum lead to improvements in children's skills in numerous areas such as communication, reading-writing, and critical thinking, these also result in detectable positive changes in their scientific tendencies. In another study, where Samarapungavan, Patrick & Mantzicopoulos (2011) compared the scientific motivation of children enrolled in an effective science program (based on critical thinking) with a control group, they found significant differentiation in favor of the experiment group. Nevertheless, Brooks (2012) concludes in a study that children are able to use their visual and manual skills more effectively within the framework of basic process skills, to retain scientific information more effectively, and to give answers that are more sophisticated to the questions asked to them, by means of a science education program.

In related literature, there are a number of scales about science competence or motivation. Science Motivation Scale (Çetin-Dindar & Geban, 2015), Academic Motivation Scale Toward Learning Biology (Aydın, Yerdelen, Yalmancı & Göksu, 2014), Continuing Motivation for Science Learning Scale (Erdoğan, Çakır, Gürel, & Şeker, 2015) and Questionnaire for Motivation toward Science Learning (Dede & Yaman, 2008) can be shown as examples for these scales. However, when all adapted and developed scales are investigated, it is seen that they are suitable for children at primary school, secondary school, and high school levels. Any scale about motivation, attitude, or competence toward science could not be found for children at the early childhood level. It is very crucial to support children by exploring their competencies, attitudes, or motivations toward science in early childhood years.

Objective

The objective of this study is to create an adaptation of Puppet Interview Scales of Competence in and Enjoyment of Science for preschoolers by Samarapungavan, Mantzicopoulos & Patrick (2008) to the Turkish culture.

Method

Overview

This scale was developed originally in English for pre-literacy children who are very young to have linguistic competence and knowledge base to express their different beliefs and opinions in areas such as science. The scale has 63 items comprising four subscales: General Scientific Competence, Specific Scientific Knowledge and Ability, Love of Science, and Ease of Scientific Learning. The scale includes criteria for both a positive and a negative evaluation of each item. Each positive response adds 1 point to the child's score, while negative

responses are considered 0 points, which makes the possible range of a total score from 0 to 63. In every item of the scale, a sentence is read to the child. In each item, there are two different images. Whereas one of the images displays the read sentence in a negative way, the other image displays the sentence in a positive way. At this point, the child is required to choose the image that is closer to him/her by internalizing the images. Before applying the scale, the children involve in an array of activities containing scientific films and books, and thus acquire some familiarity with the subjects and situations mentioned in the items of the scale. Higher total scores indicate that the child's attitude and orientation towards science are positive whereas lower scores indicate the opposite.

Study Group

Researchers used the Turkish adaptation of the scale on 1158 six year-olds enrolled in the public and private preschool education institutions in the provinces of Aksaray, Ankara, Aydın, Balıkesir, Gaziantep, İstanbul, İzmir, Karaman, Kırşehir, Konya, Mersin, Rize, Tokat, Şanlıurfa, and Uşak. Demographic information of the children who involved in the study is provided in Table 1.

Table 1. Demographic information of the sample

Demographic	Characteristic	n	%
Gender	Girl	595	51.38
	Boy	563	48.62
	Total	1158	100
Type of School	Public School	511	44.13
	Private School	647	55.87
	Total	1158	100
City	Aksaray	55	4.75
	Ankara	145	12.52
	Aydın	79	6.82
	Balıkesir	43	3.71
	Gaziantep	64	5.53
	İstanbul	105	9.07
	İzmir	99	8.55
	Karaman	88	7.60
	Kırşehir	38	3.28
	Konya	134	11.57
	Mersin	39	3.37
	Rize	43	3.71
	Şanlıurfa	74	6.39
	Tokat	97	8.38
	Uşak	55	4.75
	Total	1158	100

In the study, it was found that the average age of the children in the study is 62.78 months. During the data collection procedure, the public and private schools, for which necessary permissions were received, were visited by the researchers. The data was collected by each researcher by working with children one by one while applying the scale. This process took about 18-25 minutes for every child.

Findings

The Validity of the Scale

Linguistic Validity

In order to assess and ensure the linguistic validity of the scale, three language specialists were hired to translate independently the Puppet Interview Scales of Competence in and Enjoyment of Science from English, its original language, to Turkish. Then, the three translations were combined together, keeping the parts agreed in all three translations. The specialists who did the translation were consulted regarding the parts where their translations differed, and a consensus was reached concerning a uniform wording. The names of the subscales of the scale were also simplified by taking into account the feedback received from the specialists. The resulting

scale text was re-translated back to English by three new language specialists. Finally, three new specialists were asked to compare the English re-translation with the original English version, and they unanimously determined that there was not any significant difference between the re-translation and the original. - A field expert was asked for opinion in order to collect sufficient proofs for the Turkish version, and it was found as a result of the field expert opinion that the translation was highly consistent. In this line, language validity of the translation was ensured.

