TURKISH ONLINE JOURNAL of QUALITATIVE INQUIRY

Volume 10, Issue 1, January 2019

Editor
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ISSN 1309-6591

Published in TURKEY

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019 / Cilt 10, Sayı 1, Ocak 2019

SSN 1309-6591

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The Turkish Online Journal of Qualitative Inquiry (TOJQI) (ISSN 1309-6591) is published quarterly (January, April, July and October) a year at the www.tojqi.net.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019 / Cilt 10, Sayı 1, Ocak 2019

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DOI: 10.17569/ tojqi.428953

Research Article

Investigation of Students' Cognitive Processes in Computer Programming: A Cognitive Ethnography Study[1]

Sibel Doğan[2], Orhan Aslan[3], Mehmet Dönmez[4], Soner Yıldırım[5]

Abstract

The aim of the current study is to investigate how cognitive processes of students categorized as novice, semi-expert and expert differ in terms of creating pseudocode for a given programming task. To conduct this aim, cognitive ethnography research design was employed to reveal the cognitive process of the participants behind the specified task. In the study, three undergraduate students from a Computer Education and Instructional Technology (CEIT) department were included as participants. These students were categorized based on two parameters. The first one was the courses that took and the second on was their experiences on programming. While selecting participants, purposeful and snowball sampling methods were used. To collect data, semi-structured interviews, video recording, think aloud procedure, retrospective reviews, observations and document analysis were used. The results showed that participants differed in terms of their decision making and task completion durations, the path they followed, and their perspectives about handling the question.

Keywords: *Cognitive ethnography, programming, pseudocode, cognitive process, coding*

[1] This study was supported by METU-BAP

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Received: 31.05.2018 Accepted: 30.01.2019

Bilgisayar Programlamada Öğrencilerin Zihinsel Süreçlerinin İncelenmesi: Bir Bilişsel Etnografya Çalışması

Öz

Bu çalışmanın amacı, programlama ile ilgili belirlenen bir öğrenme görevinde acemi, yarı uzman ve uzman olarak sınıflandırılan öğrencilerin sözde kod oluşturma esnasındaki zihinsel süreçlerinin nasıl farklılaştığını araştırmaktır. Bu amacı gerçekleştirebilmek için bilişsel etnografya araştırma deseni olarak tercih edilmiştir. Çalışmada, Bilgisayar Eğitimi ve Öğretim Teknolojileri (CEIT) bölümünden üç lisans öğrencisi katılımcı olarak yer almıştır. Bu öğrenciler, öncelikle aldıkları dersler ve programlama konusundaki deneyimlerini göz önünde bulundurarak sınıflandırılmıştır. Katılımcı seçerken, amaçlı ve kartopu örnekleme yöntemleri kullanıldı. Verilerin toplanması için yarı yapılandırılmış görüşmeler, video kaydı, yüksek sesli düşünme, geriye dönük inceleme, gözlem ve doküman analizi kullanılmıştır. Sonuçlar, katılımcıların karar verme ve görev tamamlama süreleri, takip ettikleri yol ve bu soruları ele alma perspektifleri açısından farklılaştıklarını göstermiştir.

Anahtar Sözcükler: Bilişsel etnografya, programlama, sözde kod, zihinsel süreç, kodlama

Introduction

Conceptual Framework: Pseudocode and Cognition

In recent years, programming has become an essential part of everyday life and the concept of programming has become a necessity to survive in this global society. There is a need for acquiring basic competencies such as computer skills, different kinds of media, information technology and information literacy skills (Nelson, 2009). In fact, computational thinking skills is a fundamental skill for programming, and it should be integrated into all levels of the educational curriculum in order to enhance abstract thinking skills (Henderson, Cortina, Hazzan, & Wing, 2007).

According to Papadopoulos and Tegos (2012), it was emphasized for computer science education that students need to be equipped with higher order skills such as problem solving, critical and computational thinking skills. In Turkey, the Information and Communication Technology (ICT) courses have been employed to promote these skills in education. ICT and IT as terms in Turkey can be used interchangeably. Even, ICT courses are redesigned for primary and secondary education (Kalelioglu & Gulbahar, 2014). For example, in Turkey, the coding lessons are now being added to the curriculum of the early stages of education. Moreover, the Ministry of National Education (MoNE) gave ICT teachers the chance to improve it.

According to Özdener (2008), it was stated that students should be required to learn about algorithms and logic behind programming before they start to learn any kind of programming language. In other words, rather than memorizing the commands or codes, learners need to have the ability for establishing the structure such as with algorithms or pseudocode. Algorithm has been defined as a set of precise rules determining how to provide a solution to a problem or to perform a task (Garner, 2006). On the other hand, pseudocode is an alternative way to express complex algorithms by using general wording rather than syntax, keywords and comments in a particular programming language (Garner, 2006). Neither algorithm nor pseudocode depend solely on programming languages. They are used to detail the specific steps that should be followed in order to complete a given task. It might be problematic for students

to work with algorithm structures (Milková & Turčáni, 2006; Spohrer & Soloway, 1986), whereas instead, students can be supported to express their thoughts through pseudocode which can help them create connections between concrete, intuitional and symbolic knowledge (Noss, Healy, & Hoyles, 1997).

As a result, computational thinking skills is an important concept for teaching programming. While integrating programming into early levels of education, children' cognitive development processes should be taken into consideration. Computational thinking is a higher order thinking skill and it can be hard to teach it to children in early stage. According to Piaget's stages of cognitive development (Driscoll, 2000), children may not be ready to think in an abstract way before the age of 11. At this point, pseudocode can be utilized as an initial step.

The aim for the current study is to determine how the cognitive processes of university students, categorized as novice, semi-expert and expert, differ while creating pseudocode for a given task. At the end of the study, it is aimed to provide recommendations for students at the lower levels by considering the processes and where participants experienced difficulties.

Methodology

Cognitive ethnography is a method that studies cognition in everyday activities. It is rooted in both ethnography (Williams, 2006) and situated cognition. It combines human behavior in environmental context and task-oriented thinking processes. It was developed by Hutchins (1995b) and is the study of how cognitive activities are completed within the real-life setting (Hutchins, 2003; Williams, 2006). Although rooted in ethnography, cognitive ethnography investigates individual cultures and how individuals create meaning for a phenomenon (Williams, 2006). Moreover, in cognitive ethnography, activities are recorded and analyzed by segmenting unlike interviewing with groups. Furthermore, it deals with the processes such as momentarily activity development rather than focusing on defining commonalities in cultural groups. In other words, cognitive ethnography questions how an activity is accomplished and how knowledge is constructed rather than defining or focusing only on knowledge (Williams, 2006).

In addition, cognitive ethnography involves researchers who are the part of the community or live within it but their purpose is to investigate cognitive processes of participants and context in the community (Dubbels, 2011). The method of cognitive ethnography involves detailed microanalysis of recordings of the cognitive activity consisting of problem solving, decision making and reasoning (Williams, 2012). Moreover, it is conducted with multiple participants with diverse tools and artifacts (Williams, 2012). It is characterized by three main factors (Ball & Ormerod, 2000). First, data are acquired from determined or representative time slices of a situated activity. To exemplify, the segment or the slice in which the decision-making process occurs in is analyzed in detail rather than analyzing a whole video recording (Ball & Ormerod, 2000). Second, cognitive ethnography is purposive because it intends to understand the variation among individual and other external information resources such as other experienced people in terms of strategies used. Third, it emphasizes verifiability of data and method used for data collection by enabling replication of observation with different observers and methodological triangulations (Ball & Ormerod, 2000).

Situated cognition is the theoretical framework for cognitive ethnography (Hutchins, 1995a). It was defined by Robbins and Aydede (2009) as dynamic ongoing interactions with both the physical and sociocultural environment for the purpose of creating ways for human knowledge and understanding. It is a theory implying that thinking is not located in the brain. It is a complex process including different sequential connections in which information is generated from multiple sources among the brain, body and its surroundings (Hutchins, 1991, 1995b; Hutchins & Klausen, 1996).

Cognitive abilities have not evolved for us to understand a complete presentation of the world around us. Rather than focusing on the whole picture, we direct our attention to what is apparent to decide our next step (Merikle, Smilek, & Eastwood, 2001). With this absolute fact, experts differ from novices by having knowledge about where to look for necessary information. Situated cognition emphasizes that our mental processes interact with our body and its surroundings, whether real or virtual. Distributed cognition deals with external interactions between objects, individuals, artifacts, and tools in the environment (Hutchins, 1995a). On the other hand, embodied cognition is interested in the internal processes of the physical body. It was explained that cognition relies on experiences that are a combination of both bodily interactions and cognitive abilities (Thelen, Schöner, Scheier, & Smith, 2001). In the current

study, embodied cognition is the focus. In other words, the findings acquired from the performances of participants in the process of creating pseudocodes for the given programming task. Those performances are the act of writing and telling out loud.

The methodology for the current study focuses on cognitive ethnography. For the current study, three students' decision-making processes and cognitive procedures they followed, and how those three students differ in term of their cognitive interactions while performing a given task were investigated. In order to reach these aims, the following research questions are the focus of this study:

1. How does the novice, semi-expert and expert create pseudocode for the given programming task?
2. How does the novice, semi-expert and expert differ in terms of creating pseudocode for the given programming task?

While designing the study, firstly, researchers created the task with the help of subject matter experts (SMEs) who were interviewed about what kind of questions could be asked and what critical points or decisions are relevant to the task. Then, the criteria for the participant selection was decided as well as the participants to be included in the current study by way of snowball sampling. Having decided on the task and the participants, the data collection tools selected were interviews to obtain demographic information, video recordings, retrospective reviews, document analysis and observations performed before, during and after the study.

Task Creation and Participant Selection

To create an appropriate task for the selected students, SMEs were chosen from instructors and assistants of the "Programming Languages I and II" courses. These courses are provided by the CEIT department as compulsory to the undergraduate program. The SMEs were asked for a programming question to be set for the participants during the study. It was decided that the programming question should cover defining variables, using arithmetic operators, conditional statements and loops, and knowledge of extracting data from a file. According to these specifications, a programming question was defined in conjunction and in agreement with the SMEs. The specified question was about calculating the average grades and letter grades from

midterm, laboratory and final exam grades of a class of students. After calculations, participants are asked to print the grade mean of the class and a histogram showing the letter grades of the class on the screen as an output of a program. The specified programming question was reviewed by the three researchers of the current study. Then, necessary revisions were applied with the guidance of the SMEs, and a final version of the question was piloted with three students to check the question's clarity and understandability. After setting the question, it was decided to ask the question as independent from any programming language according to the advice of the SMEs. Therefore, the pseudocode of the question was decided to be asked to the study's participants. Then, three of the researchers, who graduated from the CEIT department and have worked as research assistants for five years, created the pseudocodes of the question by themselves. The pseudocodes of each researcher were then compared and combined under a common theme. This theme of the pseudocode was examined by the SMEs in order to create a sample rubric. The pseudocode of the programming question of the study includes the following topics:

- Defining variables (integer, string, array…)
- Getting input from a file
- Using arithmetic operators
- Using conditional statements
    - If, else if
- Using loops
    - For loops
    - Nested for loops
    - While loops
    - Do while loops

Furthermore, three students with similar background to the study's participants were asked to create their own pseudocode of the programming question in order to check the applicability of the question before applying it to the actual participants of the study. Any necessary revisions were completed in accordance with their comments. Following these reviews and updates, the final version of the programming question was ready to implement with the study's participants who are novice, semi-expert and expert students from the CEIT department. The aim of this study was to determine how cognitive processes of students categorized as novice, semi-expert and expert differ in terms of creating pseudocode for a defined programming task. To manage

this aim, selecting participants and defining criteria for novice, semi-expert and expert was crucial because they contribute to the phenomenon. In selecting participants, two sampling methods; criteria-based and snowball method were used.

Firstly, SMEs were asked about student profile and criteria for defining novice, semi-expert and expert. After negotiations, some criteria related with the courses students took were determined. Thus, students who took "Programming Language I (CEIT210)" course were categorized as novice, students who took both the "CEIT210" and "Programming Language II (CEIT211)" courses were categorized as semi-expert, and students who took the "CEIT210", "CEIT211" and "Project Development and Management (CEIT435)" courses were classified as expert. In addition, expert students were expected to write software by using any kind of programming language besides their formal education. In other words, it was aimed to find a person interested in programming intuitively.

After defining criteria, snowball sampling was used to select the participants. Firstly, SMEs were asked for suggestions. Both researchers and SMEs built consensus by negotiating about recommendations. In this process, the role of the researchers was also important as they have close relationship with the students because they provide assistance for the courses. After determining students for each category, the students were then interviewed in order to obtain demographic and background information. Detailed information was presented for each student in Table 1.

Table 1
Demographic Information of Participants

	Novice	Semi-Expert	Expert
High School	Vocational High School Web design and programming department	Vocational High School Web design and programming department	Vocational High School Web design and programming department
Grade level	Sophomore	Junior	Senior
Criteria	CEIT210	CEIT210 CEIT211	CEIT210 CEIT211 CEIT 435 "IEEExtreme Algorithm contest"

Participants of the study had similar education background. All of them graduated from vocational high school and their departments were web-design and programming. Also, all subjects were students at the same university and same department. Moreover, both novice and semi-expert started to be interested in programming in high school but the expert interested in programming since twelve years old. Thus, it can be said that the main difference between them was related with their programming experiences.

The determined courses were important in terms of categorizing students as novice, semi-expert and expert. In the Programming Language I and II courses, students obtain experience with programming logic and have the chance to develop their knowledge to some degree. However, the students actually get to apply their experience in the Project Management course, in which students produce a comprehensive project by using any kind of programming language.

Data Collection Instruments

In this part of the study, different types of data sources, namely semi-structured interviews with SMEs and participants, video recording, observations, think aloud procedure, document analysis and retrospective review were used. These tools were conducted before, during and after the study. Semi-structured interviews were used before starting the study. Observation, think aloud procedure and video recording were performed during the study. Finally, retrospective review was carried out after the study was completed. Afterwards, these tools were explained in detail.

Firstly, before collecting data from the participants, semi-structured interviews were conducted with SMEs to decide on the task and the participants to be included in the study. There were two SME's; one is programming languages instructor and the other is the research assistant helping the lecturer with the course. After providing brief information about the research to the SME's, they were asked questions about what kind of a task can be given to students that requires them to think, reflect and demonstrate differences in terms of expertise. Moreover, they were requested to provide their opinions about the kinds of prior knowledge participants need to have, performance standards for the task, as well as criteria to select participants as novice, semi-expert and expert.

Having collected data from the SMEs and decided on the task and participants to be included in the study, semi-structured interviews were conducted with the participants. In the interviews, participants were asked to provide information about themselves regarding the type of high school they had graduated from, the first time they learned algorithm, whether or not they had developed any software, and their background in programming.

The second data collection tool was video recording. While participants were performing the given task, a video camera recorded the participant undertaking the task. Video recording is important in cognitive ethnography studies because it provides chance to review the cognitive process aimed to be analyzed in detail multiple times back and forward. The third tool was think aloud procedure that the participants used. This tool was included in the study to support and empower the points highlighted by the participants and their work (pseudocode). As the fourth tool, while the participants were completing the given task, researchers took observation notes based on participants' problems, comments and questions related to the task, as well as further questions that will be asked in retrospective review.

After completing the task, the fifth tool, retrospective review was completed in which the researchers and each participant reviewed their respective video recording. During the review, participants were asked to reflect why they followed a certain way and what they thought while doing it. Last, document analysis was conducted on the participant's work (pseudocode). Their work was analyzed based on the predetermined rubric created by the researchers and the SMEs to investigate the performance and processes followed by the participants.

Data Analysis

Before conducting the study, firstly, semi-structured interviews were conducted with SMEs and the participants. These interviews were transcribed word by word and member checked by researchers. The interview results of the SMEs were used while selecting participants and creating the task in order to define the main phases and steps of them. The task was divided into three main phases, namely preparing the data, coding, and printing outputs. Moreover, steps that participants supposed to conduct were determined for each phase.

Secondly, researchers took observation notes and their notes were then compared and contrasted with each other in order to scrutinize their different perspectives. During the observation, notes were taken about the participants' think aloud procedure and performance. Thirdly, having just completed pseudocodes, retrospective review was performed with each participant by watching video recording together. During the retrospective review, the major points from the observation notes based on both researchers notes and think aloud data were discussed in detail. The aim was to make them think about their performances and provide deeper information about their cognitive processes. Then, recordings from retrospective review were analyzed considering each phase and steps. In this process, participants' explanations about their performances were transcribed word by word.

Fourthly, document analysis was applied to the final version of each participant's pseudocode. The researchers analyzed the participants' solution to determine how they come up with a particular solution and investigate how they differentiate from each other. Then, the three researchers' analysis for each phase and steps were compared to be sure about the accuracy of the participants' work. Lastly, participants were recorded with a video camera from behind while they conducted their task. The obtained video record was divided into part according to determined phases and steps. Each part was reviewed multiple times to get deeper knowledge about participants' performances and understand their cognitive processes. Moreover, while analyzing these parts, data obtained from observation notes, retrospective review and document analysis were considered.

Researcher Role

In the current study, researchers had an insider status. They had active roles in designing the task applied to the participants, and in determining the criteria for selecting and categorizing participants as novice, semi-expert and expert under the supervision of SMEs. Moreover, they were actively involved in the process of revealing how students' cognitive processes differ while creating the pseudocode for the programming task. The researchers' educational background is suitable for this study. All three researchers graduated from the department of Computer Education and Instructional Technology (CEIT). They are also conducting their PhD studies within the department. Moreover, three of the researchers work as research assistants at the CEIT department and assist with courses. Moreover, they work with students Thus, they

have information about the courses and their content. They all have software backgrounds at different levels.