Structural Validity

Factor analysis was utilized in order to determine structural validity. Since it would have been inappropriate to conduct both exploratory and confirmatory factor analyses on a single data set, the data was divided into two equal parts in an unbiased manner. Then exploratory factor analysis was conducted on the first part and confirmatory factor analysis on the second part. In order to determine the number of factors under which the items examined by the factor analysis were accumulated, eigenvalues and the explored percentages of variance were prioritized. The items with factor weights greater than .35 were evaluated and items with eigenvalues greater than 1 were determined to be significant. Factor loadings of items were examined and items with a factor loading less than 0.35 were excluded. As a result, 22 items were excluded from the original scale because of low factor loadings, and the analysis continued with 41 items. The results of the factor analysis are provided in Table 2.

Table 2. The eigenvalues and explored percentages

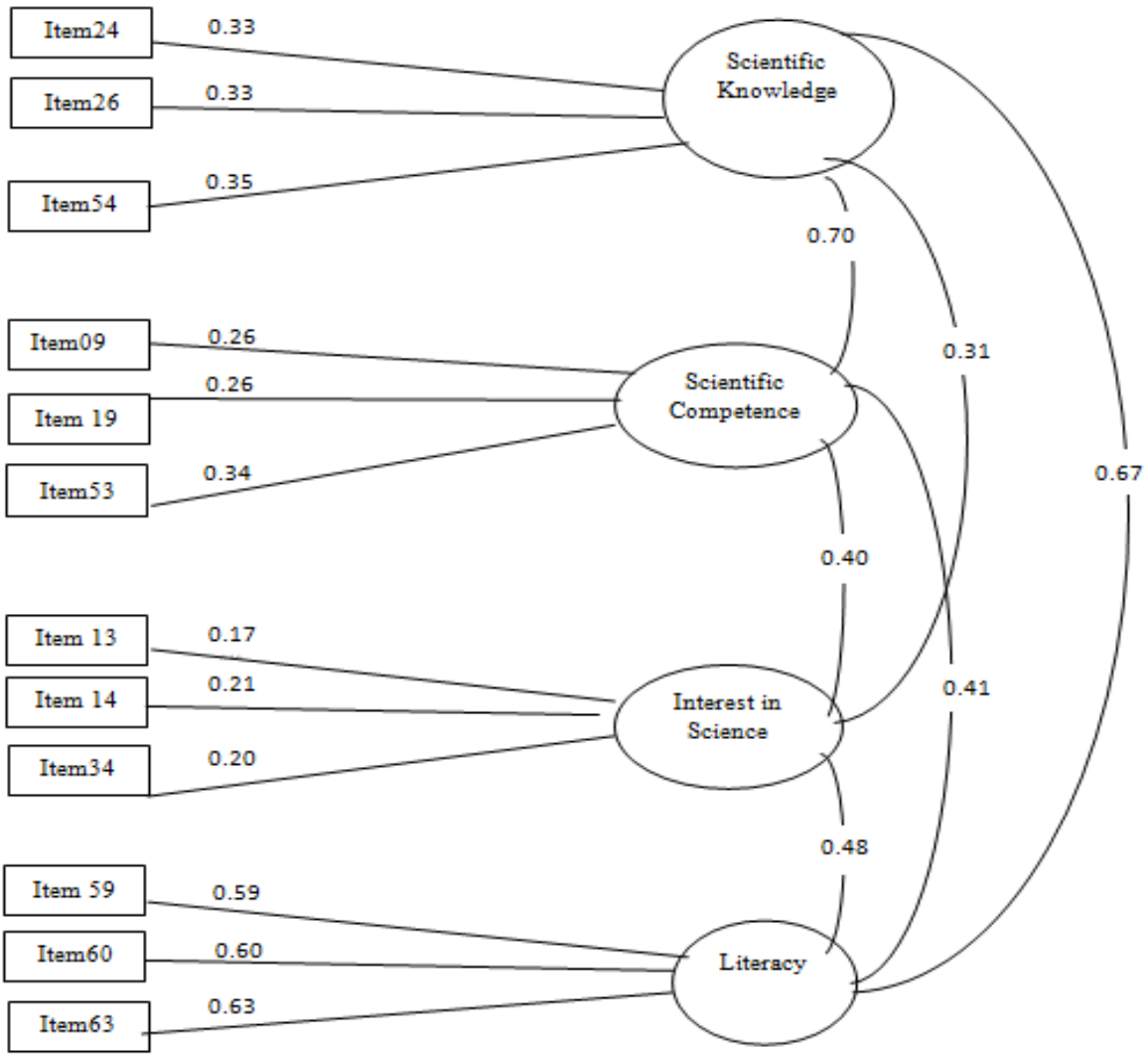
Components	Eigenvalues	Explored Var. %
1	19.861	31.525
2	5.881	9.335
3	3.478	5.521
4	1.983	3.147

*Extraction Method: Principal Component Analysis

In Table 2, it is observed that there are four components with eigenvalues over 1.00. Therefore, the scale has a four-factor structure. Nevertheless, as it is depicted in Table 2, the variability of individual factors are respectively 31.525%, 9.335%, 5.521%, and 3.147%. The combined variability of the four factors is 49.525%. Table 3 lists the factor weights and item-total score correlations for each item relative to the magnitude of the factor weight. As a result of the factor analysis, the items of the scale fall under 4 subscales.