Quality of the Research

In the current study, several measures were taken to ensure the validity issues. Firstly, member check was used (Merriam, 1998). The prepared question and rubric pseudocode were checked by two SMEs. Mathison (1988) explained that it is expected to use different data sources and tools to triangulate data. Triangulation is a strategy improving validity of the research (Huberman & Miles, 1994). In the current study, different data tools of video recording, think aloud procedure, retrospective review, observation and document analysis were used to collect data from the same participants. Furthermore, the designed programming task was piloted with three students to check the clarity of the task and was revised by considering misconceptions and grammatical errors. For further validation, while conducting the task, the students' works observed by researchers in order to perform a crosscheck. Moreover, researchers analyzed pseudocodes of participants separately and then compared their findings. In addition, findings from qualitative studies are less generalizable to other studies (Johnson, 1997), but this can be overcome by providing detailed information about research design. In the current study, the results cannot be generalized because of small sample size. However, the design of the study, task creation, participant selection and data collection procedure as well as their analyses were explained in detail to provide guidance for other researchers.

Findings

Research Question 1: How pseudocode is created for given programming tasks by novice, semi-expert and expert participants?

In this part, participants' cognitive tasks were provided by using a table acquired from video analysis. Their decision making and task completion durations were given in seconds for each steps of the phases; preparing data, coding and printing output.

In the first phase, participants were expected to define variables such as integer, string, and array, and assign variables and read data from the file. For the coding phase, participants were expected to conduct operations such as calculating mean for each individual and for the class, find the corresponding letter grades for each student and count the number of each letter grades. For the last phase, participants were asked to print a histogram for the letter grades and the mean of the class on to the screen. In Figure 1, the processes that should be followed is presented in order to provide an overall framework.

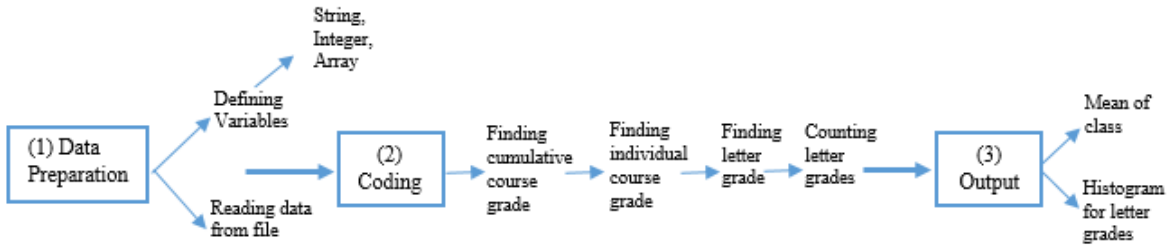

Figure 1. The overall framework of the study

Novice

The task that was given to the "novice" participant had three main phases; with individual steps within some phases. The novice spent 10 minutes completing the whole task. Table 2 shows the decision making and completion durations for the novice participant.

Table 2
Decision Making and Completion Durations – Novice

Phases		Completion duration (seconds)	Decision making duration (seconds)
Data preparation		22	13
Coding	Finding cumulative course grade	194	72
	Finding individual course grade	60	30
	Finding letter grades	101	23
	Counting letter grades	102	102
Printing outputs		15	15

It was highlighted that the novice spent 22 seconds in the first phase, data preparation and deciding to read data from a file. According to document analysis, he just read the data from a file and did not define any variable or decide on what kind of variables would be used in the following parts. Think aloud procedure and observation notes revealed that the novice talked about variables during whole his working time, yet did not demonstrate them in the pseudocode. According to retrospective review, the novice explained this situation in retrospect by saying:

> *"I did not write because I had defined those [variables] in my mind."*

The second phase was the coding, which consisted of four steps. For the first step, finding the cumulative course grade, the novice spent 194 seconds to complete it. Document analysis showed that he did not use any kind of loop for making calculations for 20 people at the same time; rather he preferred calculating the grades of each student by hand sequentially. Moreover, he did not divide the accumulated grades by the number of students to find the mean. Think aloud procedure showed that he knows that an array keeps multiple data, but he did not know how to apply it. He explained it in retrospective review by saying:

> *"I would either define variables one by one or use array. Using array was the easiest way but I thought that I would not be able to apply it [array]. I defined variables one by one because it was the guaranteed way for me."*

Observation notes also revealed that the novice lacked adequate knowledge about the implementation of control statements.

The second step was finding the individual course grade. The novice used 60 seconds for the task to be completed. Document analysis showed that the novice did not use any kind of loop for finding the individual grades. Instead, he went for defining variables and making calculations by hand for each student. During this step, he did not mention using any kind of loop to perform the operations just once. Observation notes also provided information that the novice did not process multiple operations once, but designed the process for one entity at a time. The third step of the second phase was finding the letter grades of the students. The task took 101 seconds for novice to complete. Think aloud procedure indicated that he mentioned about using conditional statement to find the letter grades, but did not apply it to the

pseudocode. For the last step, the novice spent 102 seconds. While conducting the step, he put into words using a counter for counting the number of letter grades. However, according to document analysis, the novice did not apply what he had decided for the step. Observation notes revealed that he could build the logic behind the operation, but could not apply it.

The last phase of the study was providing outputs and the novice took 15 seconds in total. According to document analysis, he could not print mean for the class nor the histogram for the number of each letter grades. In the retrospective review, he expressed this by saying:

> *"I could not connect the number of letter grades and printing them as stars [histogram]."*

To conclude, while writing the pseudocode, the novice generally had required preliminary knowledge about what to do. However, he had trouble in the implementation of control statements and variable definitions because of inadequacy of practice making a single operation for multiple entities.

Semi-expert

The semi-expert spent about 15 minutes to complete the whole task. Table 3 shows the decision making and completion durations for the semi-expert participant.

Table 3
Decision Making and Completion Durations – Semi-Expert

Phases		Completion duration (seconds)	Decision making duration (seconds)
Data preparation		75	7
Coding	Finding cumulative course grade	117	10
	Finding individual course grade	68	9
	Finding letter grades	103	47
	Counting letter grades	101	10
Printing outputs		256	25

In the first phase, the semi-expert spent 75 seconds to complete the phase. Document analysis revealed that she read data from a file using a loop, but did not define any variables beforehand. In the retrospective review, she explained the reason by saying:

> *"I realized that I defined variables in my mind and I forgot to write them [variables] down in my pseudocode."*

In the second phase, she performed all four steps in a different way. Document analysis revealed that she first calculated each students' individual grades, then she found the letter grades and counted them. Finally, she reported the cumulative course grade by summing the individual course grades.

For the first step, while trying to find the individual course grades, the semi-expert used 68 seconds to complete the step. Document analysis presented that she used a loop to calculate the individual course grades. During the step, she explained she had trouble in making calculations at first, then decided to use a loop for that purpose.

Afterwards, she combined the second and third steps. Document analysis revealed that she found the letter grades and the number of them in the same loop by using conditional statements. In these steps, she spent 103 seconds to find the letter grades and decide to use control statements. Moreover, the semi-expert allocated 101 seconds to count the number of letter grades and decide to use counters in her conditional statements. Observation notes and her expressions during these steps indicated that she experienced some confusion. Although she was expected to use an array to assign letter grades, she could not, and explained this situation in retrospective review by expressing:

> *"The variables [letter grades] that I assigned kept being overwritten and I could not think how to control [assigning them to variables] it at that moment… I did not think about using array; if I had, it would have made more sense."*

For the fourth step, she spent 117 seconds to complete. Document analysis showed that the semi-expert used a loop to calculate the cumulative course grade by summing the individual course grades and then dividing it by the number of students at the same time.

The last phase was printing outputs. The semi-expert spent 256 seconds to complete and decide to use nested loops. However, document analysis showed that she did not reflect what she thought in the pseudocode. She explained it in retrospective review by saying:

> *"I created it [nested loops] in my mind but I could not verbalize it in my pseudocode. I could have stated it in a clearer sentence."*

To sum up, the semi-expert established the overall structure for the given task and thought of the task as a whole. Although, she experienced confusion in some steps of the task, she overcame this through her own solutions to some point. The semi-expert could not reach the next level due to her lack of content knowledge.

Expert

The expert spent about 27 minutes to complete the whole task. Table 4 presents the decision making and completion durations for the expert participant.

Table 4
Decision Making and Completion Durations – Expert

Phases		Completion duration (seconds)	Decision making duration (seconds)
Data preparation		355	63
Coding	Finding cumulative course grade	452	53
	Finding individual course grade	258	15
	Finding letter grades	133	15
	Counting letter grades	116	39
Printing outputs		90	9

In the first phase, the expert spent 355 seconds for completing the task and decision making. Document analysis showed that the expert conducted this phase in detail. He read data from a file by importing necessary libraries. He transferred the data from the file to a two-dimensional array after first checking whether or not the file was empty. He then prepared the data for further operations. Observation notes of the researchers revealed that the expert planned this phase intensively by considering further steps. While performing the phase, he explained each

of his processes in detail by providing rationales behind his thoughts. During the phase, he pointed out different alternatives such as object, array and class.

In the second phase, his first step was to calculate the cumulative course grade. The expert spent 452 seconds in total. Document analysis reported that he defined the function to find the mean of each exam by using the indexes of the pre-defined array. Then, he summed them up to find the course mean. During the process, he explained that he preferred function to avoid making multiple mean calculations.

Having completed the first step, the expert combined the second and third steps. In the second step, it took 133 seconds for expert to use a control statement to calculate the individual course grades. For the third step, he spent 116 seconds to complete and find the letter grades by using conditional statements. Document analysis revealed that the expert defined an array to store the letter grades and a variable for individual grades. In a loop, he calculated the individual grades and assigned them to the result temporarily. Then, with a conditional statement, he equated the individual grades with the letter grades and assigned them to the pre-defined array. Both think aloud procedure and observers' notes demonstrated that his content knowledge was sufficient. He explained all his work with the reasons behind his actions and compared the way he chose with alternative options. In the retrospective review he emphasized this by stating:

> *"While writing code, I always think about alternative methods and try to choose the more efficient course for my work... For example, while defining variables, I think about different types and try to choose one which utilizes the least memory by considering the needs of the program I am writing."*

For the last step of the coding phase, the expert spent 116 seconds for the task. Document analysis indicated that he defined an array to keep he numbers of each letter grade. Moreover, he preferred to use a loop to bring the letter grades to the stage and use a conditional statement to increment counters for each of them. Observation notes indicated that he overlooked that he could combine this step with second and third steps. It would have been an easier way to conduct the operation. In the retrospective review, he explained this by expressing:

> *"I could have included this operation [counting the letter grades] in the previous loop [loop used in second and third steps], but I did not pay attention to this because it was not a complex project."*

Printing outputs was the last phase of the task. It took the expert 90 seconds to complete and print the mean of the class and the histogram. Document analysis showed that the expert ignored printing the mean. He used nested loops for printing the histogram as output. Think aloud procedure indicated that he first thought one loop would be enough, but then realized immediately that he should use nested loops.

In conclusion, the expert's content knowledge was adequate to conduct the task. He explained all his work in detail with reasons and provided alternative methods during the whole task. He built the main structure at the beginning very well. He determined what he need basically and added some other variable definitions during his work. He rectified his mistakes and tried to apply more efficient alternatives during his work.

Research Question 2: How does the novice, semi-expert and expert differ in terms of creating pseudocode for the given programming task?

When the participant's pseudocode was examined, the researchers noted how the participants conducted the task given in the first part of the result. In Table 5, their differentiations are presented for each phase and step in detail.

Table 5
Comparison of Duration – Novice, Semi-expert & Expert

	Data Preparation		Coding		Printing Outputs	
	CD	DMD	CD	DMD	CD	DMD
Novice	22	13	457	227	15	15
Semi-expert	75	7	389	86	256	25
Expert	355	63	959	122	90	9

Note. CD: Completion Duration (seconds), DMD: Decision Making Duration (seconds)

For the first phase, preparing the data, the expert participant spent more time on variable definitions and decisions for further steps. Moreover, he created the structure of the whole task at the beginning. On the other hand, the novice and the semi-expert did not spend as much time and effort on this phase. They just read the data from a file without defining any variable. In

the retrospective review, they explained their reasoning as they had just defined variables in their mind.

In the second phase, the participants were supposed to perform operations for calculating the mean for each individual and for the course, finding letter grades and counting the number of grades. During this phase, the novice could not conduct operations for all of the students at once. He could not actualize the multiple operation in a loop. On the other hand, both the semi-expert and the expert considered operations for all the students at the same time by utilizing a loop. Furthermore, in this phase, only the expert thought about storing the calculated results in an array. The novice did not even think about it. However, the semi-expert realized that the results were overlapping, but she was confused about how to resolve the problem. Moreover, during these stage, the expert talked about alternative ways for operations and storing the results. He explained why he chose the method he applied with reasons. He came up with more efficient ways. In addition to these, there were differences in terms of their sequence of calculations. Both the novice and the expert calculated the cumulative course grade before calculating the individual course grades. In the retrospective review, they explained that they divided the task into two parts by considering the problem. In retrospective review, both the novice and the expert stated that they had not understood the question completely. They said that they could have performed better if they handled the question as a whole. However, the semi-expert did consider the problem as a whole. She first calculated the individual course grades and then summed them to find the cumulative course grade. Besides, all the participants thought about calculating individual course grades and finding letter grades in the same loop. However, only the novice could not apply it his pseudocode. Apart from these, the expert used function rather than repetitively calculate the mean over and over.

The last phase was printing the mean of the class and a histogram for the letter grades. Generally, all participants knew what to do for this step. However, the novice could not actualize how to apply the necessary operation. The semi-expert completed this phase successfully, but the expert forgot to print the mean of the class.

Discussion and Conclusion

The results showed that participants differed in terms of the durations they spent, the paths they followed and their perspectives about handling the question they were tasked with. Initially, they differed in terms of the decision making and task completion durations for the steps. The 'expert' participant spent more time (~27 minutes) to complete the given task, while the 'novice' spent the least amount of time (~10 mins). The reason for this differential was that the expert's solution was very detailed and included a lot of information as well as alternate solutions. The expert's extensive knowledge caused him some level of confusion as he could not effectively orchestrate his knowledge for the solution. On the other hand, the solution of the novice participant was superficial.

Next, the participants differed with regards to the path they followed in creating their pseudocode. This differential resulted from the degree as to how well they understood the question. Both the novice and the expert did not visualize the question as a whole, but rather they divided the question in two parts which actually made their job harder. Thus, it can be said that comprehending the question can be thought of as the baseline before starting or creating pseudocode.

Moreover, participants' perspectives about handling the question were also different. The expert considered the question as a project, the semi-expert as a program, while the novice approached the question like a mathematical problem. Differences in their knowledge levels and amount of practice they'd experienced led to different approaches for the given question. The novice had some knowledge of arrays, but lacked adequate practice in its implementation. As a result, he handled the question as a mathematical problem without considering how a computer will understand written pseudocode that lacked computational thinking.

Coding or programming needs higher level skills such as problem solving, critical and computational thinking (Papadopoulos & Tegos, 2012); skills which require abstract thinking. However, Driscoll (2000) claimed that when Piaget's stages of cognitive development are considered, children may not be able to develop abstract thinking until the age of eleven. Therefore, until they are able to develop higher level skills, younger students can be supported to express their thoughts as a baseline. Debate classes and communities can be examples of

leading students to acquire critical thinking skills. After students are equipped with this skillset, they will be better prepared to transfer their thoughts in an ordered way more easily. Students need to be taught about creating stepwise solutions for a given problem rather than simply diving into the codes, commands and scripts of a specific programming language. Afterwards, more complex and structured tasks or questions can be provided to enhance their problem solving and critical thinking skills. Finally, students can integrate or use such skills within any programming language, and thereby be equipped with a much-enhanced skillset to tackle the tasks they are likely to encounter throughout their educational career and beyond.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019: 26-51
DOI: 10.17569/ tojqi.438333

Research Article

Analysis of Digital Citizenship Subject Contents of Secondary Education Curricula

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Abstract

The aim of this study is to analyze the secondary education curricula in terms of the subdimensions of digital citizenship. Curricula used for secondary education (High School 1st, 2nd, 3rd and 4th Grades) in the 2017-2018 academic year were used as data source. The curricula examined in this scope belong to the following courses: Computer Science, English, Geopgraphy, Democracy and Human Rights, Religion and Ethics, Philosophy, French, Visual Arts, Music, Medical Knowledge and Traffic, Revolution History and Atatürkism, History, Turkish Language and Literature and Contemporary Turkish and World History. The study was carried out with qualitative research methods, and data were collected through document review. In the analysis of the data, induction analysis method was used on the basis of "Digital Citizenship Scale for the Young" developed by Kuş, Güneş, Başarmak and Yakar (2017). The present study reveals that the courses having the highest number of references to digital citizenship in the curricula are "computer science" and "democracy and human rights". Although computer science curriculum gives wide coverage to digital skills, the coverage of rights and responsibilities in the digital environment and ethical and critical thinking skills is limited. In the curricula of the other courses, contents related digital citizenship are highly limited.

Key words: *Citizenship, digital citizenship, secondary education curriculum, content analysis*

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Received: 28.06.2018 Accepted: 30.01.2019

Ortaöğretim Programlarının Dijital Vatandaşlık Konu İçeriklerinin Analizi

Öz

Bu araştırmanın amacı ortaöğretim programlarının dijital vatandaşlığın alt boyutları açısından analiz edilmesidir. Araştırmada 2017-2018 eğitim-öğretim yılında, ortaöğretim düzeyinde (Lise 1, 2, 3, 4 sınıf) uygulanan öğretim programları veri kaynağı olarak kullanılmıştır. Bu kapsamda incelenen ortaöğretim programları: Bilgisayar Bilimi, İngilizce, Coğrafya, Demokrasi ve İnsan Hakları, Din Kültürü ve Ahlak Bilgisi, Felsefe, Fransızca, Görsel Sanatlar, Müzik, Sağlık Bilgisi ve Trafik, T.C. İnkılap Tarihi ve Atatürkçülük, Tarih, Türk Dili ve Edebiyatı, Çağdaş Türk ve Dünya Tarihi dersleridir. Araştırma, nitel araştırma yöntemiyle gerçekleştirilmiş, araştırma verileri doküman incelemesi yoluyla toplanmıştır. Verilerin çözümlenmesinde, Kuş, Güneş, Başarmak ve Yakar (2017) tarafından geliştirilen "Gençlere Yönelik Dijital Vatandaşlık Ölçeği" esas alınarak tümevarım analizi yöntemi kullanılmıştır. Araştırma sonucunda, dijital vatandaşlıkla ilgili en fazla içeriğe "bilgisayar bilimi" ile "demokrasi ve insan hakları" öğretim programında yer verildiği görülmektedir. Bilgisayar bilimi dersi öğretim programında dijital becerilere geniş yer bir şekilde verilmesine ragmen; dijital ortamdaki hak ve sorumluluk, etik ve eleştirel düşünme becerilerine çok az yer verilmiştir. Diğer derslerin öğretim programında ise dijital vatandaşlıkla ilgili oldukça sınırlı içeriğe rastlanılmaktadır.

Anahtar Sözcükler: *Vatandaşlık, dijital vatandaşlık, ortaöğretim programı, içerik analizi*

Introduction

The fact that internet becomes more accessible to the masses day by day and thus spreads rapidly makes significant contributions to social development. Positive impacts, innovations and benefits of internet on many aspects of daily life such as communication, exchange of information, journalism and media, promotion and advertisement, travel and holiday, public services, banking, trade, entertainment, social relations and intercultural interaction, environment, health and education are now acknowledged by everybody (Bayzan, 2011). Intense exchange of information, intense content production and possibility of both good and bad intentions in the production/sharing of information have led to the need of using internet in a conscious, reliable and effective manner. To this end, an internet user needs to act consciously against possible risks in an internet environment (Çubukçu & Bayzan, 2013). In this scope, it is seen that competence areas such as command over technology, innovation, communication and cooperation, research and obtaining information, providing solutions for problems and "digital citizenship" have come to prominence for the students (ISTE, 2008). Being one of the competence areas concerning the youth, digital citizenship has become even more important in recent years. Ribble and Bailey (2005) defines digital citizenship as "teaching of appropriate technological behaviors". Also, digital citizenship is expressed as responsible behavior norms related to the use of technology. A person who knows how to correctly use technology and the digital tools coming into our lives together with technology, respects ethical rules and individual rights in digital platforms, as well, and uses digital tools safely and with a sense of responsibility is called "digital citizen" (Mossberger, Tolbert, & McNeal, 2008).

With the decision numbered 184 and dated 2005, the Board of Education of Discipline decided to restructure Science High Schools, Anatolian High Schools, Anatolian Fine Arts High Schools, Sports High Schools, Anatolian Teacher Training High Schools, Anatolian Vocational and Technical High Schools, Technical High Schools, Religious High Schools and Anatolian Religious High Schools (Ünal & Ünal, 2010). Similarly, it was stated in the Ninth Development Plan covering the years between 2007 and 2013 that the secondary education curricula would be based on program diversity instead of school diversity (Ninth Development Plan, 2006). Today this structure of secondary education continues. Ministry of National Education renewed the curricula of 21 secondary education courses in the 2017-2018 academic

year and pusblished them on the website of the Board of Education and Discipline. In the renewed programs, it was emphasized that basic skills and competences, which are required and demanded for success of the students in daily life, were determined and comparisons were made with the programs of different countries and their experiences were considered (MEB, 2018). When the secondary education course schedules are examined, it is seen that students studying in different types of high schools have different compulsory and elective courses. The curricula renewed in 2018 were prepared in consideration of basic skills and competences. Among these basic skills and competences, information and communication technologies literacy, which reflects the features of the concept of digital citizenship, stands out. In this scope, the following were listed as the competences that students need to possess among the basic skills and competences of the curricula (MEB, 2018).

- ✓ Information and communication technologies literacy is needed for keeping up with the age.
- ✓ A student needs to have a positive attitude towards the use of information and communication technologies for satisfying the need of information and communication technologies literacy.
- ✓ A student should use information and communication technologies effectively.
- ✓ A student should manage the flow of information from various sources.
- ✓ A student should pay attention to the security warnings concerning access to and use of information.
- ✓ A student should act in compliance with laws and moral rules.
- ✓ A student should have media literacy and digital literacy skills (MEB, 2018).

These skills and competences stated in the secondary education curricula renewed in 2018 are directly related to digital citizenship. It is striking that these skills and competences are related to the subdimensions of digital citizenship such as “digital skill”, “critical thinking”, “digital security”, “digital ethics” and “rights and responsibilities”.

In Turkey, the frequency of internet usage is significantly higher among the young population aged between 16 and 24 than the other age groups (TÜİK, 2016). Therefore, high school students stand out as the group having the highest level of internet usage. Widespread use of digital technologies among the young is accompanied by certain opportunities as well as certain risks. For instance, abuse of personal information, exposure to inappropriate content or cyber

bullying, insult, calumniation and use of private information or inappropriate images with the aim of inflicting damage etc. are commonly encountered. Individuals should be assisted in becoming digital citizens through the teaching of responsibility and ethics (Farmer, 2010). At this point, formal environments are of great importance in helping the youth to be digitally literate citizens in digital environments. Also, there are various environments where children can gain digital literacy skills apart from the formal education environment provided by the schools. In schools, course contents are determined by the curricula. In line with the principle that education prepares an individual to life, students should be raised in accordance with the requirements of the world in which students will take part as adults (Tüzel, 2013). In this scope, it is important that curricula include digital citizenship skills which are the main requirements of this century.

When considered in terms of digital citizenship, a course titled "Information and Communication Technologies" was delivered at the secondary education level until 2017. Examining the curricula of the course of Information and Communication Technologies (2017), Peker stated that aims of the course (3 aims), units of the course (2 units) and subjects of the course (12 subjects) included the elements of digital citizenship. However, in accordance with the secondary education course schedule published in 2018, this course was removed from the course schedule and was replaced by a course titled "Computer Science" which would be given to the students phase by phase and was designed in the form of two classes. Thus, considering that curricula and course structures were changed in 2018, determining the skills and competences that the students are required to acquire with respect to digital citizenship from all curricula renewed at the secondary education level and detecting the deficiencies in this area are important.

In the literature review, it is seen that studies concerning digital citizenship are quantitative survey research mainly directed at students and teachers (Altınay, 2016; Bardakcı, Akyüz, Samsa-Yetik, & Keser, 2014; Çepni, Oğuz, & Kılcan, 2014; Çiftçi & Sakallı, 2016; Çubukçu & Bayzan, 2013; Elçi & Sarı, 2016; Kocadağ, 2012; Öztürk, 2015).There is only one domesitc study examining the curricula in terms of digital citizenship. Peker (2017) analyzed the curricula of the course of "information and communication technologies" in terms of the elements of digital citizenship. However, digital citizenship is not only related to information and communication technologies or computer science. Digital citizenship is an area which concerns all aspects of life and all courses. Therefore, analysis of the curricula of other courses

at the secondary education level is important. Based on this thought, the present study aims at analyzing the secondary education curricula in terms of the subdimensions of digital citizenship.

Method

Research Model

The present study was carried out by using the qualitative research model. Qualitative research allows for the presentation of the research results on the basis of codes and categories through the reading of data one by one (Merriam, 1998).

Data Sources of the Research

In this study, curricula implemented at the secondary education level (High School 1st, 2nd, 3rd and 4th grades) in the 2017-2018 academic year were used as data source. In this scope, the curricula examined belong to the courses of Computer Science, English, Geography, Democracy and Human Rights, Religion and Ethics, Philosophy, French, Visual Arts, Music, Medical Information and Traffic, Revolution History and Atatürkism, History, Turkish Language and Literature and Contemporary Turkish and World History. These curricula are used in the Anatolian High Schools, Anatolian High Schools with Preparatory Class, Science High School, Social Sciences High School, Anatolian Religious High Schools, Science High Schools, Fine Arts High Schools, Sports High Schools and Anatolian Religious High Schools as per the decision numbered 56 and dated 19.02.2018 of the General Directorate for Secondary Education. When the secondary education course schedule is examined, the status of some courses as compulsory or elective (such as the course of computer science) changes depending on the type of the high school. Within the scope of the study, all secondary education courses included in the course schedule with compulsory and elective ones were analyzed. However, courses included in the Curricula of the Anatolian Religious High Schools such as Islamic law, hermeneutics, hadith and professional Arabic etc. were not included in the scope of the study and were not analyzed.

Collection and Analysis of Data

Data were collected through document review. Document review encompasses the analysis of the written materials containing information on the phenomenon or phenomena to be examined (Yıldırım & Şimşek, 2011).

In the analysis of the data, induction analysis method was used. Main aim of this analysis method is to reach concepts and relations which may explain the collected data. In the study, the steps stated below were taken by following the phases of coding data, determining the themes, organizingand identifying the data by codes and themes and interpreting the findings (Yıldırım & Şimşek, 2011).

I. First, a form was designed to examine the content of the secondary education curricula related to digital citizenship. This form was based on "Digital Citizenship Scale for the Young" developed by Kuş, Güneş, Başarmak and Yakar (2017). This scale consist of eight subdimensions, which are communication, righs and responsibilities, critical thinking, participation, security, digital skills, ethics and commerce.
II. Secondly, curricula were analyzed on the basis of eight subdimensions of digital citizenship. All texts in the curricula were read by two researchers (excluding questions), and the statements determined were coded in the relevant value box. When content is related to two subdimensions, it was coded to both subdimensions separately. Sample data analysis performed in this process is shown in Table 1.

Table 1
Sample Data Analysis by Digital Citizenship Subjects of Secondary Education Curricula

Codes	Subtheme	Theme
Making them individuals having a good understanding of technological concepts, systems and processes as digital citizens…	Digital Skills	Digital Citizenship
They benefit from information technologies in their research and sudies related to music.		
They take measures for ensuring protection of personal data and information security in internet environment…	Digital Security	
Necessary cautions should be made and necessary measures should be taken for safe use of internet.		
Materials downloaded from internet and used should not be plagiarised and ethical rules and coprights should be respected.	Ethics	
While listening music in internet, ethical rules should be paid attention.		

III. Lastly, results of the analyses conducted by two researchers separately were compared and coding made by both researchers was marked as "Consensus" or "Dissensus". Agreement percentage formula was used with the aim of determining reliability in the content analysis. Agreement percentage was calculated as "Reliability = Consensus / (Consensus + Dissensus) x 100" (Miles and Huberman, 1994). According to Yıldırım and Şimşek (2011), if agreement percentage is or exceeds 70 % in reliability calculations, it is accepted that reliability percentage is reached. In the present study, agreement percentage of coding was found to be 0.81 for the first question by using this formula. In the incompatible codes, opinion of an expert was received and coding was repeated in the relevant value box. Categories were created under the eight subdimensions by combining these codes and findings were presented for each course curriculum. Texts of secondary education curricula were directly quoted during the presentation of the findings.

Findings

Findings of the study where secondary education curricula were analyzed in terms of subdimensions of digital citizenship are as follows. Availability of emphasis on digital citizenship in the curricula first in terms of subdimensions of digital citizenship and then in terms of the courses in the curricula is shown in the form of tables. Also, explanations were made by making direct quotations from the texts of secondary education curricula.

Table 2
Availability of Subdimensions of Digital Citizenship in the Curricula

Subdimensions	Course Name	*f*
Digital Skills (34)	Computer Science	*23*
	English	*4*
	Music	*2*
	Medical Knowledge	*1*
	Revolution History and Atatürkism	*1*
	Turkish Culture and Civ. History	*1*
	Religion and Ethics	*1*
	Visual Arts	*1*

Subdimensions	Course Name	*f*
Digital Security (15)	Computer Science	6
	Music	4
	Visual Arts	2
	Turkish Language and Literature	2
	English	1
Ethics (12)	Music	*4*
	Democracy and Human Rights	*3*
	Computer Science	*3*
	Revolution History and Atatürkism	*1*
	History	*1*
Communication (9)	Computer Science	*6*
	English	*2*
	Turkish Language and Literature	*1*
Digital Participation (7)	Democracy and Human Righs	*4*
	Computer Science	*3*
Rights and Responsibilities(4)	Computer Science	*2*
	Democracy and Human Rights	*2*
Critical Thinking (2)	Computer Science	*1*
	Philosophy	*1*
Digital Commerce (1)	Geography	*1*

As seen in Table 2, the course curriculum including the subdimensions of digital citizenship the most is the curriculum of the *Computer Science* course. In the Computer Science course, the subdimension included in the curriculum the most is “digital skills” while subdimensions of “rights and responsibilities” and “critical thinking” are included at the least. Subdimension of “digital commerce” is not included at all. Following the computer science course, curriculum of democracy and human rights course includes digital citizenship the most. The subdimension included in the curriculum of this course the most is “digital participation”.

Curricula of English, music, visual arts, Turkish language and literature and revolution history and Atatürkism courses emphasize certain subdimensions of digital citizenship, as well. In the curricula of the courses of Turkish culture and civilisation history, geography, religion and ethics, philosophy and medical knowledge, there is only one reference to digital citizenship.

The subdimensions to which the curricula of these courses refer the most are “digital skills” and “digital security”. On the other hand, the subdimensions referred in the curricula at the least are “critical thinking” and “digital commerce” and “rights/responsibilities”. Subdimension of digital commerce is emphasized in the curricula only once and this stands out

as a significant deficiency in terms of digital citizenship. Findings showing the secondary education courses highlighting digital citizenship and those having significant deficiencies in this issue are given in Table 3.

Table 3
Availability of Subdimensions of Digital Citizenship in Different Curricula

Course Name	Subdimensions	*f*
Computer Science 44	*Digital Skills*	*23*
	Digital Security	*6*
	Communication	*6*
	Ethics	*3*
	Rights and Responsibilities	*2*
	Digital Participation	*3*
	Critical Thinking	*1*
Democracy and Human Rights (9)	*Digital Participation*	*4*
	Ethics	*3*
	Rights and Responsibilities	*2*
Visual Arts (3)	*Digital Security*	*2*
	Digital Skills	*1*
Music 10	*Digital Security*	*4*
	Ethics	*4*
	Digital Skills	*2*
Medical Knowledge (1)	*Digital Skills*	*1*
Revolution His. and Atatürkism (2)	*Digital Skills*	*1*
	Ethics	*1*
History (1)	*Ethics*	*1*
Turkish Culture and Civ. His. (1)	*Digital Skills*	*1*
Geography (1)	*Digital Security*	*1*
Religion and Ethics (1)	*Digital Skills*	*1*
Philosophy (1)	*Critical Thinking*	*1*
Turkish Language and Literature (3)	*Digital Security*	*2*
	Communication	*1*
English (7)	*Digital Skills*	*4*
	Communication	*2*
	Digital Security	*1*

When Table 3 is examined, it is seen that there is emphasis on the subdimensions of digital citizenship in 13 courses in the secondary education curricula and statements and explanations related to the subdimensions of digital citizenship are not available in the other nine courses. When the courses highlighting the subdimensions of digital citizenship are examined, it is seen that they are generally “verbal courses”. Also, it is striking that there is no emphasis on digital citizenship in non-verbal courses such as physics, biology, chemistry and mathematics.

In the curricula, references to digital citizenship exist under the title of "Competences" in the introduction part, which is common in all curricula. In the part titled "digital competence" under the title of competences, emphasis is laid on the *security*, *critical thinking*, *digital skill* and *communication* subdimensions of digital citizenship. This competence statement common in all curricula is as follows:

> *"It covers the use of information and communication technologies for business, daily life and communication in a safe and critical manner. This competence is supported by basic skills such as use of computers for access to information as well as evaluation, storage, production, presentation and exchange of information and participation in common networks and communication through internet."*

Computer Science

Computer science curriculum consists of two parts as Level 1 and Level 2. When students take this course for the first time, they learn the attainments containing key issues related to computer science in the Level 1. When the course is taken for the second time, it is envisaged that students learn the attainments containing advanced level subjects in the Level 2. It has been determined that elements of digital citizenship are included in the general aims of the curriculum, skills specific to the courses and Level 1 attainments of the course. When the computer science course is evaluated in terms of digital citizenship, the following conclusions are reached:

Digital Skills

In the computer science curriculum, digital skills are included in different items in the part related to general aims. In the general aims, it is stated that the target is to raise individuals who understand technological concepts and systems, use information technologies in line with the purpose, can use internet-based services effectively, have acquired the problem solving skills, seek for opportunities for learning in the internet environment and can conduct works on web design.

As content, digital skills are included in the 3rd unit titled "programming". In this unit, attainments are generally related to project development in online tools, cooperation and

problem solving. Digital skills are given wide coverage in the part titled "skills specific to course". In this part, reaching different information in internet, evaluating social skills, effective use of technological tools and developing original products by using technological tools are emphasized.

Digital Security

In the part related to the general aims, with respect to digital security, it is stated that the target is to ensure protection of personal data in the internet environment and information security. In the part titled skills specific to the course, ability of the students to provide information security in the electronic tools is emphasized.

In the unit titled "Ethics, Security and Society", which is one of three units of computer science course, a separate title is opened for security and attainments related to digital security are included here. Under the title of security, attainments related to knowledge about information security and threats and safe identity management are included. The following attainments can be given as example for these references:

> *"Student explains the threats related to information security." (Level 1; Unit 1; Subject 2)*
>
> *"Student carries out the processes for providing information security in the personal computer and network environment." (Level 1; Unit 1; Subject 2)*

Communication

Communication dimension of digital citizenship is referred to in the part dedicated to skills specific to the course. With respect to communication, it is emphasized that these skills will allow for correct and effective use of Turkish, improved listening and speaking skills of students in audiovisual tools, communication with different students and intercultural interactions by increasing communication skills through the use of different communication technologies.

Ethics

The first subject title of the computer science course curriculum is "ethical values". In the attainments under this title, ethical dimension of digital citizenship is given wide coverage. At this point, it is emphasized that ethical values and code of ethics are applicable in the internet environment, programs and communications in the virtual platforms. In the part related to the aims specific to the course, awareness about compliance with online reputation management and intellectual property rights is emphasized. The following attainments can be given as example for digital ethics:

> *"Student explains the ethical principles that should be respected during the use and management of information technologies and internet environment." (Level 1; Unit 1; Subject 1)*
>
> *"Student gives examples for cases of breach of ethical principles." (Level 1; Unit 1; Subject 1)*

Rights and Responsibilities

There is reference to the "rights and responsibilities" dimension of digital citizenship only in the part titled "skills specific to the course". In this part, it is emphasized that the students will know their rights and responsibilities in the online environments and display positive, safe, legal and ethical behaviors in the use of technologies. In the attainments part of the curriculum, there is no reference to the "rights and responsibilities" dimension of digital citizenship.