Table 3. Item-total score correlations of the factor weights after the application of varimax rotation

Scientific Knowledge			Scientific Competence			Interest in Science			Literacy		
Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$
BGY35	.813	.747	BGY09	.695	.754	BGY13	.450	.550	BGY59	.592	.549
BGY48	.798	.742	BGY19	.632	.682	BGY14	.587	.470	BGY60	.677	.737
BGY42	.795	.787	BGY20	.683	.652	BGY15	.459	.429	BGY61	.797	.835
BGY44	.791	.781	BGY43	.567	.729	BGY21	.537	.672	BGY62	.730	.778
BGY29	.791	.738	BGY50	.752	.614	BGY22	.579	.709	BGY63	.745	.798
BGY47	.782	.732	BGY51	.782	.754	BGY25	.571	.592			
BGY31	.780	.811	BGY52	.735	.742	BGY27	.462	.453			
BGY49	.768	.699	BGY53	.744	.706	BGY34	.501	.604			
BGY37	.757	.767									
BGY40	.756	.777									
BGY45	.752	.633									
BGY38	.748	.755									
BGY33	.743	.812									
BGY24	.732	.817									
BGY26	.731	.778									
BGY32	.728	.727									
BGY46	.710	.804									
BGY36	.683	.815									
BGY54	.661	.788									
BGY39	.624	.692									
N of items	20			8			8			5	
Reliability	.967			.907			.803			.877	



Chi-Square: 2629,12 df: 773 p = 0,000 RMSEA= 0,071

Figure 1. Confirmatory factor analysis diagram for items

The varimax rotation technique was used to facilitate the exploration of important factors. The items in the factors, which seem to be important due to their post-rotation factor weights, were also listed in Table 3. From the view that the sub-dimensions can be renamed, these four factor dimensions were named as "Scientific Knowledge", "Scientific Competence", "Interest in Science", and "Literacy", based on the contents of these factors and in accordance with the opinion of the expert of the field. In addition to exploratory factor analysis, confirmatory factor analysis was also conducted on the scale, the results of which are provided in Figure 1.

The most frequently computed statistics on the model-data fit in confirmatory factor analysis are Chi-square (x^2), x^2/sd, Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR), Goodness-of-Fit-Index (GFI), and Adjusted Goodness-of-Fit-Index (AGFI). Model-data fit is indicated by a computed x^2/df (3.401) ratio lower than 5, GFI and AGFI values greater than .90, and RMR and RMSEA values smaller than .05. However, ~~a~~ GFI greater than .85, AGFI greater than .8, and RMR and RMSEA smaller than .10 could also be taken as reasonable lower-bounds for model-data fit (Anderson & Gerbing, 1984: Reported by Duyan & Gelbal, 2008). Perfect model fit and acceptable model fit ranges for goodness of fit statistics were given in Table 4 below (Hair, Black, Babin & Anderson, 2010; Hu & Bentler, 1999; Kline, 2011; Tabachnick & Fidel, 2013; West, Taylor & Wu, 2012). Additionally, statistics concerning the model-data fit revealed by the confirmatory factor analysis conducted on the Puppet Interview Scales of Competence in and Enjoyment of Science were provided in the same table.

Table 4. Model-data fit values

	Perfect Model Fit	Acceptable Model Fit	Goodness-of-Fit
Chi-square	-	-	2629.12
df	-	-	773
p-value			.000
χ^2/df	χ^2/df <3	3<χ^2/df < 5	3.401
CFI	CFI > 0.95	0.90 < CFI <0.95	0.97
NFI	NFI > 0.95	0.90 < NFI <0.95	0.96
GFI	GFI > 0.95	0.90 < GFI <0.95	0.80
IFI	IFI > 0.95	0.90 < IFI <0.95	0.97
RMR	RMR < 0.05	0.05 < RMR < 0.08	0.011
SRMR	SRMR < 0.05	0.05 < SRMR < 0.08	0.054
RMSEA	RMSEA < 0.05	0.05 < RMSEA < 0.08	0.071

The statistics concerning the model-data fit revealed by the confirmatory factor analysis conducted on the Puppet Interview Scales of Competence in and Enjoyment of Science are provided in Table 5.

Table 5. Goodness-of-fit indicate values

Chi-square	df	p-value	CFI	NFI	GFI	IFI	RMR	SRM	RMSEA	90%C.I RMSEA
2629.12	773	p<.05	.97	.96	80	.97	.011	.054	.071	.068-.074

Figure 1 depicts the model constructed to express the theoretical structure of the Puppet Interview Scales of Competence in and Enjoyment of Science. According to the results of the confirmatory factor analysis conducted to investigate the fit of this model to data, the fit between the model and data is high. The fact that CFI and NFI values, both of which are indicators of model-data fit, are higher than .90 indicates that model-data fit is high. Moreover, it can also be argued that the model-data fit is high because the IFI value, which yields the value of the SRMR probability independently of sampling, is .97. It is also possible to interpret that SRMR value is smaller than .08 as an indication of a good fit, as SRMR reveals the model-data fit with regards to the model's standardized error (Hu & Bentler, 1999).

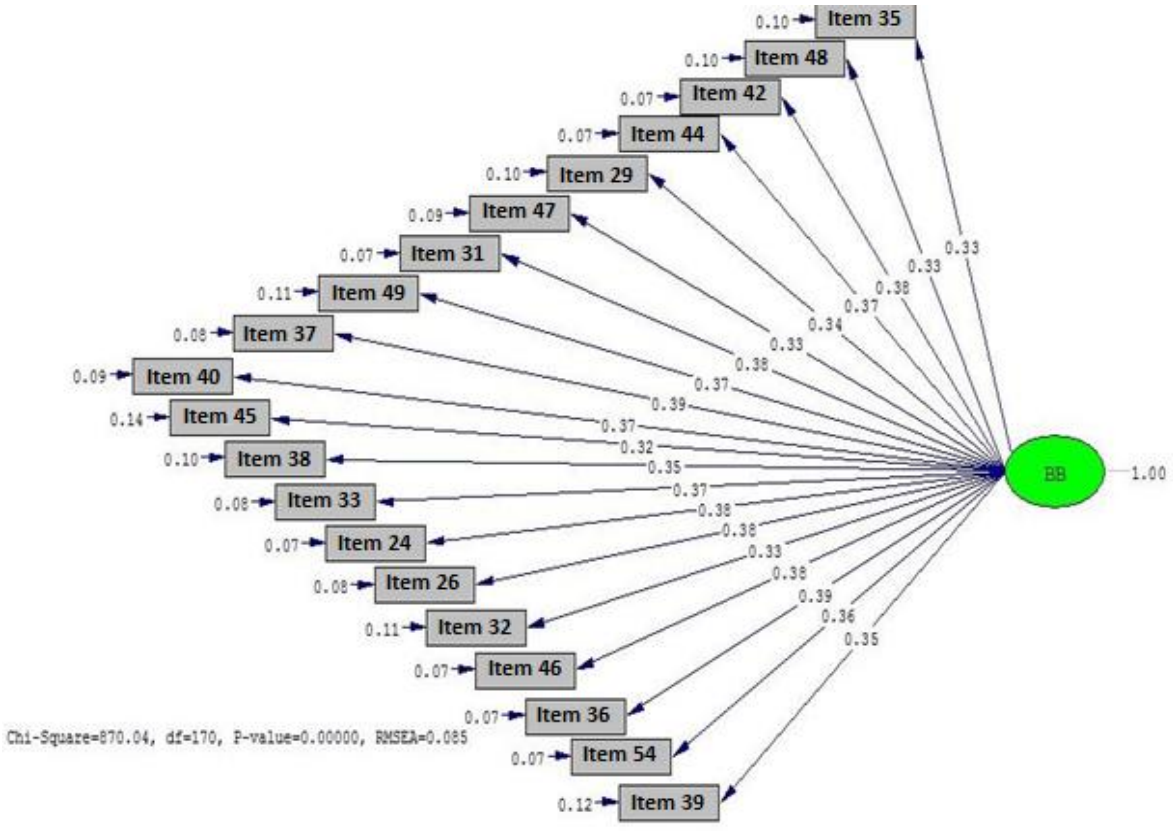


Figure 2. Confirmatory factor analysis results for questions in the subscale of scientific knowledge

A holistic evaluation of the values that track model-data fit reveals the finding that the model exhibits good fit to data, and that the scale has structural validity. In this regard, it can be concluded that the items comprising the scale can actually measure the otherwise-hidden variable of competence and enjoyment of science. Confirmatory factor analysis (CFA) was also conducted for the scale since it was stated by the developer that the scale is flexible and since subscales were created taking the items that work for the Turkish culture. The results presented in Figure 2, Figure 3 and Figure 4.