Digital Participation

"Digital participation" dimension of digital citizenship is included in the parts related to general aims, skills specific to the course and attainments in the computer science curriculum. In this respect, development of innovative and creative projects for the solution of problems experienced by the old or the disabled in daily life and new ideas for real world problems is emphasized.

Critical Thinking

There is only one emphasis on the "critical thinking" subdimension of digital citizenship iin the part titled "skills specific to the course". Under the title of "restructuring information" in the part related to the skills specific to the course that the computer science course curriculum targets to make students adopt, it is emphasized that students should evaluate the accuracy, reliability and suitability of the information, media, data or other sources they reach. The part on attainments does not have a reference to "critical thinking", which is another important subdimension of digital citizenship.

Democracy and Human Rights

Democracy and human rights curriculum includes the concepts of digital citizen, digital citizenship and cyber bullying. As skill, the skill of "using information and communication technologies" is mentioned. Also, references are made to "ethics", "digital participation" and "rights and responsibilities" subdimensions of digital citizenship in the curriculum of the democracy and human rights course.

Ethics

In the curriculum of democracy and human rights course, basic principles are specified in the part titled "learning-teaching process". One of these principles is "effective use of information and communication technologies in line with ethical principles", which is specified in the ninth article. In the explanations made under this article, use of information and communication technologies in line with ethical principles, active participation in democratic and social life and observance of ethical principles in this process (compliance wiith public decency, not misleading others, not taking actions considered crime by laws etc.) are emphasized.

Digital Participation

In the last attainment explanation of the theme titled "Living the democracy: active citizenship" in the curriculum of democracy and human rights course, participation in democratic life through social media tools is emphasized.

Rights and Responsibilities

In the last attainment of the theme titled "Living the democracy: active citizenship", it is stated with respect to the subdimension of rights and responsibilities that students should use information and communication technologies in a responsible manner without misleading or causing damage to other people and should not engage in actions considered crime by laws.

Visual Arts

Curriculum of the visual arts course gives coverage to the digital security and digital skills subdimensions of digital citizenship.

Digital Security

In the part titled "points to consider" in the curriculum of the visual arts course, warnings related to the safe use of internet and information technologies are given. Concept of "cyber security" is used, and it is emphasized that security principles should be explained to the students during the lectures.

Digital Skills

In the area titled "Cultural Heritage" of the visual arts course curriculum, there is an attainment related to the preparation of a webpage and promotion presentations on the museums and art galleries. The following is emphasized in the explanation of this attainment:

> *"Students are made to create and present webpages, brochures, school newspapers, posters or promotion presentations for museums and art galleries by making use of the information they obtained…" (12th Grade; 2nd Learning Area).*

Music

Out of subdimensions of digital citizenship, "digital security", "ethics", "digital skills" stand out in the music course curriculum. There is no statement related to the other subdimensions in this curriculum.

Digital Security

In the part related to the learning areas, attainments and explanations at the level of 9, 10, 11 and 12th Grades of the curriculum, the necessity of paying attention to "cyber security" while listening to music in the internet environment is emphasized separately for each grade. The following attainment statement can be given as example from the relevant curriculum:

> *"It is reminded that cyber security and ethical rules should be respected while listening to music in the internet environment." (9th Grade, 3rd Learning Area, 2nd Explanation)*

Digital Skill

In an attainment specified in the learning area titled "musical creativity" applicable to all class levels in the music course curriculum, use of information technologies in the research and studies related to music is emphasized. Also, in the explanation of an attainment for the 12th grade students, it is emphasized that students should create a music archive as digital data by making use of the information technologies. The following examples can be given for the references in the curriculum:

> *"Student benefits from information technologies iin the research and studies related to music." (Grade 11, Learning Area 3, Attainment 3)*
>
> *"Students create a music archive as both written and digital data with the support of various information technology tools (computer, various memory units etc.)." (Grade 12, Learning Area 4, Attainment 3).*

Ethics

In the part related to learning areas, attainments and explanations applicable to all grades in the curriculum of the music course, the necessity of abiding by the ethical rules while listening to music in the internet environment is repeated in all classes.

> *"Students are reminded that cyber security and ethical rules should be observed while listening to music in the internet environment." (Grade 10, Learning Area 3 and Attainment 2).*

Medical Knowledge

In the part titled "points to consider" of the curriculum of the medical knowledge course, there is only one explanation concerning the subdimension of *digital skill* of digital citizenship. In this explanation, it is emphasized that students should use information technologies actively and visit official webpages. Other than this, there is no reference to digital citizenship in the curriculum of medical knowledge course.

Revolution History and Atatürkism

In the curriculum of Revolution History and Atatürkism course, subdimensions of digital citizenship are emphasized only in the part of points to consider in the implementation of the curriculum. In this part, there are references to the subdimensions of *digital skill* and *ethics*. In the curriculum, use of sources such as internet in practices including historical research method is emphasized. Also, in the part related to the points to consider in the implementation of the curriculum, avoidance of plagiarism and observance of ethical rules and copyrights in the use of materials downloaded from internet are expressed as follows:

> *Rules determined by the Ministry of National Education should be respected in the use of digital sources. In particular, sources should be properly cited in the use of materials downloaded from internet to avoid plagiarism and ethical rules and copyrights should be observed (points to consider in the implementation of the curriculum).*

History

As in the course of Revolution History and Atatürkism, *ethics* subdimension of digital citizenship is emphasized in the curriculum of the history course. With respect to this, it is stated that sources downloaded from internet should be cited properly to avoid plagiarism and ethical rules and copyrights should be respected in the part titled points to consider in the implementation of the curriculum.

Turkish Culture and Civilisation History

In the curriculum of the Turkish culture and civilisation history course, there is reference only to the *digital skill* subdimension of digital citizenship. In this reference, it is stated that students should be directed to the digital sources in the part related to the points to consider in the implementation of the curriculum. Other than this, there is not any attainment statement or reference to digital citizenship.

Geography

Unlike the curricula of other courses, geography course curriculum makes reference to *digital commerce* subdimension of digital citizenship. In the unit titled "human systems" of the curriculum for the 12th grade geography course, there is an attainment stating that the importance of cyber security in e-commerce should be emphasized. This statement is as follows:

> *"Importance of cyber security in e-commerce is emphasized by including commerce practices." (Grade 12, Learning Area 2, Attainment Explanation 11).*

Religion and Ethics

In the curriculum of the religion and ethics course, there is reference only to *digital skill* subdimension of digital citizenship. In the part related to the attainments, it is recommended that contemporary information sources should be used. The relevant statement in the curriculum is as follows:

> *"It is emphasized that dreams, revelation and inspiration are not accepted as information sources by Islamic scholars. Also, contemporary information sources (like digital records) are mentioned. (Grade 9, Unit 1, Attainment Explanation 1)*

Philosophy

In the curriculum of the philosophy course, there is reference only to the *critical thinking* subdimension of digital citizenship. Other than this, there is no emphasis on digital citizenship

in the attainment statements or explanations. It is stated that students should discuss the information shared in internet and social media in terms of value and reliability of the information.

> *"It is ensured that students discuss the information shared in newspaper and magazine news, internet, social media and TV programs in terms of value and reliability of the information." (Grade 10, Unit 3, Attainment Explanation 2)*

Turkish Language and Literature

In the curriculum of the Turkish language and literature course, there are references to the *digital security* and *communication* subdimensions of digital citizenship. With respect to the subdimension of digital security, it is stated in the part related to the points to consider in the implementation of the curriculum that rules related to the use of digital sources and security measures should be respected. In the part of contents, it is stated that personal information should be secured while writing e-mails. Also, there is reference to the communication subdimension of digital citizenship in the part of contents and it is stated that "students should carry out e-mail writing studies in accordance with the phases of letter writing".

English

There are references to the subdimensions of *digital security*, *communication* and *security* of digital citizenship in the curriculum of the English course.

Digital Skills

In the part related to the attainments of the curriculum of the English course, it is emphasized that students should be able to write online/digital stories in cooperation, to analyse different professions through websites and to identify the jargon related to technology and web. Also, it is stated that students should be able to write an e-mail to a hotel or a friend. It is emphasized that they should visit websites and learn more information about the companies. These references are made in the curriculum as follows:

> *"Students will be able to write an online/digital story in cooperation." (Grade 10, Theme 8, Subtheme of writing, Attainment 2)*

"Students will analyse different job advertisements from newspapers/websites to match with the CVs." (Grade 11, Theme 1, Subtheme of Reading, Attainment 1)

"Students will be able to identify a jargon related to a webpage or a written word." (Grade 12, Theme 9, Subtheme of Reading, Attainment 1)

Discussion and Conclusion

The following conclusions were reached in the present study where secondary education currciula were analysed in terms of the subdimensions of digital citizenship.

At the level of secondary education, the highest number of references to digital citizenship was found in the computer science course curriculum. This curriculum gives wide coverage to digital skills such as understanding technological concepts, using technological systems and processes, using information technologies effectively and solving a problem encountered. This finding is quite normal. However, coverage of rights and responsibilities in digital platforms as well as ethics and critical thinking skills is highly limited and this is a signigicant problem. It is highly important that individuals use their digital skills in line with rights and responsibilities and ethical principles. Also, individuals should have the capacity to make an assessment on the validity and reliability of the information that they want to reach since the information provided in digital platforms might be wrong, incorrect or deficient. In this sense, individuals should be able to think critically. However, it is seen that curriculum of the course of computer science scarcely addresses this skill. When considered in connection with computer literacy, course of computer science plays a key role in helping students acquire certain skills. In this scope, students taking this course should have the skills to determine the social, economic and ethical results and to use computer effectively in daily life, which are the most important skills following knowledge about software and hardware (Korkmaz & Mahiroğlu, 2009). Peker (2017) analysed the curriculum of the information and communication technologies course in terms of the elements of digital citizenship and concluded that this course included the elements of digital citizenship in a highly limited manner. Öztürk (2015, p.95) concluded that "digital citizenship should be taught with sample activities in a more effective and practical manner in the courses of computer technologies and citizenship and democracy education in the schools to raise a good citizen and a good digital citizen". In all stages of education, education system should take digital learning environments into

consideration in order to promote learning and personal development and global citizenship skills and values should be incorporated into the system (Granberg, 2009; Seale, Draffan, & Wald, 2010: cited by Altınay, 2016).

Technology has had a significant impact on citizenship education as well as all other areas. Although difficulty of using internet in a controlled manner makes it hard to take conscious steps with respect to the impact of technology on social change, many young citizens living in the contemporary world are interested in contributing to the society (Ribble, Bailey, & Ross, 2004). In this respect, it is important to determine how the young citizens are affected by technology and how the curricula direct them during citizenship education. The findings of this study show that course of "democracy and human rights" follows computer science course in terms of coverage of digital citizenship in the curriculum. The curriculum of this course states that students should participate in democratic life from digital platforms in an effective manner by using information and communication technologies in accordance with ethical principles but this reference is highly insufficient. Also, coverage of rights and responsibilities in the digital environment is very limited. However, as stated by Çubukçu and Bayzan (2013), all individuals, as digital citizens, have responsibilities against the injustice and illegal contents available in the internet environment. Thus, rights and responsibilities against all risk groups in the internet cannot be ignored.

"Democracy and human rights" course is of great importance for teaching the students at the secondary education level their rights and responsibilities. However, a serious paradox shows up at this point. While instructors still focus on traditional citizenship education, the young and even children are taking part in the "digital environments" much more and going beyond the borders of the current citizenship education. In this sense, the young have put the interactive information technologies at the center of social life (Bennett, 2008). This paradox has created significant gaps between the "citizenship rights and responsibilities taught in te school" and "rights and responsibilities in the digital environments" in which the young frequently take part. Turkey is at the top in terms of the number of internet users (Bayzan & Özbilen, 2011). Also, when statistics are examined, it is seen that the frequency of internet usage is quite high especially among the young population when compared to the other age groups (TÜİK, 2017). Additionally, nation-wide information projects such as e-state and FATIH (Movement of Enhancing Opportunities and Improving Technology) Project in Education are considerably important developments to ensure that Turkey uses technology in an effective and correct

manner in the digitalising world (Çubukcu & Bayzan, 2013). However, it is thought-provoking that subdimensions of digital citizenship are not addressed sufficiently in the course of "democracy and human rights", which might teach students at the secondary education level their rights and responsibilities in the digital environments.

Digital citizenship is not only related to the course of computer science and democracy and human rights. Digital citizenship and its subdimensions are closely associated with the other courses, as well. Thus, curricula of the other courses include references to digital citizenship and its subdimensions. For instance, references to digital security, ethics and digital skills are encountered in the music course curriculum. It is stated that cyber security and ethical rules should be respected in particular while listening to music in the internet environment. In internet environment, security is explained as all kinds of unauthorized access to the defined information including reading, learning, modifying or deleting (Tennant, Ober, Lipow, Lynch, & Tonta, 1996). Mason (1986) determined ethical problems of the information age under four main titles, which are copyright, accuracy, confidentiality and access. Considering this comprehensive definition and types of digital security and ethics, it is striking that secondary education curricula are insufficient in this regard. Subjects of digital security and ethics, which are found to be deficient in the secondary education curricula, are actually related to the concept of "information ethics". Information ethics does not concern only those working in the information sector or institutions and organisations providing services in this field, and its boundaries cannot be drawn clearly. It is of particular concern to all individuals and institutions directly or indirectly associated with science and technology (Fidan, 2016).

In the curriculum of the English course, digital citizenship is emphasized with respect to the use of English in the internet environment (digital skills) and communication in English.

References to digital citizenship are highly limited (only once or twice) in the curricula of the courses of medical knowledge, revolution history and Atatürkism, history, Turkish culture and civilisation history, geography, religion and ethics and philosophy. In these courses, references are related to the use of digital sources and compliance with ethical principles.

Considering the duration of internet usage by the students at the secondary education level, it is important to design the curricula in a manner to raise awareness among the students, families and schools for the use of internet for beneficial purposes (Kahraman, Yalçın, & Çevik, 2011).

At the secondary education level, subdimensions of digital citizenship covered by the curricula most frequently are *digital skills* and *digital security* while the subdimensions included in the curricula at the least are *critical thinking*, *digital commerce* and *rights/responsibilities*. Nevertheless, as stated by Hollandsworth, Dowdy and Donovan (2011), the concept of digital citizenship covers a wide spectrum of behaviors having various risks and probable negative outcomes.

Recommendations

Within the scope of this study, secondary education curricula were assessed in terms of the subdimensions of digital citizenship and courses were compared. Inclusion of digital citizenship and its subdimensions in the curricula of the courses at the secondary education level can be considered to be a positive result. However, considering that digital environments are various, digital sources are abundant and rates of the young to be present in the digital environment are high in today's world, it can be recommended that courses give wider coverage to the skills required by digital citizenship. When the digital skills envisaged by the curricula are taken into account, subdimensions of digital citizenship can be associated with the relevant subjects in all courses at the secondary education level. With a broad perspective, digital citizenship and its subdimensions should not be associated only with computer science course and the curricula of the other courses should include the information and skills required by digital citizenship. Also, course of democracy and human rights should give wider coverage to the teaching of rights and responsibilities in the digital environment. In our country, if the young, who have high rates of computer and internet usage, know how to use information and communication technology tools and internet correctly, many problems in daily life can be eliminated.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019: 52-89
DOI: 10.17569/ tojqi.453426

Research Article

Development of Argumentation Skills through Socioscientific Issues in Science Course: A Collaborative Action Research[1]

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Abstract

This study was designed as a collaborative action research, aimed to develop secondary school 8th graders' argumentation skills through socioscientific issues (SSI) in science course. The participants of the research were comprised of 26 eight graders. In the study, an action plan which had lasted 27 weeks was implemented. The data was collected by means of written documents related to the argumentation skills, unstructured observations, teacher and student diaries. The data was analyzed using content analysis. The study results showed that at the end of the implementation, all students were able to create arguments that were comprised of components of claim, warrant, evidence, counter claim-warrantand rebuttal. Also, in the process of development of argumentation skills, some problems both related to the components of argumentation skills and learning-teaching variables were observed. Thisresearch is significant in terms of presenting information regarding regulations to be made for the development of argumentation skills through SSI in science course and problems that may be encountered in this process, forimplementation processof collaborative action research.

Keywords: *Qualitative research, Collaborative action research, Science education, Socioscientific issues, Argumentation skills*

[1] This study is based on PhD thesis of the first author supervising by the second author and presented at 3rd National Congress on Curriculum and instruction, Turkey

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Received: 14.08.2018 Accepted: 30.01.2019

Fen Bilimleri Dersinde Sosyobilimsel Konularla Argümantasyon Becerisi Geliştirilmesi: Bir İşbirlikçi Eylem Araştırması

Öz

Sosyobilimsel konularla fen bilimleri derslerinde ortaokul sekizinci sınıf öğrencilerinde argümantasyon becerisi geliştirilmesinin amaçlandığı bu çalışma işbirlikçi eylem araştırması olarak desenlenmiştir. Araştırmanın çalışma grubunu, 26 sekizinci sınıf öğrencisi oluşturmuştur. Araştırmada, 27 hafta uygulama gerçekleştirilmiştir. Veriler argümantasyon becerisine ilişkin yazılı dokümanlar, yapılandırılmamış gözlem, öğretmen ve öğrenci günlükleri ile toplanmıştır. Araştırma verileri içerik analizi yapılarak çözümlenmiştir. Araştırma sonuçları, uygulama sonunda öğrencilerin tamamının iddia, gerekçe, kanıt, karşı iddia ve gerekçe ile çürütücü bileşenlerinden oluşan argümanlar üretebildiklerini göstermiştir. Ayrıca, argümantasyon becerisi gelişimi sürecinde argümantasyon becerisi bileşenleriyle ve öğretme-öğrenme süreci değişkenleriyle ilgili çeşitli problemler saptanmıştır. Araştırma, sosyobilimsel konularla argümantasyon becerisi gelişimi için yapılacak düzenlemeler ve süreçte karşılaşılabilecek problemlerle ilgili bilgiler sunması, işbirlikçi eylem araştırmasının uygulama süreci hakkında bilgi vermesi açısından önem taşımaktadır.

Anahtar Sözcükler: *Nitel araştırma, İşbirlikçi eylem araştırması, Fen eğitimi, Sosyobilimsel konular, Argümantasyon becerisi*

Introduction

Science education studies have shown a significant interest in argumentation in the last decade, and argumentation has become a common goal for science education curriculums in many countries (Özdem Yilmaz, Cakiroglu, Ertepinar, & Erduran, 2017). Argumentation has been defined as a process of asserting, supporting, criticising and purifying an idea/a perspective (Osborne, Collins, Ratcliffe, Miller, & Duschl, 2003). The main aim of argumentation in science education is to develop students' skills to produce evidence to support their perspectives (Sandoval & Millwood, 2008; Yore, Florence, Pearson, & Weaver, 2006). In addition to this, argumentation is identified as a central point for scientific implementations in science classes (Newton, Driver, & Osborne, 1999). Developing students' communication and critical thinking skills, supporting their science literacy development, and cultivating skills of reasoning and the ability to select opinions and theories based on logical criteria are considered among the contributions that argumentation can bring to science classes (Jimenez-Aleixandre & Erduran, 2007). Furthermore, argumentation has numerous functions in science classes, such as ensuring understanding of the epistemology of scientific knowledge, identifying the effects of personal and social values on decision making, and allowing the evaluation of evidence from multiple perspectives (Driver, Newton, & Osborne, 2000). The fact that argumentation has made significant contributions to the process of science education makes studies on equipping pupils with this skill crucial. In that regard, there seems to be a large number of studies on the development of argumentation skills (Driver et.al, 2000; Erduran, Ardac, & Yakmacı-Güzel, 2006; Kuhn, 2010; Lazarou, Sutherland, & Erduran, 2016; Osborne, Erduran, & Simon, 2004; Özdem Yilmaz et al., 2017; Sadler & Donnelly, 2006; Simon, Erduran, & Osborne, 2006; Yan & Erduran, 2008; Yerrick, 2000). It appears that the analysis of factors which are influential in the development of argumentation skills, the assessment of levels of argumentation skills, and experimental studies on developing argumentation skills have an important place among these studies. One of the contexts in which argumentation skills can be cultivated during science education appears to be the integration of SSI. SSI reflect social dilemmas and debates that emerge in relation to scientific and technological products and processes, and harbor ethical and moral meanings at their center (Sadler & Zeidler, 2005a). SSI, constituting an important part of science literacy (AAAS, 1990; Fensham, 2002; Roberts, 2007; Sadler, 2004), spark debates

that create an opportunity to generate different opinions and argumentation (Simonneaux, 2007).

Accordingly, it is observed that various studies (Akbaş & Çetin, 2018; Atabey & Topçu, 2017; Dawson & Venville, 2010; Dawson & Carson, 2017; Evren-Yapıcıoğlu & Kaptan, 2018; Lin & Mintzes, 2010; Martín-Gámez & Erduran, 2018; Molinatti, Girault, & Hammond, 2010; Öztürk, 2017; Ritchie, Tomas, & Tones, 2011; Romero, 2018; Sadler & Donnelly, 2006; Zeidler & Nichols, 2009; Zohar & Nemet, 2002; Tsai, 2017) within the related literature have been conducted on argumentation skills developed through SSI. Among these studies, it can be seen that research related to socioscientific issues are also plentiful. For example; Lin and Mintez (2010), in their study with sixth graders, aimed to improve argumentation skills in socioscientific topics through individualized teaching practices. Dawson and Venville (2010) worked on teaching strategies to develop argumentation skills in socioscientific topics in high school genetics classes. The results of these studies show that socioscientific subjects are one of the factors to develop argumentation skills. In their experimental study, Molinatti et al. (2010) carried out a study to investigate the effects of discussions related to stem cell uses on high school students' argumentation and decision making skills. Ritchie et al. (2011) worked on the influences of academic writing project about socioscientific topics on students' science literacy development. The results showed that practice on argumentation writing on socioscientific topics supported the development of students' biology related concepts and their positive attitude towards science. Sadler et al. (2004) investigated how the students conceptualized and interpretated the nature of the science and how they evaluated the evidences about socioscientific situations. The findings indicated that interpreting the data on the nature of science in terms of making comments and evaluating socioscientific situations was affected by some factors such as scientific knowledge and personal beliefs. Zeidler and Nichols (2009) analysed various studies in their work called "Socioscientific issues: theory and practice" and explained socioscientific issues and its background. In line with this, they analysed deeply socioscientific topics and especially from the discussion perspective, sociomoral discussion, argumentation, critical thinking and discussion in detail. Osborne et al., (2004) concentrated on teaching argumentation, designing and evaluating learning environment reinforcing learning in their academic contexts. Öztürk (2017) investigated the effect of metacognition on socioscientific argumentation skills through causal-comparative

research. Evren-Yapıcıoğlu and Kaptan (2018) in their study, aimed to investigate the effect of socioscientific issues based instruction approach on development of argumentation skills of science teacher candidates. Topçu, Sadler, & Yilmaz-Tuzun (2010) were developed scale to evaluate argumentation skills regarding socioscientific issues. Dawson and Carson (2017), developed and tried scenarios regarding socioscientific issue of climate change to evaluate students' argumentation skills. In his research Romero (2018) aimed to determine the mental models about a social-scientific problematic specific to high-school Colombian students and to analysis the argumentative schemes regarding these mental models. Martín-Gámez and Erduran (2018) indicated in their study, how pre-service teachers view quality of arguments and teaching strategies regarding argumentation on energy which is a socio-scientific issue. Tsai (2017) in his study suggested the SSIs-Online-Argumentation Pattern (SOAP) to improve a pedagogical strategy enabling students to participate in online argumentation of SSIs. Akbaş and Çetin (2018) investigated the level of argumentation and informal reasoning of gifted students by means of the scenarios regarding socioscientific issues with a case study. Topçu & Atabey (2017) investigated the affect of socioscientific issues based instruction on middle school students' argumentation quality. It is seen that an important part of these studies concentrated on developing argumentation skills by conducting activities based on SSI. However, in some studies (Candan, 2006; Güven, 2002; Kıvanç, 2003; Newton et al., 1999; Sandoval & Millwood, 2005; Wu & Tsai, 2007; Yiğittir, 2003) several problems were experienced during the development process of argumentation skills, and this skill was not sufficiently attained. For the effective development of argumentation skills, this situation requires the problems encountered during the implementation process to be determined and resolved. This calls for action research studies to be conducted.

By conducting a collaborative action research for the purpose of developing argumentation skills insecondary school students, information will be provided regarding the regulations to be established in order to cultivate these skills in science courses during secondary school years, and problems that may be encountered in this process can be identified. Considering the controversial nature of SSI, it can be said that it is an appropriate context for the development of argumentation skills during science learning-teaching process. The results from such a study will contribute to the literature working to develop argumentation skills internationally in science education, as well as studies on SSI. In line with the stated reasons, this study aimed to find the answers to the following research questions:

How can argumentation skills be developed using SSI in science courses for 8th graders? What can problems be encountered during the implementation process? How can these problems be resolved?

Method

Research Model

This study, investigating how 8th graders' argumentation skills can be developed in science courses through SSI, is a collaborative action research. Action research is a process of inquiry about problems and taking action to solve them (Pine, 2009, p.30). It refers to teacher-conducted classroom research that aims to clarify and resolve practical teaching issues and problems (Richards & Farrel, 2005, p.171).By looking at examples of the use of the method in the research literature, we may identify features: action research is situational-it is concerned with diagnosing a problem in a specific context and attempting to solve it in that context; it is usually collaborative-teams of researchers and practitioners work together on a project; it is participatory-team members themselves take part directly or indirectly in implementing the research (Cohen & Manion, 1994, p.186). As a collaborative process, action research begins when educational researchers, university faculty, and teachers assist each other in developing the skills to identify and conceptualize problems (Pine, 1981). In this type of research, there is collaboration between university professors who are considered as helpers of the process and school teachers where the actual research takes place (Vula & Saqipi, 2015). Most collaborative action research focuses on practical problems defined by the participating practitioners (Elliott, 1977; Rapoport, 1970; Wallat, Green, Conlin, & Haramis, 1981, cited by Smulyan, 1983). As Calhoun (1993) states, collaborative action research can be applied to problems occurring in a single classroom or several classrooms. In this process, teachers and researchers work together to solve problems. This research process is based on a system of discussion, investigation, and analysis in which the researchers are a part of the process (Pine, 1981). Accordingly, this study included a group of students who had experienced a problem regarding argumentation skills. The teacher and the researchers worked together in order to resolve this problem. Through this work, an action plan was developed and implemented in order to develop argumentation skills.

The Participants of the Research

The participants of the study comprised of a total of 26 8th graders, 14 girls and 12 boys, who had experienced problems in argumentation skills. The students attended a secondary school in the city center and their academic achievement scores for science course ranged from 39.90 to 99.50. The teacher, called as the practising teacher had seven years of teaching experience, and had observed problems in students regarding argumentation skills. She joined the study voluntarily. The school had a computer lab where students can carry out research.

Procedure Conducted During the Research

Assessment studies

The work on the identification of the situation was followed in two phases to obtain deep information about the situation. In the first, the students' argumentation skills were observed and analyzed for approximately three months. As a result of this analysis, it was seen that the students could not justify their answers through warrants and evidences. When they provided warrants, they could not use high level argumentation skills such as producing counter claim-counter warrant and rebuttal. In the second phase, the students' argumentation skills were analysed in a written way in order to identify the situation better. Two of the students were at the level of claim and warrant and the others were only at the level of claims proposing

Forming the group of experts

In accordance with the science education, argumentation skills, curriculum development, qualitative research, SSI, and the content of the SSI, a team of 14 experts from various fields was formed for the study to get their opinion on activity planning and validity studies as part of the research.

Forming the validation committee

A validation committee was formed for the study in order to consult with the experts on data analyses throughout the research practices. The validation committee included a science teacher, an expert in argumentation skills, and a person from the expert group depending on

the subject. In the process of forming the committee, the fundamental criteria taken was that the science teacher and the argumentation skills expert should have knowledge in SSI and qualitative research. The validation committee made sure that the researchers were given the opportunity to constantly and critically question and monitor themselves, as well as the process, and that their comments regarding the occurrences or facts they thought they had observed reflected reality.

Preparation and implementation of the action plan

The action plan was prepared in consideration of the assessment study, findings from the literature review, and opinions of the group of experts. Accordingly, Toulmin's Argument Pattern (TAP) was taken as basis for the argumentation skill as is the case in majority of science education studies. TAP (1958) is being used as an important tool in studies carried out for improving argumentation knowledge during studies on science education. Moreover, it has been observed that the model has been used with various revisions due to problems regarding the understanding of the components of the model during application. In this regard, difficulties in distinguishing the components of "data and warrant" or "data and backing" is among the most important problems in application (Johnson, 1996; Zohar & Dori, 2003; Lin & Mintzes, 2010; Kelly, Druker, & Chen, 1998; Sadler & Donnelly, 2006). This model has been used in the study also after certain revisions in accordance with the related literature findings and the needs of the study. The focus during the study for developing argumentation skill was on skills of developing claim, warrant, evidence, counter claim-warrant, rebuttal. Of these; claim, warrant and rebuttal have been taken directly from TAP. In addition, the evidence component which corresponds to data in traditional logic (Aldağ, 2006) was also included in the process as was the case in the studies of Kuhn (1991) and Lin and Mintzes (2010) due to the aforementioned problems. Similar to the study by Lin and Mintzes (2010), the counter-arguments component related with developing opposing views during the argumentation period were also used after being detailed by warrants as counter claims. In conclusion, three stages were determined in the study for developing argumentation skill based on assessment findings, expert opinions and theoretical results related with the literature (Figure 1). The researchers and application teacher worked together during the study. Planning, action, observation, reflection studies (Kemmis & McTaggart,

1988, cited by Burns, 2010) were carried out each week for this purpose and the results acquired during this process were used for planning the upcoming week.

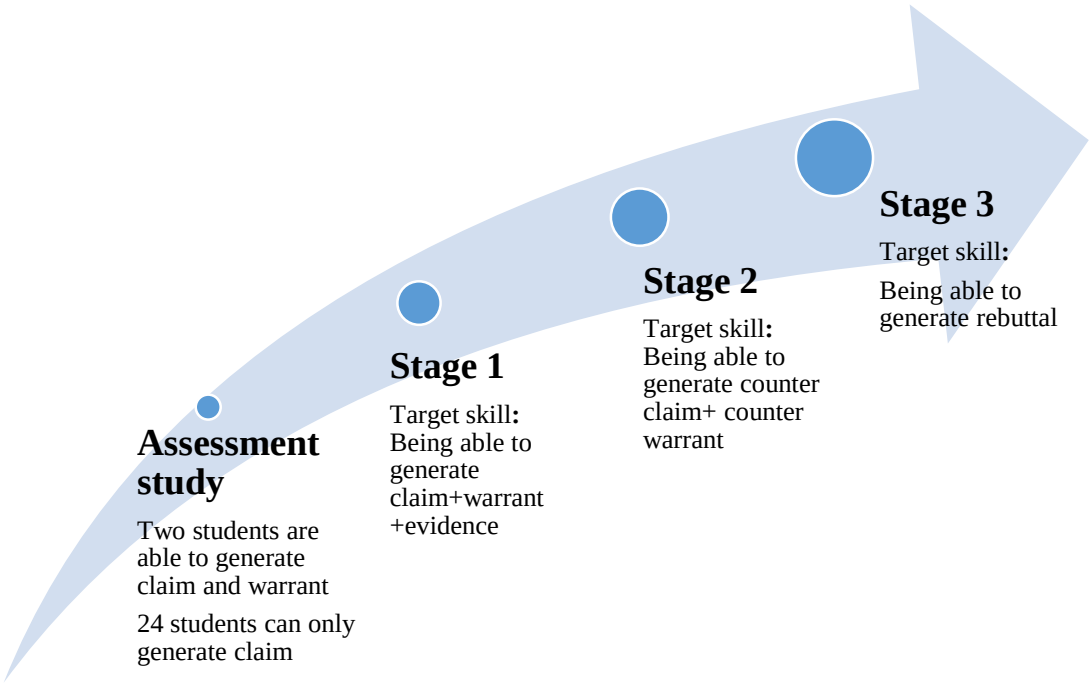

*Figure 1.*The research process stages of argumentation skills development

After learning outcomes were prepared for these three stages in the process of action plan development, the eighth-grade science course curriculum was examined for these outcomes with regards to SSI, and learning activities were planned. During the preparation of the activities, three dilemma scenarios were taken from the available literature (Koker, 1996, cited by Ratcliffe & Grace, 2003; Sadler & Zeidler, 2005a; Sürmeli, 2010). Other contradiction scenarios, media report analysis studies, and activities where legal procedures were recreated were developed by the researchers by consulting an expert opinion. The stages and activities of action plan are shown in Table 1.

Table 1
Stages and Activities of Action Plan

A1: Introduction of the argumentation skill		
Stage-1 Being Able to Generate Claim-Warrant-Evidence	Stage-2 Being Able to Generate Counter Claim-Counter Warrant	Stage-3 Being Able to Generate Rebuttal
A2: Ordering male child (Preimplantation genetic testing, PGT) A3: Job application (use of genetic tests during the process of job application) A4: A new step in the process of acquiring health insurance (use of genetic tests) A5: A genetic discovery excellent humans A6: Cloning a dead child A7: GMO products A8: Hydroelectric power plants (HPPs)	A9: Wind power plants-WPPs (media report analysis) A10: Pesticides - use of methyl bromide A11: Drinking water treatment A12: Water pollution: purifiers in the water A13: Acid rain A14: Chernobyl nuclear energy plant accident (research project)	A15: Nuclear energy plants A16: Base stations A17: Base stations: We are claiming our rights * (jigsaw+role play) A18: Cell phones* (media report analysis project) A19: Thermal power plants * A20: Global warming A21:Climate refugees* (role play) A22: What do we gain from recycling?* (project study)

*Activities running for two weeks

The practice period of the study, the first week as an introductory session, lasted for 27 weeks. Each week before the practice, the students were given information about which socioscientific issue was on the agenda of the activity, so they were given a chance to collect data about the issue of the activity. Additionally, supportive training was provided to pupils in order to help them become skilled in conducting research. The researcher video-recorded the process as an observer participant. During the activities, students were provided with first written and then verbal argumentation skill practices. Preparation, evaluation and problem solving-oriented practices were conducted with the teacher throughout the implementation process. Weekly qualitative data was collected from the students, analyzed for monitoring and evaluation practices and subjected to validity and credibility studies. These results provided information as to whether the desired goals were achieved, and provided a basis for the planning of the following activity to be conducted.

The procedure for a week can be summarized as follows:

In the first week, the activity entitled “ordering male child” was carried out. The aim of this activity was to develop students' ability to produce claims-warrant-evidence. In the

preparation stage teacher and researchers worked together on the activity. In this process, the questions were answered: How will the activity be applied? What kind of questions should be asked to the students? What kind of needs should be taken into consideration? In practice process, the activity was applied by teacher and researher video recorded the process as an observer participant. During the activities, students were provided with first written and then verbal argumentation skill practices. In this process, the teacher asked the students questions requiring them to use their argumentation skills (claim-warrant-evidence). At the end of the activity, video-recordings and written documents (teacher and student diaries, activity papers) were collected and transcribed in order to determine the development of argumentation skills and to analyse the problems encountered. Also, discussions were made with the teacher about whether the objectives are achieved, what kind problems were observed by her, what kind the problems and difficulties she encountered in the application process. After collecting the data, analyses were done for both the development of argumentation skills and the problems encountered in the process. In this process, the opinion of the validity committee was also consulted and the data set was analyzed for the realibity of coding by an expert. After this process, argument structures (gaining claim-warrant-evidence generation skill, see Table 2, results for A2) and problems occured in the application process (see, pages 13-14) were determined. The teacher and researhers worked together on what to do at the next cycle and how to solve problems. In this direction, the next activity was planned. Since the desired aim was not reached in this activity, it was decided to make a new activity for the development of this aim; claim-warrant-evidence generation skill and in order to resolve problems, a meeting was planned for the students.