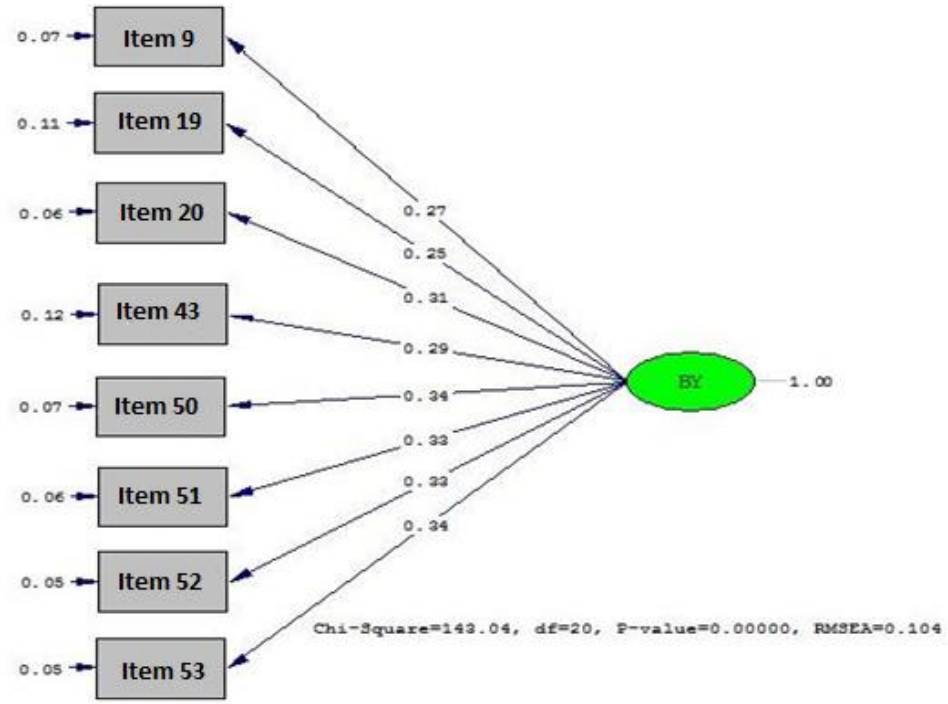


Figure 3. Confirmatory factor analysis results for questions in the subscale of scientific

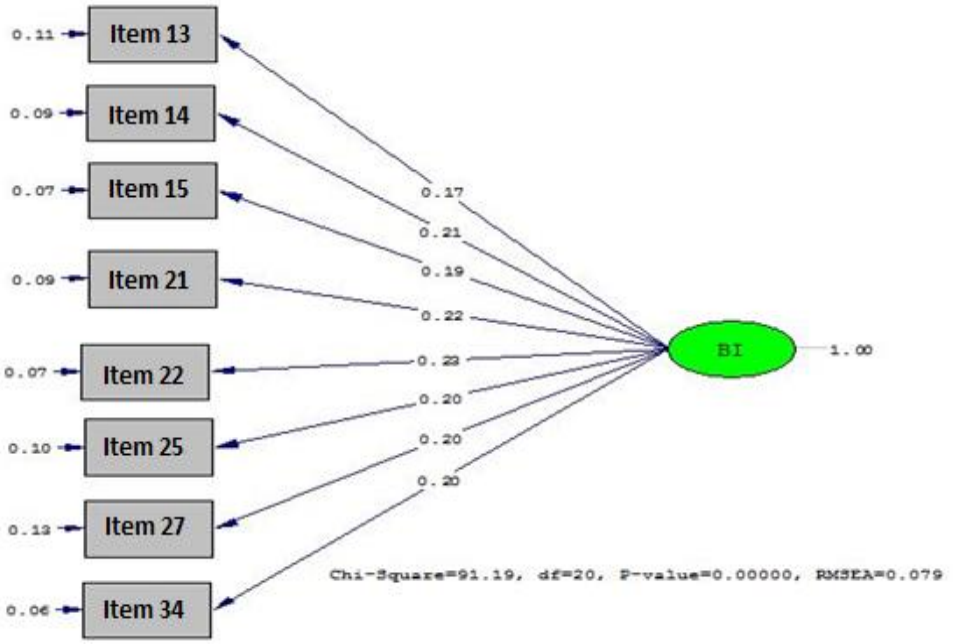


Figure 4. Confirmatory factor analysis results for questions in the subscale of interest