Data Collection Tools

Pre-Assessment of Written Argumentation Skills Form (PAWASF)

The PAWASF was used to determine the written argumentation skill levels of students in the assessment studies. PAWASF included Gene Therapy for Intelligence (Sadler & Zeidler, 2005a), and Global Warming (Bell & Laderman, 2003) dilemmas. In order to determine argumentation skill level, open-ended questions were prepared following the related literature (Lin & Mintzes, 2010; Sadler & Zeidler, 2005a; Topcu et al., 2010). PAWASF was presented to expert opinion, and it was finalized following a pilot application.

Written documents on activities and projects

In the implementation process each week, the data regarding students' development of written argumentation skills was collected by using written documents on activity papers and projects.

Unstructured observation (Video-recordings)

The video-recordings were used for collecting data related students' verbal argumentation skills development. Furthermore, these video-recordings were presented for the examination of different researchers in order to prevent researcher bias, and they were used as data sources for validation studies. Unstructured observation was followed during all activities.

Teacher and student diaries

These diaries were used in order to see the implementation process, problems encountered, feelings and thoughts, and things that were learned from the point of view of teachers and students. In this way, data triangulation and confirming information were gained.

Data Collection

PAWASF was applied for assessment study beforestarting the implementation process. The activities were conducted for 27 weeks, and weekly video-recordings and written documents were collected throughout the process.

Data Analysis

The analysis of argumentation skill development data

In order to determine the development of argumentation skills in the study, video recordings and written document data were collected and transcribed weekly following the activities. The transcriptions were analyzed using content analysis. In the course of the analysis, the

transcripts were read line by line multiple times, in order to determine the components of arguments generated by students. In doing so, it was aimed to see whether the students developed the target skill or not till that phase of the study. Consequently, the data collection and analysis were co-conducted at this stage, while new findings were compared with the previous ones, as well as with findings from different data sources. In short, the comparison process was consistently monitored (Glaser & Strauss, 1967 cited by Neuman, 1991). These findings provided information on the students' development of argumentation skills during the implementation process, and were used for the planning of the following stage. Argument structure codes were grouped under three categories taking into consideration the stages from which they emerged: as argument structures regarding the claim-warrant-evidence development process, argument structures regarding the counter claim-counter warrant development process, and argument structures regarding the rebuttal development process.

The analysis of the problems experienced during the argumentation skill development

The basic principle of action researches is to detect and solve the problem encountered during the implementation process at the exact time and place it occurs (Best & Kahn, 2006). Accordingly, analyses were conducted for the problems encountered during and after the activities. In the weekly analyses, the data collected after each activity was analyzed, and problems regarding argumentation skills development were identified. In this process, the teacher and student diaries, video-recordings, and activity papers were analyzed and compared. This made it possible to see the problems from the teachers' and students' perspectives, and provided confirming information through data variety. These findings became an important source for improving the effectiveness of the process, and for the adjustments to be made in the following stage.

Problem codes regarding argumentation skills development were created during the analysis process. Then, the codes were grouped based on similarities and differences and the problem categories were established. The problem categories which were consistent with the related literature were analysed in terms of meaning and relation. After that, the problems themes were made up. These findings, based on the stages in which they occurred, were grouped under problems encountered during the claim-warrant-evidence development process;

problems encountered during the counter claim and counter warrant development process; and problems encountered during the rebuttal development process.

Credibility and Validity Studies During Research

Actions taken in order to ensure the validity and credibility of the research results are as follows:

Data was collected from different sources in the research study, and the process was recorded in order to prevent data loss and long-term interaction ensured. The study group was identified in detail in order to allow transferability. The ways in which research results were achieved, as well as evidence regarding inferences were presented clearly and plainly. The video-recordings, other records in relation to the process, data analyses and interpretations were presented to the review of field experts at a validity meeting conducted after the process. In this way, it was ensured that the researchers were given the opportunity to constantly and critically question and monitor themselves, as well as the process, and that their comments regarding the occurrences or facts they thought they had observed reflected the reality. Throughout the activities the researchers consistently questioned their role in the research process, and whether or not they were exhibiting any bias. The credibility of the research results was ensured by submitting the data set throughout the process to the review of an expert in argumentation skills and qualitative research knowledge. The coding of the expert and that of the researchers were compared, and any codes that created difference of opinion were resolved by discussing them with the expert.

Findings

The Findings of Stage 1 (Claim-warrant-evidence development)

The findings in this phase were given under two headings as the findings related to claim-warrant-evidence generation skill development and the findings regarding problems encountered in the claim-warrant-evidence development process.

The findings related to claim-warrant-evidence generation skill development

Table 2 shows the argument structures in written documents and verbal argumentation process in the process of the claim-warrant-evidence development and the frequency of students in each classification.

Table 2
Argument Structures and Numerical Data Regarding Claim-Warrant-Evidence Generation Skill Development

Argument structures and numerical data in written documents							
Argument Structures	Activity numbers						
	A2 f	A3 f	A4 f	A5 f	A6 f	A7 f	A8 f
Only claim	22	15	5	-	-	-	-
Claim + One warrant	3	6	13	14	5	-	-
Claim + More than one warrant	1	3	3	3	5	3	-
Claim + Warrant + Evidence	-	2	5	9	16	19	19
More than one claim + Warrant + Evidence	-	-	-	-	-	4	7
Total	26	26	26	26	26	26	26
Argument structures and numerical data found in verbal argumentation process							
Argument Structures	Activity numbers						
	A2 f	A3 f	A4 f	A5 f	A6 f	A7 f	A8 f
Only claim	16	8	5	2	-	-	-
Claim+ One warrant	2	6	10	10	3	-	-
Claim + More than one warrant	1	3	3	3	5	3	-
Claim + Warrant + Evidence	-	1	2	3	11	19	17
More than one claim + Warrant + Evidence	-	-	-	-	-	4	7
Total	19	18	20	18	19	26	24

f: frequency of students

When Table 2 was examined, five structures of argument were identified, which became distinct in terms of the type and number of components in the written and verbal argumentation process during the stage of gaining claim-warrant-evidence generation skills. When findings regarding arguments that were comprised only of a claim were analyzed, it was seen that arguments of this structure decreasingly continued throughout the first four activities. It was observed that students who developed arguments of this structure merely asserted a claim in their explanations, and did not include any statements relating to how this opinion could be valid and correct. An argument that exemplifies this situation is as follows: "*I think this technology should be used on perfect humans. They should select one or two people from each area of science and use it on them...*" (S12)

On the other hand, it was observed that argument structures that are comprised of claim and a warrant were generated by three students during the written argumentation process in the initial activity, and only by two during the verbal argumentation process. Additionally, an increase was observed in the number of arguments until the fifth activity, and a reduction after that point, coming to an end in the seventh activity. An excerpt from the process of verbal argumentation with this argument structure is as follows: "*People should not be given a chance to choose their child's gender. If so, the number of boys will increase in our country and the natural balance will be lost* …" (S11)

When this explanation is examined, we can say that a warrant which supports the claim was presented, the information is structured in a more orderly fashion, and that awareness is taking shape regarding the necessity of a supporting statement.

After that, it was followed that a significant number of students started to use the claim and more than one warrant argument structures earlier than the claim-warrant-evidence argument structures. In this phase, instead of supporting their claims through evidences, they tended to use more than one warrant. This type of arguments structures can be exemplified as below:

> "*I would have allowed the use of GMO products. Because that would mean more crops would be produced, and everyone would be able to get cheaper food, and agricultural pesticide use would go down, making us less affected by chemicals that are harmful to our health*..." (S17)

The argument structure made up of claim-warrant-evidence was observed to have a slow progress throughout the phase, and was generated by all students in the last two activities. Seven of the students were seen to improve their argument structures in this phase, combining claim-more than one warrants- more than one evidence. Examinations of the data showed that these seven students with better academic achievement demonstrated faster progress in terms of argumentation skills, and produced better quality arguments. At the same time, these examinations revealed that the development process of this skill in the four pupils with lower academic achievement progressed more slowly compared to others. An excerpt from the verbal argumentation process serving as an example of the argumentat structure of claim-multiple warrants-evidence is shown below:

> "*Teacher, I think it is necessary for our country to construct HPPs, I mean they must be built. Because there is an ever-growing need for energy, and if they build HPPs, it could be a solution to the energy problem -How? How can you prove what you just said? - I can talk about my research results. As HPPs are renewable energy sources, they work with over 90% efficiency without fuel expense, and our country has a huge potential for using them. If we take advantage of this potential, it will resolve our energy problem, and minimize our foreign dependency -So what else can you tell us in favor of building HPPs? -They must be built for the purpose of protecting the environment. Because, they are environmentally-friendly; they can be renewed; and they are clean energy sources. Because they do not produce environmentally hazardous waste or greenhouse gas that lead to global warming. The most important evidence is the fact that it has been supported by UNESCO as environmentally friendly...*" (S17)

Regarding the findings of the claim-warrant-evidence development, the participants can be said to develop their claim-warrant and evidence generation skills in the implementation phase with socioscientific issues.

The findings regarding problems encountered in the claim-warrant-evidence development process

Studies were conducted in order to identify and resolve the problems that were experienced during the claim-warrant-evidence development process in the research. Findings concerning the problems identified at this stage were presented in Table 3.

Table 3
The Findings About Problems Related to the Claim-Warrant-Evidence Development Process

Problems Related to Claim-Warrant-Evidence Development	Problems understanding components of argument-warrant-evidence • Inability to understand the necessity to present supportive information • Inability to differentiate warrant and evidence • Inability to decide what information counts as evidence
	Connection problems in generating claim-warrant-evidence • Presenting warrant that does not support claim • Presenting evidence that does not support claim and warrant • Presenting claim and warrant for two opinions • Presenting religious warrants and being unable to support them with evidence

Problems about the teaching-learning process variables	Problems with the teacher	• Problems in asking questions • Problem regarding confidence and anxiety
	Problems with the students	• Lack of research skill • Lack of verbal language skills • Lack of supportive information

When Table 3 was examined, the problems experienced in the process of gaining claim-warrant-evidence generation skills were concentrated under two themes.

The problems in claim-warrant-evidence skills development were divided into two categories. Among these, problems in understanding the components of claim-warrant-evidence were identified as; inability to understand the necessity to present supportive information, inability to differentiate warrant and evidence, and inability to decide what information can be evidence. The problem of being unable to understand the necessity to present supportive information continued to decrease throughout the first three activities. Students who experienced this problem were observed to have only expressed their claims during the argumentation phase, and not generated supportive warrant and evidence as to why this opinion might be correct. It was established that students present the warrant as evidence, as part of the problem of being unable to differentiate between warrant and evidence. When failing to decide what information could be used as evidence, students were observed to have used statements such as "I carry out experiments as evidence" rather than using scientific data or epitomic information. Under the category of connection problems in argument-warrant-evidence generation, the problems of presenting warrants that did not support the claim, presenting evidence that did not support the warrant, presenting claim and warrant for both opinions, presenting religious warrants, and an inability to support statements with evidence were identified. These problems demonstrated that while awareness was formed regarding components of argumentation, there was a failure in establishing the correct connections. Furthermore, it revealed the fact that students were not making statements focused on a particular opinion, and that they presented religious warrants, unable to establish an evidence-based connection. An exemplifying excerpt demonstrating the problem of presenting religious warrants and being unable to support them with evidence is as follows: "*I do not want there to be a way to create perfect human beings. Because God creates everyone as He sees fit, and it is a sin anyway. So I don't agree with this opinion...*" (S15)

In order to resolve such problems detected during the process, meetings were conducted with the students along with the teacher. In these meetings, the students were given extra explanations and feedback. New activities were organized to give the students to acquire new experiences. The second theme, problems concerning variables in the education process, can be grouped under two categories. One of these are problems identified in the teacher, and they were established as problems in asking questions, and with confidence andanxiety. As for the problems about questioning, it was observed that especially in the first sessions of the implementation, the teacher forgot asking questions which guided the students to produce the warrant and the evidence such as –Why do you think so? –What is your warrant? –Do you have any evidences? - What are they? In these situations, it was seen that the student gave an explanation. The teacher listened to him/her but did not ask any further questions. Instead, the teacher allowed another student to talk.

Again, in this phase, the teacher was seen to have experienced a lack of confidence and anxiety. Both problems were solved in time as the teacher gained experience. On the other hand, problems detected in the students were identified as lack of research skill, lack of verbal language skills and lack of supportive information.

In cases where the problem in verbal argumentation skills development was experienced, students were observed to have failed to fully express their thoughts, or to have put forth disorganized explanations. When the causes of this problem, which were more often observed in students with lower levels of academic achievement, were examined, insufficient verbal linguistic skills development, nervousness and lack of experience were identified among these causes. Additionally, it was observed that several students were able to generate better arguments in writing, even though they could not do that verbally, which meant that their verbal argumentation skills developed more slowly. The research study also showed that students experienced problems related to insufficient supportive information at the time of argument generation phase. In order to resolve this problem, students were provided with information early on regarding the activity’s topic. In this way, students were given the opportunity to acquire knowledge on the topic, and encouraged to do research.

Consequently, it can be said that various problems were experienced in relation to the education process during the argument-warrant-evidence development phase, and that they were resolved.

The Findings of Stage 2 (Counter Claim-Counter Warrant Development)

The findings in this phase were given under two headings as "the findings related to counter claim and counter warrant generation skill development" and "the findings regarding problems encountered in the counter claim –counter warrant development process".

The findings related to counter claim and counter warrant generation skill development

Table 4 shows the argument structures related counter claim and counter warrantin the written documents and verbal argumentation process and the frequency of the students.

Table 4
Argument Structures and Numerical Data Regarding Counter Claim-Counter Warrant Generation Skill Development

Argument structures found in written documents and the numerical data						
Argument Structures	Activity numbers					
	A10 f	A11 f	A12 f	A13 f	A14 f	A15 f
Claim-Warrant-Evidence	21	16	5	-	-	-
Claim-Warrant-Evidence-Counter Claim	4	6	8	7	4	-
Claim-Warrant-Evidence-Counter Claim-Counter Warrant	1	3	10	15	16	18
More than one claim-Warrant-Evidence-Counter Claim- Counter Warrant	-	1	3	4	6	8
Total	26	26	26	26	26	26
Argument structures found in the process of verbal argumentation and the numerical data						
Argument Structures	Activity numbers					
	A10 f	A11 f	A12 f	A13 f	A14 f	A15 f
Claim-Warrant-Evidence	19	16	5	-	-	-
Claim-Warrant-Evidence-Counter Claim	4	6	8	5	4	-
Claim-Warrant-Evidence-Counter Claim-Counter Warrant	1	3	8	10	12	16
More than one claim-Warrant-Evidence-Counter Claim- Counter Warrant	-	1	3	4	6	8
Total	24	26	24	19	22	24

f: frequency of students

When Table 4 was analyzed, four different argument structures were exhibited in the counter claim and counter warrant development phase. Regarding argument structures with the components of claim-warrant-evidence-counter claim, it was revealed that they were often produced in the first activities and different from the arguments in the first phase, only counter claim component was added into argument structures. An example of a written argument that matches this structure is as follows:

> *"I think that the use of methyl bromide should be banned. Because methyl bromide is not only risky for the environment, but it also has adverse effects on humans. For example, when it is inhaled in large amounts, it leads to lung and central nervous system diseases... When it comes to its adverse effects on the environment, for example, it thins out the ozone layer, and this has effects on human health, as well as all living species and agriculture... Therefore, I think it should be banned. Those who do not agree with this opinion will think the opposite and say that the use of methyl bromide should not be banned" (S6)*

The argument structure comprised of claim-warrant-evidence-counter claim-counter warrant identified at this stage included information regarding the fact that the arguments suggested with the problem were supported with warrants and evidence, and what the counter claim and counter warrant could be in case of a disagreement. A dialog that exemplifies such argument structure is as follows:

> *"-Teacher, I think WPPs should be built -Why? -Because, they are a constant source of energy. They do not need raw materials, they are a domestic energy source, and would meet our energy need to a great extent. Because, WPPs are supposed to have a high potential of 48MW in our country. This shows their importance. -So, what could people who disagree with you argue and what warrants would they give? -They would claim that WPPs should not be built. And their warrant could be that agricultural lands might be harmed" (S11).*

When these explanations are examined, it is seen that skills to evaluate different points of view other than the one that was argued for were more effectively used.

Another argument structure which was found in this process consisted of more than one claim-warrant-evidence-counter claim- counter warrant. This argument structure was more developed in terms of counter claim and counter warrant components and it was mostly seen in the last activities and showed a faster development with academically high achievers. An example of such arguments is as follows:

> *"-I believe it is more important to prevent the spread of microbes in drinking water. Because if not, many people will get sick. Their lives will be in danger. It will also negatively affect the economy. Research studies I found support this. It was determined that around 1 million people around the world died this year due to diseases related to water, and this demonstrates that it is an important problem. Then there are also treatment expenses. Even if these people do not die, lots of money will be spent on treatment expenses as these diseases are rapidly transmitted to others, and this shows that it will greatly damage the economy - What could be a counter argument? -People who do not share the same opinion would say that it is more important to minimize the risk of getting cancer from drinking water. As a warrant, they would say that their lives will be in danger, and treatment will be harder and more expensive" (S1).*

When findings regarding the development of counter claim and counter warrant were generally assessed, it can be said that as a result of the applications there was a transition from using only the argument structure of claim-warrant-evidence components, to generating arguments ofmore than one claim-warrant-evidence-counter claim- counter warrant, and that the students exhibited different development profiles in this phase.