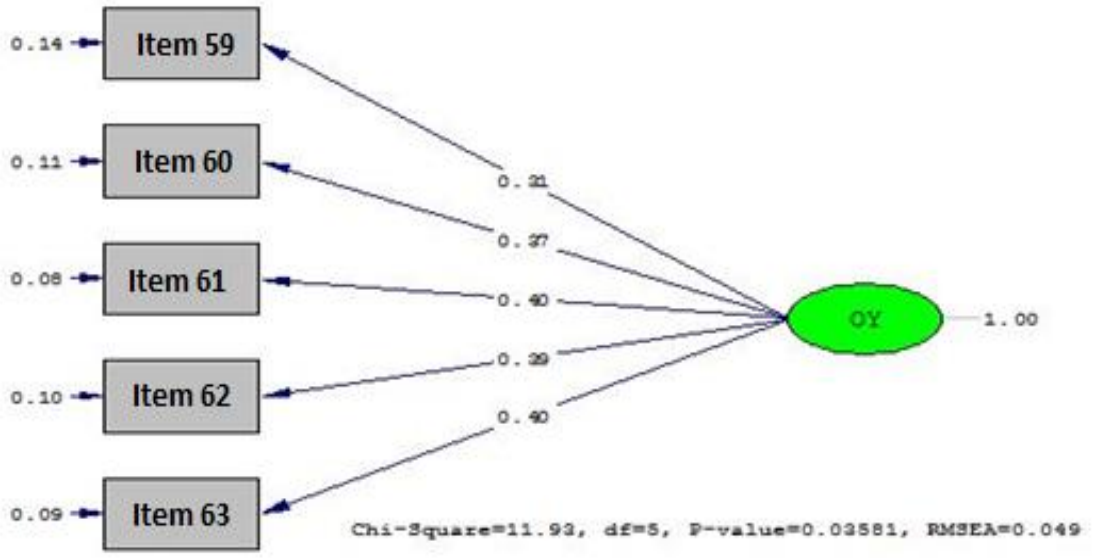


Figure 5. Confirmatory factor analysis results for questions in the subscale of literacy

Reliability of the Scale

Firstly, an itemized analysis of the scale was conducted and the characteristic response pattern was determined for each item. The correlations between the total score (X) and individual items (r(jx) item indicative strength level) were computed and listed in the final column (r(jx)) of Table 3. For each respective subscale, the item-total score correlations fluctuate between .58 and .81, .47 and .78, .61 and .76, .59 and .76. As the item indicative strength is .30 for each item (Özçelik, 2010), which means a good measurement, the correlations between the subscales and total score demonstrate the adequate indicative strength of individual items. KR-20 (Kuder Richardson), which is a special case of Cronbach alpha coefficient that yields the internal consistency of a collection of items scored 1-0, was used to estimate the reliability of the scale. The internal consistency coefficient of the items for respective subscales was found to be .96, .81, .90 and .87. As these values were sufficiently high, it was concluded that the Puppet Interview Scales of Competence in and Enjoyment of Science is reliable.

Conclusion and Suggestions

In this study, exploratory and confirmatory factor analyses were conducted in order to examine the factor structure of the Puppet Interview Scales of Competence in and Enjoyment of Science, and mutually congruent findings that support each other were reached. The results of the study indicate that the Turkish language adaptation of the scale exhibits the same four-factored structure as the one the original scale has. The fact that some of the items were found to have low factor values by the analyses and therefore had to be taken out from the scale can be explained by an appeal to cultural differences. In particular, the virtual total absence of reading and writing education in Turkey's preschools is a significant cultural difference. This is why; the Turkish adaptation of the scale contains pictures so as to facilitate effective application of the scale on illiterate preschool children. The facts that the items comprising the Puppet Interview Scales of Competence in and Enjoyment of Science have desirable qualities and that the degree of reliability and validity of the scale is high and comparable to that of the original indicate that the adapted scale can be used to determine the levels of competence in and enjoyment of science among preschoolers in Turkey.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

Acknowledgements

Authors would like to thank to the developers of the original scale for granting permission to adapt it Turkish and are also grateful to all the participants and contributors involved in the study for their valuable support.

References

Akman, B. (2003). Okulöncesinde fen eğitimi. *Yaşadıkça Eğitim Dergisi*, *79*, 14-16.

Akman, B. (2010). *Erken Çocukluk dönemde bilim ve teknoloji*. Doctoral Seminar Lecture Notes, Ankara.

Akman, B., Üstün, E. & Güler, T. (2003). 6 yaş çocuklarının bilim süreçlerini kullanma yetenekleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *24*, 11-14.

Aktaş-Arnas, Y. (2002). Okulöncesi dönemde fen eğitimi. *Yaşadıkça Eğitim*, *76*, 4-6.

Aydın, S., Yerdelen, S., Yalmancı, G.& Göksu, V. (2014). Biyoloji öğrenmeye yönelik akademik motivasyon ölçeği: Ölçek geliştirme çalışması. *Eğitim ve Bilim, 39*(176), 425-435.

Barton, D. (2010). Early years science is so much more than just "knowledge and understanding of the world". *Primary Science*, *111*, 5-7.

Bornstein, M. H. & Lamb, M. E. (2005). *Developmental science: An advanced textbook* (5th Edition). New Jersey: Lawrence Erlbaum Associates Inc. Publishers.

Brooks, C. E. (2012). *Visual aids and manipulatives: transforming student learning and retention of science concepts in a preschool classroom*. Unpublished Master Thesis, Hofstra University, NY.

Çetin-Dindar, A. & Geban, Ö. (2015). Fen bilimleri motivasyon ölçeğinin Türkçe'ye ve kimya'ya uyarlanması: Geçerlilik çalışması. *Pegem Eğitim ve Öğretim Dergisi, 5*(1), 15-34.