The findings regarding problems encountered in the counter claim-counter warrant development process

In comparison to other phases, less problems were encountered in the development of counter claim and counter warrant. The most important problems experienced in this phase were identified as lack of versatile thinking process, lack of effort, andlack of enough knowledge. Among these, the problem of lacking a versatile thinking process was mostly observed in pupils with low academic achievement, and they demonstrated a slower development in counter claim and counter warrant generation skills. As a result of lack of enough knowledge, they produced insufficient warrants. It was observed that they presented comprehensive information supporting claim and warrant but weak information in counter claim and counter warrant. Furthermore; at the beginning of the development process of counter claim and counter warrant, some of the students did not seem to show any efforts to produce counter claims and counter warrants. Instead; they continued to come up with warrant and evidence. This problem was solved in the first two weeks.

As a solution these problems, the students were re-informed about why important and how to produce counter claim and counter warrant and activities were re-organized to provide more experiences for the students.

The Findings of Stage 3 (Rebuttal development)

The findings in this phase were given under two headings as "the findings related to rebuttal generation skill development" and "the findings regarding problems encountered in the rebuttal development process".

The findings related to rebuttal generation skill development

Table 5 presents the argument structures found in the written documents and verbal argumentation process in the phase of rebuttal generation skill development and the frequency of them.

Table 5
Argument Structures and Numerical Data Regarding Rebuttal Generation Skill Development

Argument structures found in the written documents and the numerical data								
Argument Structures	Activity numbers							
	A16 f	A17 f	A18 f	A19 f	A20 f	A21 f	A22 f	A23 F
Claim-Warrant-Evidence-Counter Claim-Counter Warrant	24	21	18	10	4	4	1	-
Claim-Warrant-Evidence-Counter Claim-Counter Warrant-Rebuttal	2	5	8	16	22	22	25	26
Total	26	26	26	26	26	26	26	26
Argument structures found in the verbal argumentation process and the numerical data								
Argument Structures	Activity numbers							
	A16 f	A17 f	A18 f	A19 f	A20 f	A21 f	A22 f	A23 f
Claim-Warrant-Evidence-Counter Claim- Counter Warrant	20	15	14	10	4	4	-	-
Claim-Warrant-Evidence-Counter Caim- Counter Warrant-Rebuttal	2	5	8	9	12	15	15	18
Total	22	20	22	19	16	19	15	18

f: frequency of students

According to Table 5, two argument structures which differed in terms of component types and the number were observed in the process of rebuttal generation skill. Of these, the first argument made up of claim-warrant-evidence-counter claim-counter warrant components was mostly produced during the first activities and in the implementation phase, it continued to decrease. The second argument structure with claim-warrant-evidence-counter claim – counter warrant-rebuttal components was not frequent in the first activities but continued to increase in the process. Also, this structure developed slower in the verbal argumentation process than the written argumentation process. In the findings related to the argument structure with claim-warrant-evidence-counter claim-counter warrant -rebuttal components were learned by only two students in the first activity and were developed so slowly. Furthermore, it was seen that the rate of generation rebuttal skill differed among the students. It developed faster with high academic achievers. This skill could not be developed with four lowest academic achievers till the last two activities. An example dialogue related to the use of rebuttal generation skill is as in the following:

> *"Thermal power plants must be built. Because these plants are imperative for meeting our country's energy need, and in keeping our national income inside the country..."(S9)*
>
> *"-Teacher, I don't agree with S9. OK, they may make important contributions to meeting energy needs, but they harm the environment. They adversely affect people's right to have a healthy life, and their right to environmental protection...our country has a great potential for clean energy sources, like HPPs and WPPs. Why are they imperative? They could be, if we didn't have other sources of energy, but while we have such opportunities, they are not imperative..." (S11)*

These quotations from the verbal argumentation process indicated that the students could develop rebuttals to invalidate each other's perspectives. In this context, it is possible to say that the activities served the purpose of developing rebuttal generation skill.

The findings regarding problems encountered in the rebuttal development process

Table 6 points out the problems faced in the process of rebuttal generation skill development in the study.

Table 6.
Findings Related to Problems in the Process of Rebuttal Generation Development

Problems about rebuttal component	• The problem of not being able to understand the rebuttal component • The problem of not being able to conduct a thought process in order to develop a rebuttal
Problems related to the teacher	• Biases and anxiety • Inability to create the appropriate environment for rebuttal development • The problem of giving feedback in the process of rebuttal producing
Problems related to the students	• Biases and anxiety • The problem of not realizing the importance of rebuttal in the argumentation process

As seen in Table 6, the problems experienced during the process of the development of rebuttal were categorized under three headings as the ones related to the rebuttal component, related to the teacher and related to the students. Two different problems were identified about the rebuttal component. One of these was the problem of not being able to understand the rebuttalcomponent, which reflected the difficulties students run into in making sense of the concept of rebuttal. Especially in the initial stages of the process, the majority of students experienced difficulties in making sense of the rebuttal component. While the problem of not being able to conduct a thought process in order to develop a rebuttal represented the inability to establish the required context of contemplation in order to generate rebuttal during the argumentation process, that is, the inability to exercise the process of deliberating a counter claim against one's own claim to prove under what conditions such a counter claim would be invalidated. Resolving these problems included conducting interviews with students, and repeatedly providing them with the information on what a rebuttal was, and how they could make use of it. New activities were organized.

Problems related to the teacher were identified as, biases and anxiety, inability to create the appropriate environment for rebuttal development, the problem of giving feedback in the process of rebuttal producing. Such problems were observed in the initial activities. In this sense, the teacher seemed to have biases and anxiety with regards to her competence in the process of rebuttal generation, and failed to offer detailed feedback related to the quality or validity of the rebuttal generated. She also struggled with difficulties about giving answers and explanations to the questions that the students asked about the rebuttal.At the same time, the teacher seems to have preferred to allow studentsto speak at random, rather than making

encouraging arrangements for students to generate rebuttalby juxtaposing opposing views. In addition to this, the teacher fell short of posing questions to students who disagreed with the generated argument, with regards to why that argument could be invalid. Solution-oriented works were conducted with the teacher before and after the activity in order to be able to address these problems.

Problems regarding biases and anxiety, and the problem of not realizing the importance of rebuttal in the argumentation process as problems related to the students. In terms of bias and anxiety, it was seen that the students had the difficulty of differentiating rebuttal when they first encountered it in comparison to other components.During the implementation process, although some students spent effort to produce other components, they did not show any attempts to produce rebuttal. When they were asked about this, they said that they could not do it even if they worked for it. To resolve these problems, meetings were conducted with the students who experienced this problem, they were encouraged throughout the process, and assistance was provided throughout the process whenever they needed it. Additionally, in this process, some of the students were determined to have difficulties in recognizing the importance of this component, and made statements regarding its redundancy. In this regard, one of the students said the following: "*...I'm already presenting a warrant and evidence to support my opinion, don't they prove its accuracy? Why are we doing this, is it really necessary?...*"(S13).

As a matter of fact, throughout the process it was observed that students tended to present more warrants and evidences rather than generating rebuttal. To overcome this problem, the students were given extra information and explanation about the importance of the rebuttal. Furthermore, these students were put together with the students who were good at producing rebuttals. In doing so, they were guided to realise that only supporters were not enough in this process.

Discussion, Conclusion and Implications

The results of the study highlighted that SSI-based implementations developed 8th graders' argumentation skills and the quality of arguments produced in this process changed in a

positive way. Similar results regarding the success of SSI-based activities in developing argumentation skills were identified in different studies. Lin and Mintezs (2010) carried out a study with 6th graders and investigated the development of argumentation skills in socioscientific issues. The results of their study showed that the students improved their argumentation skills such as their claim, rationale, evidence and counter argument. Maloney and Simon (2006), in their study with children aged 10 and 11, aimed to develop argumentation and decision making skills in the context of socioscientific issues. Four activities were practised in three different schools. At the end of the study, a development was observed in the students' argumentation skills. In another study Atabey and Topçu (2017) in their study, demonstrated that SSI based instruction is an effective approach to improve the middle school students' argumentation quality. In their high school genetics classes, Dawson and Venville (2010) implemented class discussions and writing activities related to socioscientific topics to develop the students' argumentation skills. They observed a development in the students' argumentation skills and they highlighted four important factors in developing argumentation skills: class discussions, the implementation of writing activities, socioscientific issues and student roles. Evren Yapıcıoğlu and Kaptan (2018) studied with science teacher candidates using mixed research method, showed that socio-scientific situation-based teaching approach affected positively the development of argumentation skills. Topçu & Atabey (2017) investigated socioscientific issues based field trips affects on argumentation quality. The results showed that socioscientific issues based field trips developed students' argumentation quality. Zohar and Nemet (2002) investigated dilemmas in human genetics and teaching argumentation skills. They found out that nearly 90 % of the students were successful in developing arguments and there was an increase with the quality of arguments.When these findings in the related literaure have in general been considered, it can be said that socioscientific issues develop argumentation skills.

On the other hand, the argumentation skill development was also investigated in the related literature in terms of academic achievement. Of these, Zohar and Dori (2003) carried out a study with secondary school students and found out that students at all grades could develop their argumentation skills after they were given training but high achievers exhibited more advanced argumentation skills. While in their studies Lin and Mintzes (2010) showed that there is a close relationship between argumentation skills and academic achievement, and that students with high academic achievement developed a much more advanced argumentation

skills compared to those with lower levels of academic achievement. Hakyolu (2010) also supported these findings with his research. In his study with students from different levels of academic achievements, Hakyolu revealed that the students with high achievement level were better at both participating in argument situations and producing quality arguments. It can be said that such findings support the conclusion of this study that more successful students show faster development pattern and produce richer argument structures.

More comparisons were found in the relevant literature, such as Puvirajah (2007) who analyzed the validity and quality of arguments and revealed the necessity of having evidence to support claims and establish quality arguments, as well as the importance of acquiring the habit of conducting scientific research in order to do that. According to Levinson (2006), research should be done in order to provide evidence for SSI except science classes. Similarly, Kariper, Akarsu, Slisko, Corona and Radovanovic (2014) draw attention to the importance of scientific research for the development of argumentation. Demircioğlu and Uçar (2014) stated that students develop and defend claims with more scientific explanations after reading scientific articles.In that regard, it is possible to say that this study accurately identified the lack of research skills as a problem within the process, and established the necessity of conducting studies for resolving this problem.

When problems identified in the development of argumentation skills were further assessed within the context of findings in the related literature, Zeidler's (1997) carried out a study about the influential factors on the argumentation process and the reasons of the students' mistakes. Zeidler identified lack of previous experience in producing arguments, the presentation of insufficient evidence, and the effects of fundamental beliefs on arguments as causes of these mistakes. In relation to that, he said that inexperienced students' prejudice, their inability of producing evidence, the effect of beliefs on argumentation process and uncertainty over what constitutes accurate evidence were the leading sources of the mistakes. Johnson (1996) considered the inability to differentiate evidence and warrant to be one of the problems encountered in the process of argumentation. Zeidler, Osborne, Erduran, Simon, & Monk, (2003) demonstrated that students experienced problems in recognizing the difference between the components of data, warrant and evidence. In their study with the students between 12 and 17 years old, Dawson and Venville (2010) found out that a great majority of the students could not support or justify their claims or could only produce simple warrants,

could not do reasoning. Martín-Gámez and Erduran (2018) stated that pre-service teachers had problems in understanding arguments. In this context, they indicated that pre-service teachers did not understand the function and the meaning of warrants. Sadler and Donnelly (2006), in their study with high school students, identified that moral thinking and content knowledge were influential factors on the quality of argumentation. According to Evren Yapıcıoğlu and Kaptan (2018), religious judgments and content knowledge are important factors for the decisions on socioscientific issues. Hogan (2002) with secondary students and Zeidler, Walker, Ackett, and Simmons (2002) with high school students showed that beliefs and moral thinking were effective on decision making in SSI. In this context, it can be said that religious and moral explanations are influential of the process of decision making (Simonneaux, 2007). Sadler and Zeidler (2005b) worked on the relationship between content knowledge and argumentation skill and mentioned that content knowledge was effective on the validity of arguments. They added that the students with broad content knowledge were good a reflecting their background on the process of argumentation and the students with narrow content knowledge could not show their content background as evidences. As a matter of fact, according to Kind, Kind, Barmmby and Adamson (2009), there is a significantly meaningful relationship between argumentation and students' existing knowledge. Duschl and Osborne (2002) and Aufschnaiter, Erduran, Osborne and Simon (2008) presented parallel findings, saying that as the students' knowledge level increased, their argumentation skill increased as well. According to various studies about the argumentation skill, it was claimed that the students were not ready to analyse the others' claims and warrants, to structure and support their own arguments (Driver et al. 2000; Jimenez-Aleixandre et al. 2000). When these findings were assessed in a general sense, biases based on lack of experience, inadequacies in generating evidence and warrant, reflection of beliefs and moral contemplation in the argumentation process, the inability to decide what the quality of evidence might be, the inability to differentiate between warrant and evidence, lack of supportive information and in that context of content knowledge, and incompetence in the analysis of counter arguments (counter claim and its warrants) can be considered to be some of the problems encountered in the development of argumentation skills. On this note, problems regarding confidence, concern and bias based on lack of experience, and problems regarding the inability to generate supporting warrant and evidence, inability to support arguments as a result of presenting religious warrants, inability to decide what information can be counted as evidence, inability to differentiate between

warrant and evidence, and lack of supporting information, all of which were identified within the scope of this research study, are supported by the findings in the relevant literature. On the other hand, the results of this study reveal the existence of problems such as the fact that developing rebuttal generation skills takes a long time, and that the process of generating rebuttal is not fully understood and a context of contemplation cannot be established. The generation of rebuttal is a process that requires a high level of contemplation skills, and is a significantly difficult task for the majority of students (Lin & Mintzes, 2010). Wu and Tsai (2007) showed that only 38 % of the high school students could produce rebuttals. It is a probable outcome that this process, which requires the use of advanced contemplation skills, and arguments and counter arguments to be considered together prior to generating rebuttal (Kuhn, 1991), so it is a probable result that primary school students show a slower development process.

Furthermore, the teacher was observed to have experienced problems throughout the process in relation to asking questions, lack of confidence, anxiety, and process management. Considering the fact that experience has been a significant factor in resolving problems related to the teaching process, as well as in improving the process management (Byra & Sherman, 1991; Fernandez & Ritchic, 1992), and that such problems are automatically resolved throughout the process in parallel with the experiences gained, such problems related to the teacher could be associated with lack of experience regarding argumentation skills education. Similarly, different studies draw attention to the lack of teachers' and pre-service teachers' knowledge and skill for teaching argumentation skills. In this context, they emphasize the importance of conducting studies to provide experience for teaching argumentation skill (Martín-Gámez & Erduran, 2018; McNeil, González‐Howard, Katsh‐Singer & Loper, 2016; Uçar & Demiraslan Çevik, 2017). In the light of these results, some suggestions can be given:

The study was conducted with a group of 26 students attending a middle socio-economic class school. In this context, these results obtained from the research are only generalizable for this group of students and therefore limited to its own context. In order to obtain broader results, studies should be done with students from different socio-economic classes and classes grades.

In this present research, the implementation process was managed by an experienced teacher. It has been known that the year of experience and level of expertise are influential factors in classroom practices. Follow-up studies with teachers having different skills may provide more comprehensive information both for the problems in this process and opportunities to see whether these problems differ or not.

During the implementation process, the teacher encountered problems and the problems were solved. In-service teacher training programmes should be held to equip teachers with knowledge and skills about what kind of managements should be done to improve the students' argumentation skills.

In this research, it was seen that not all students were good at developing argumentation skills at the same pace. As it has been found out that low achievers have been slow in this process, it is clear that they need more experience. Moreover; it is suggested that students should be given feedback about their development, problem-focused meetings should be organized and students should be helped when needed. In addition, it is recommended that achievement level differences among students should be considered and the process should be observed carefully and students should be presented practice opportunities until their argumentation skills developments are complete.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019: 90-111

DOI: 10.17569/ tojqi.496012

Research Article

Information for Knowledge: A Case Study on Education Faculty Students' Internet-based Selective Learning Habits

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Abstract

The purpose of this study is to scrutinize education faculty students' internet-based selective learning habits on a qualitative basis. A single-case holistic case study was conducted on an internet-based selective learning process following information retrieval. Participants were 37 sophomore students enrolled at three different departments of a state university in Turkey. Research data were collected in 2015 through observation records, field notes, participant diaries and interview questions. A four-week observation procedure was implemented in order to collect data on information search behavior and knowledge acquisition on the purpose of selective learning. Two stepwise-interviews were carried out based on typical sampling understandings: a co-constructed interview was conducted with the participants browsing only for information retrieval, using the data originated from the focus group interview on selective learning. Predisposition towards information retrieval and knowledge acquisition for selective learning were the two main themes derived from the data, and descriptive analysis was used to address these themes. The findings were interpreted in company with the subthemes-concepts structure and a series of implications were drawn based on the results of the study. The results of the study showed that a tendency to detailed search behavior is a threshold for selective learning. Participants with a tendency to learn selectively wanted to interact with the participants using online dictionaries and trying to conduct a specified search process. Although they were not given extra information about any criterion within the scope of the study, selective learners were capable of applying and discussing the search criteria (ie. whether a website cited any reference, the content credibility and usability) echoed by themselves. While being free to select the search topic in the field of study is an important motive for selective learning, being completely free for searching and reporting a topic does not work for both two groups. The study ends with some suggestions for future research, stakeholders and current practice.