Dede, Y.& Yaman, S. (2008). Fen öğrenmeye yönelik motivasyon ölçeği: geçerlik ve güvenirlik çalışması. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 2*(1), 19-37.

Dubosarsky, M. D. (2011). *Science in the eyes of preschool children: Findings from an innovative research tool*. Unpublished Doctorate Thesis, University of Minnesota, Minneapolis, MN.

Duschl, R. A., Schweingruber, H. A. & Shouse, A. W. (2006). *Talking science to school: Learning and teaching science in grades K-8.* Washington, D.C.: The National Academies Press.

Duyan, V. & Gelbal, S. (2008). Barnett çocuk sevme ölçeği'ni Türkçe'ye uyarlama çalışması. *Eğitim ve Bilim*, *33*(148), 40-48.

Erden, F. T. & Sönmez, S. (2011). Study of Turkish preschool teachers' attitudes toward science teaching. *International Journal of Science Education, 33*(8), 1149-1168.

Erdoğan, D., Çakır, M., Gürel, C.& Şeker, H. (2015). Daimi bilim öğrenme motivasyonu ölçeği'nin Türkçe'ye uyarlanması: Geçerlik ve güvenirlik çalışması. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 5*(2), 125-136.

Eshach, H. & Fried, M. N. (2005). Should science be taught in early childhood? *Journal of Science Education and Technology, 14*(3), 315-336.

Farenga, S. J., Joyce B. A.& Ness D. (2001) The science and mathematics of nature. *Science Scope*, *25*(2), 10-13.

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19*(1), 138-149.

Hair, J. F., Black, W. C., Babin, B. J.& Anderson, R. E. (2010). *Multivariate data analysis*. Englewood Cliffs, NJ: Prentice Hall.

Holt, B. G. (1977). *Science with young children*. Washington, DC: National Academy Press.

Howe, A. C. & Jones, L. (1998). *Engaging children in science*. New Jersey: Prentice Hall,Inc.

Hu, L, T. & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1- 55.

NRC (National Research Council). (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

NRC (National Research Council). (2000). *Inquiry and the National Science Education Standards*. Washington, DC : National Academy Press.

Kline, R.B. (2011). *Principles and practice of structural equation modeling*. New York: The Guilford Press.

Özçelik, D.A. (2010). *Test hazırlama kılavuzu* (4. baskı). Ankara: Pegem Akademi.

Pianta, R. (2012). *Handbook of early childhood education*. New York: The Guilford Press.

Platz, D. L. (2004). Challenging young children through simple sorting and classifying: A developmental approach. *Education, 125*(1), 88-96.

Samarapungavan, A., Mantzicopoulos, P. & Patrick, H. (2008). Learning science through inquiry in kindergarten. *Science Education, 92*(5), 868-908.

Samarapungavan, A., Patrick, H. & Mantzicopoulos, P. (2011). What kindergarten students learn in inquiry-based science classrooms. *Cognition and Instruction, 29*(4), 416-470.

Saracho, O. N. & Spodek, B. (2007). *Contemporary perspectives on science and technology in early childhood education*. USA: Age Publishing Inc.

Tabachnick, B. G.& Fidell, L.S. (2013). *Using multivariate statistics*. New Jersey: Pearson Education, Inc.

West, S. G., Taylor, A. B. & Wu, W. (2012). Model fit and model selection in structural equation modeling. In R. H. Hoyle (Eds.), *Handbook of Structural Equation Modeling* (pp. 209-231). New York: Guilford Press.

Author Information

Berrin Akman
Hacettepe University
Department of Early Childhood Education
ORCID iD: 0000-0001-5668-4382

Erhan Alabay
Universityof Health Science
Department of Child Development
Contact e-mail: erhan.alabay@sbu.edu.tr
ORCID iD: 0000-0003-4025-2352

Mefharet Veziroglu-Celik
İstanbul Medipol University
Department of Early Childhood Education
ORCID iD: 0000-0003-3790-9026

Pınar Aksoy
Tokat Gaziosmanpasa University
Department of Early Childhood Education
ORCID iD: 0000-0001-6107-3877

Selahattin Gelbal
Hacettepe University
Department of Educational Science
ORCID iD: 0000-0001-5181-7262

Appendix 1. English version of Puppet Interview Scales of Competence in and Enjoyment of Science

Sub-dimensions	Original item numbers	New item numbers	Scale items (score 1)
Scientific Knowledge	24	1	I know a lot about insects.
	26	2	I know why living things camouflage.
	29	3	I know how many legs insects have.
	31	4	I know a lot about different kinds of living things.
	32	5	I know how to measure things like a scientist.
	33	6	I know a caterpillar seen.
	35	7	I know what different living things need to stay alive.
	36	8	I can remember what my (science) books are about.
	37	9	I know how to use a science notebook.
	38	10	I am good at telling what is an insect.
	39	11	I know how fish breathe.
	40	12	I know a lot yet about animals that live in the ocean.
	42	13	I know how a hermit crab camouflages.
	44	14	I know how to make a prediction.
	45	15	I know how to make an observation.
	46	16	I know what tools to use to measure how heavy a book is.
	47	17	I am good at telling what makes things move.
	48	18	I know how a force makes things move.
	49	19	I know how to make a ball go fast on a ramp.
	54	20	I know lots of new science words.
Scientific Competence	9	21	I have fun learning science.
	19	22	I like reading scientific books.
	20	23	Science is beneficial.
	43	24	I know how to ask questions like a scientist.
	50	25	I like learning about how things move.
	51	26	I want to know more about living things.
	52	27	I have fun yet learning about animals that live in the ocean.
	53	28	I want to learn more about how things move.
Interest in Science	13	29	I like using different science tools
	14	30	I know how to do science.
	15	31	I learn science well.
	21	32	Learning about living things is easy.
	22	33	I am good at making an observation.
	25	34	I know how to use different tools to learn about science
	27	35	I can remember new science words
	34	36	I am good at making predictions.
Literacy	59	37	I know how to read different words
	60	39	I can read on my own.
	61	39	I can read stories with many words in them.
	62	40	I don’t need help with reading.
	63	41	I am good at reading new words.

Appendix 2. Turkish Version of Puppet Interview Scales of Competence in and Enjoyment of Science

Alt boyutlar	**Orjinal madde numarası**	**Yeni madde numarası**	**Ölçek maddeleri (1 puan)**
Bilimsel Bilgi	24	1	Böcekler hakkında çok şey biliyorum
	26	2	Canlıların neden gizlendiklerini biliyorum.
	29	3	Böceklerin kaç bacağı olduğunu bilirim.
	31	4	Farklı türde canlılar hakkında çok şey biliyorum.
	32	5	Bir bilim adamı gibi nasıl ölçüm yapacağımı biliyorum.
	33	6	Tırtılın nasıl göründüğünü biliyorum.
	35	7	Farklı canlıların hayatta kalmaları için ihtiyaç duyduğu şeyleri biliyorum.
	36	8	Bilimsel kitaplarımın hangi konularda olduğunu hatırlayabilirim.
	37	9	Bilim defterini nasıl kullanacağımı biliyorum.
	38	10	Böceğin ne olduğunu anlatmada iyiyim.
	39	11	Balıkların suda nasıl nefes aldıklarını biliyorum.
	40	12	Okyanusta yaşayan hayvanlar hakkında çok şey biliyorum.
	42	13	Bir yengecin nasıl gizlendiğini biliyorum.
	44	14	Nasıl tahminde bulunacağımı biliyorum.
	45	15	Nasıl gözlem yapacağımı biliyorum.
	46	16	Bir kitabın ağırlığını ölçmek için hangi aleti kullanacağımı biliyorum.
	47	17	Maddelerin nasıl hareket ettiğini anlatmada iyiyimdir.
	48	18	Bir kuvvetin nesneleri nasıl hareket ettirdiğini biliyorum.
	49	19	Bir topun yokuşta nasıl hareket ettiğini biliyorum.
	54	20	Bir çok bilimsel kelime bilirim.
Bilimsel Yeterlik	9	21	Bilim hakkında daha fazla şey öğrenmek isterim.
	19	22	Bilimsel kitapları okumayı severim.
	20	23	Bilim faydalıdır.
	43	24	Bir bilim insanı gibi nasıl soru soracağımı biliyorum.
	50	25	Nesnelerin nasıl hareket ettiğini öğrenmeyi seviyorum.
	51	26	Canlılar hakkında daha çok şey öğrenmek istiyorum.
	52	27	Okyanusta yaşayan canlılar hakkında bilgi sahibi olmaktan keyif alıyorum.
	53	28	Nesnelerin nasıl hareket ettiği konusunda daha çok şey öğrenmek istiyorum.
Bilimsel İlgi	13	29	Farklı bilim aletlerini kullanmayı severim.
	14	30	Bilimin nasıl yapıldığını biliyorum.
	15	31	Bilimi iyi öğrenirim.
	21	32	Canlılar hakkında bilgi sahibi olmak kolaydır.
	22	33	Gözlem yapmada iyiyim.
	25	34	Bilimi öğrenmek için farklı aletleri nasıl kullanacağımı biliyorum.
	27	35	Yeni bilimsel kelimeleri hatırlayabiliyorum.
	34	36	Tahmin yapmada iyiyim.
Okuma Yazma	59	37	Farklı harfleri nasıl okuyacağımı biliyorum.
	60	39	Tek başıma okuyabiliyorum.
	61	39	Çok sözcük içeren hikayeleri okuyabiliyorum.
	62	40	Okurken yardıma ihtiyaç duymam.
	63	41	Yeni kelimeleri okumada iyiyim.