Keywords**:** *Learning habits, selective learning, information search behavior, information retrieval.*

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Received: 12.12.2018 Accepted: 30.01.2019

Bilgi İçin Enformasyon: Eğitim Fakültesi Öğrencilerinin İnternet Tabanlı Seçici Öğrenme Alışkanlıkları Üzerine Bir Durum Çalışması

Öz

Bu araştırmanın amacı eğitim fakültesi öğrencilerinin internet tabanlı seçici öğrenme alışkanlıklarını nitel temelde derinlemesine incelemektir. Enformasyon edinimini izleyen bir internet tabanlı seçici öğrenme sürecini ele almak üzere bir bütüncül tek durum çalışması yürütülmüştür. 2015 yılında Türkiye'de bir devlet üniversitesinin ikinci sınıfında öğrenim görmekte olan ve üç farklı anabilim dalından 37 katılımcının yer aldığı araştırmanın veri kaynakları gözlem kayıtları, alan notları, katılımcı günlükleri ve görüşme sorularına verilen yanıtlardan oluşmaktadır. Dört haftalık bir sosyal gözlem ile enformasyon arayışı davranışı ve izleyen süreçte olası bir seçici öğrenme amaçlı bilgi edinimi konusunda veri toplanmıştır. Gözlemlerin ardından tipik durum örneklemesine uyan bir yordamla iki aşamalı görüşmeler gerçekleştirilmiş; seçici öğrenmeye yönelen katılımcılarla gerçekleştirilen odak grup görüşmesinden yararlanılarak enformasyon arayışı davranışı aşamasında kalan katılımcılarla işbirlikli yapılandırılmış görüşme gerçekleştirilmiştir. Enformasyon arayışı davranışı eğilimi ve seçici öğrenme amaçlı bilgi edinme, betimsel analiz süreçlerinin iki ana teması olarak ön plana çıkmıştır. Araştırmanın bulguları alt-temalar ve işaret ettikleri kavramlar eşliğinde yorumlanmış ve bir dizi doğurguya dikkat çekilmiştir. Araştırmada detaylı arama yapmak isteğinin seçici öğrenmeye yönelmede bir eşik olduğu, enformasyon arayışı davranışından seçici öğrenmeye geçişte katılımcıların sözlük kullanan ve özelleşmiş arama yapmaya çalışan katılımcılarla etkileşim kurma eğilimi olduğu, doğrudan bir eğitim verilmese de seçici öğrenme eğiliminde olan katılımcıların kaynak aramada da kendilerince uygun gördükleri fakat aynı zamanda genel kabul gören kriterlere (Web sitesinin kaynak gösterip göstermediği, içeriğin kabul görüp göremeyeceği ve kullanılabilirlik) ulaşabildikleri sonuçları ortaya çıkmıştır. Aynı zamanda seçici öğrenmeye yönelmede alan kapsamında kalma koşuluyla konu seçiminde serbest bırakılmanın önemli bir etken olduğu sonucuna ulaşılırken, konu seçiminde tamamen serbest olmak her iki grup için de iş görmemiştir. Çalışma araştırma alanı, paydaşlar ve güncel uygulamalara ilişkin önerilerle sonlandırılmıştır.

***Anahtar sözcükler**: Öğrenme alışkanlıkları, seçici öğrenme, enformasyon arama davranışı, enformasyon edinimi.*

Introduction

Retrieving information and transforming it for gathering knowledge have become the two most important issues in today's era of digital learning environments. Internet-based education accordingly, is a primary branch to meet the required skills for building a knowledge society. The Internet poses a paradox as it makes individuals receive instant, new but excessive amount of information. Thus, staying connected for a habitual learning is a critical issue in today's learning environments. Learning habits, directionally require a selective learning process for transforming information into knowledge.

Jones and Kohler (1958) were the first echoing selective learning as a concept of acceptable information. This understanding plays a strong role in criticizing the information and a possible following cognitive and constructivist philosophy. When considered with an opposite approach, a non-selective learning process can be addressed by behavioral aspects of learning. Hence, Garson (2006, p. 240) points out that classical conditioning is the most obvious example of non-selective learning. In 1940s the research field was mostly in conjunction with perception variable (Postman, Bruner & McGinnies, 1948) and personal values and environmental factors were the basic concerns of interest. As a matter of fact, selective learning requires paradigmatic rationales for a behavior and its reflections as studied through the lenses of information retrieval and search behaviors in today's day and age. This paradigmatic motive leads researchers to shift between cognitive and constructivist perspectives, as compared in Table 1:

Table 1

Two Viewpoints for Selective Learning

Cognitivist perspective (Weiss, 2012, p.2990)	**Constructivist perspective**
• memory span, immediate memory for word lists. Not straightforward.	• ongoing interest in new understandings, systems and organizations
• the ability to suppress retrieval of less relevant items	• respecting all kinds of information with a literacy perspective, the ability to select beneficial ones serving for knowledge construction
• incentive, or response to reward	• intrinsic motivation combined with social contexts
• metacognition, devising a strategy to remember high-valued items to achieve a goal, not to make a high score	• multitasking and active learning to take responsibility of more authentic experiences

As can be seen in Table 1, remembering, responding and memorizing are among the most distinct behaviors in cognitive-based selective learning process. In contrast, constructivist approaches provide a wide variety of applications for selective learning by centering an individualistic and alternative view, especially with Internet-based practices.

Internet-based selective learning (Ibsl), broadly refers to a self-paced, learner-centered and self-selective learning process, allowing experimentation in a *safe* environment, accommodation of different ability levels and types of learner, open access to information; reduced teaching costs, provision of reliable and timely help information, and reduced publication costs (Nunes & Fowell, 1996). From Web users' perspective, three types of user query needs are identified (Manning, Raghavan & Schütze, 2008) in an Ibsl process: *Informational queries*, the ones that this study targets, seek general information and users with informational queries typically try to assimilate information from multiple web pages. *Navigational queries*, seek the website or home page of a single entity that the user has in mind. Third, *a transactional query* is a prelude to the user performing a transaction on the Web, such as purchasing a product, downloading a file or making a reservation.

An important aspect of selective learning is separating information and knowledge and criticizing the reflections of both two concepts in a correct order. Figure-1 summarizes Ackoff's (1989) data-information-knowledge-wisdom (DIKW) hierarchy, which is a good example of this understanding:

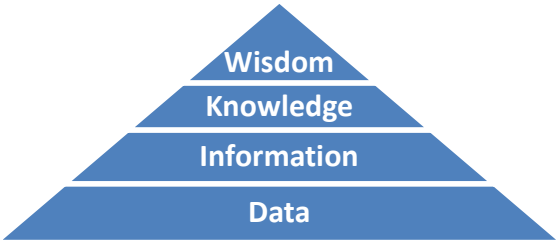

Figure 1. The DIKW hierarchy

Bellinger (2004) adds understanding relations, patterns and principles which are described as the three main skills serving for Ackoff's (1989) hierarchy. On the other hand, Clark (2004) addresses five sub-skills for developing understandings that fit the hierarchy: researching, absorbing, doing, interacting and reflecting, respectively. Prior to Ackoff (1989), Zeleny(1987) uses the concept enlightment at the top of the hierarchy and reaching the sense of reality and right-wrong in a social context is assumed more important than wisdom. Reaching the wisdom is a problematic issue (Choo, 2001) and the rest of the phases in the hierarchy may contain some kind of anti-structure. At this point, Bernstein (2011) draws attention to an anti-thesis and uses misinformation, disinformation and error against Information, and ignorance for Knowledge. In fact, these anti-concepts become contaminative for learning, especially in Internet-based social contexts.

DIKW hierarchy also provides a comprehensive background for the concepts of knowledge economy and knowledge ecology. Today developmental rate of the societies is highly associated with the quality of the relations between information and knowledge. In this sense, information retrieval and using technology for knowledge acquisition play an important role in reconceptualization of learning. Technology may be described as a learning catalyst in this process.

Background knowledge on information retrieval is an important component of learning process and studied since early stages of the research efforts on learning habits. While Fidel (1991) pointed out that subject knowledge affected only experienced searchers, Hsieh-Yee (1993) found out that searchers use more of their own terms in searching a topic they knew about. It seems that both two approaches function as a symbiotic pair in today's world of multitasking. As a matter of fact, being knowledgeable about the content or a task is an important factor for selective learning. There are recent studies on the issue and some of them are not subject to Internet. McDonald and Ma (2015) conducted a study on 4 and 6 year-old children's knowledge attribution and selective learning. The study contains two sub-studies and first study seeks a choice between formally and casual dressed person in terms of knowledge potential. On the other hand, the second study is realized with the same characters and seeks different behaviors while getting help about a learning task. Results show that participants find formally dressed individuals more

knowledgeable and choose them while getting help about the task. Reliability of the information on the Internet has similarities with the study and if meaningful criteria are met, then it is acceptable information for the users and learners. Another study on selective learning was conducted by Henderson, Sabbagh and Woodward (2012), which focuses on the relevance principle in preschoolers' selective learning. The study seeks a link between 4 year-olds' word learning and their everyday communicative contexts. The speakers' and objects' presence is a factor to evaluate for selective learning and results show that participants' selective learning is attuned to relevance, and an overarching principle of prospective relevance.

The literature on selective learning on the Internet highly associates with information seeking and also different learner and searcher characteristics. Zhou (2013) conducted a study on twelve male Chinese university students' different activities during online search and found that high performance level-participants formulate a strategy and adapt it through different search tasks. Most of the participants begin to search more in detail when they read the content carefully and noted the key terms. Moreover, high performance group did bring their prior knowledge or paraphrase the information into a meaningful answer. Low performance group could not synthesize information effectively. Another study which was conducted by Al-Suqri (2011) emphasizes on information-seeking behaviors of 50 social science scholars and originated some main and sub-themes on the issue. The study did not categorize the users on high or low performance. According to the results, main themes vary on awareness of resources (sub themes: print-electronic and other types, may be considered as associated concepts), implications of being unable to find resources (feeling and actions), other barriers to effective research (IT-related, time related), initiation (consideration, preparation and expectations), exploration (prioritization of sources, informal-formal sources, familiarity and knowledge, keyword search and overcoming barriers), shifting (extracting, revisiting), resources selection (judge, quality, validity, well-known). Search strategies and problems are among the most encountered issues raised during Internet-based information seeking. In a study conducted by Kabakci et al. (2010), 21 elementary school teachers' search strategies were investigated and three common strategies came to the fore: using operators and commands, keyword search and subject specific websites at the beginning of the searching process. Some of the teachers complained about the lack of the Turkish resources, and the other problems echoed were irrelevant or insufficient information and

accessing the resources (ie. membership, virus). Apart from these individualistic realities, some research understandings focus on collaborative information seeking. Hyldegard (2009) touches upon individuals and group members' information behaviors during an Internet-based search in specific tasks. Participants are 10 graduate students and demographic surveys, process surveys, diaries and interviews were used. The results show that similarities in behavior were found between group work and individualistic work, a similar interest to learn selectively between these two approaches was found at the beginning of the activities. As searching activities were increased, an interest to writing activities were increased and the study reported that complex problem solving activities seemed to be more complex in a group work setting.

Internet plays an important role in today's knowledge-based systems. An intensive and predominantly discourse-centered information is transferred into new information, and also knowledge. Hence, a fast and elusive process for learners of this new era requires specified skills. Skills for retrieving and transferring information into knowledge are important for both students, and teachers who train the individuals and directionally build future jobs. An education faculty can be described as a minimal example of knowledge society, and a broad range of research understandings can come to the fore while discovering the possibilities for Internet-based practices.

Purpose of the study

The purpose of this study is to conduct an in-depth analysis of education faculty students' Internet-based selective learning habits. The study also purposes to approach behavioral aspects of Internet-based selective learning for gathering knowledge. The following research questions were considered to address the purpose of the study:

1. Which behavioral characteristics do the participants have when searching about a content-specific topic on the Internet?
2. What views do the participants of Information Retrieval (IR) Group have about the factors causing them not being able to focus on selective learning?

3. What views do the participants of Selective Learning (SL) Group have about the factors ensuring selective learning for gathering knowledge?

Methodology

Research paradigm

The research is designed as a single-case holistic case study (Yin, 2009), and has a descriptive nature. With a single-case study, researchers look for an average case; a case that is a typical example of a specific phenomenon (Mills, Durepos & Wiebe, 2010, p.61). As a matter of fact, researcher subjectivity and rigor are two important limitations of case study design. To balance rigor and relevance, I added participants from different departments of an education faculty into sampling and collected data with the help of independent observers, asked participants to keep diaries and used field notes for enhancing data triangulation. A field expert also analyzed the data and thematic coherence was validated.

Many opportunities and possibilities may gain currency for case studies. The march of observed events mostly leads researchers to conduct focus group, structured, semi-structured or even co-structured interviews. On the other hand, voluntariness and sustainable observation are among the most important challenges of case study procedure, which was introduced in the following sections.

Context and participants

The study focused on higher education and faculties functioning for teacher education. Since content knowledge is an essential part of teacher competencies, searching for a possible selective learning is directionally centered, and behavioral characteristics, choices and tendencies were addressed within the context of the study. Participants were 37 sophomore students of a state university, from Special Education (n=12), Psychological Counselling and Guidance (n=12), and Mathematics Education (n=13) departments and aged between 19 and 21. They were volunteer

participants and a written statement including the rationale for the study and video recordings was provided to them. Their identity remained confidential throughout the research process.

The case

This study mainly focuses on the possibilities following information search behavior, especially when students encounter a choice between using information for only filling the blanks of a design or homework and using it also for knowledge acquisition. The case within the scope of the study is the choice between information retrieval and knowledge acquisition. Students occasionally transfer information from Internet to an offline platform (*ie. presentation softwares and/or literature reports*) for definitional information. In this case, some students use information temporarily and therefore may break a link for learning, while some deal with it, showing signs of a connectivist perspective. It is accordingly important to reflect their experiences and follow the searching behavior for a possible selective learning habit in repetitive Internet-based practices.

In the study, the process of Internet-based practice consisted of activities related to content-specific topics in participants' field of study, and also different fields. Participants were to follow basic instructions of each activity (how to search, summarize and interpret) and write a reflection discussing the topic. As selective learning's nature offers, they were free to select any topic. Each activity lasted one hour and there were a total of 12 activities in four weeks' time. The case was viewed in a mostly taxonomic structure including various skills which can be listed as follows: Apply, analyze, evaluate, create, characterizing, organizing, valuing and responding which were assigned to different weeks. The instructions were quite flexible and a participant was free to google or search in social networks, blogs, Wikis or video lectures. Ethical issues were considered and a handout was provided to participants at the beginning of the research process.

Instruments, data collection and analysis

The study used various instruments for observing and interviewing the participants. Figure 2 depicts the research process which started with developing observation criteria and finished with determining sub-themes and concepts:

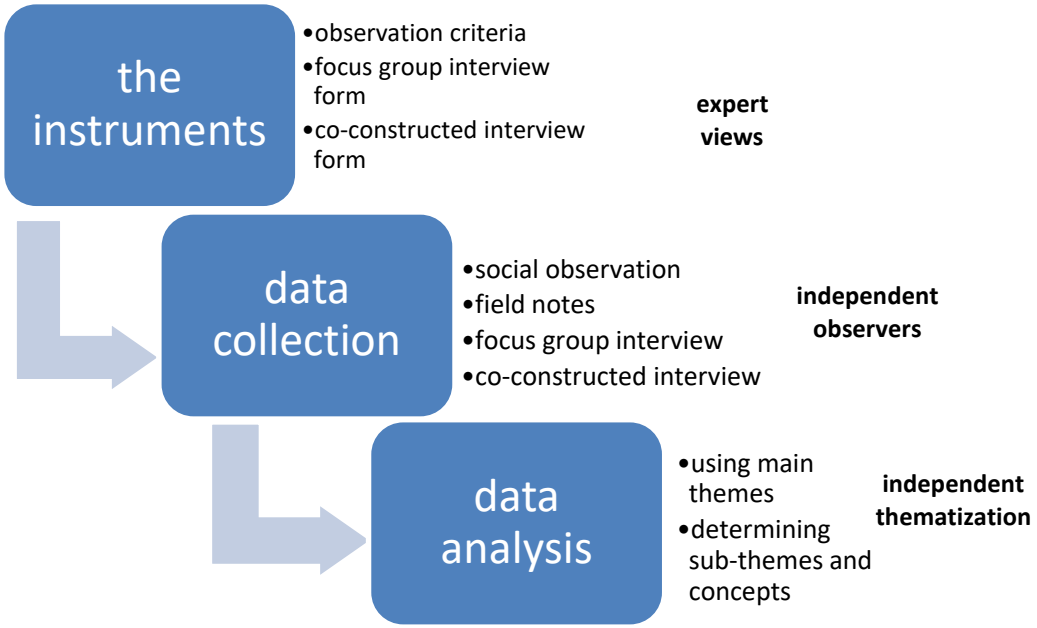

Figure 2. Research process

A four week-social observation procedure was conducted by two independent observers within the scope of the study. The observations were realized through the following criteria by using checklists, seeking whether a participant:

- conducts a detailed search for a content-specific topic?
- uses more than one search engine?
- uses time effectively?
- gives up searching early?
- read the specific information about the concepts of his/her field of study carefully?
- cites only definitional information?

- cites detailed explanations?
- adds views and plausible comments?
- adds new definitions, syntheses and evaluations?

Two video cameras were used throughout the observations, and in this way internet search behaviors could be viewed in detail on the basis of gesture-facial expression, and also browsing the Internet from both two sides. The participants completed diaries for each week of the research process, and I took field notes in order to reflect the nature of the phenomenon. This approach is quite beneficial as it depicts the case both from the participants and the researcher perspective.

Before jumping into the process of coding data, as Stuckey (2015) noted by stating "It is important to think about your research question and the big picture, which some may refer to as "storyline" or "meta-narrative"."., this study directionally followed a similar approach and behavioral characteristics of the participants conducting a research on the Internet and their story through a possible selective learning process was centered. A focus group interview was conducted with SL Group and interview findings were used for constructing the second interview for IR Group. This alternative approach is called *co-constructed interview* and was echoed by Miller (2011).The rationale for conducting such a methodology is that selective learners' data were quite beneficial for organizing a descriptive structure for IR Group's interview.In brief, data originated from SL Group became main themes for interviewing IR Group. Thematization work included using the same coding strategy for both two interviews: The most common themes ran for sub-themes originated from interviews, field notes and diaries. The nature of the study required a descriptive manner for analyzing research data, since two main themes came to the fore: *searching for information (information retrieval)* and *knowledge acquisition for selective learning.* An independent expert analyzed the raw data (video analyses included) and two thematic analyses found to be similar with a 88 per cent coherence, as Miles and Huberman (1994) suggested with *reliability=consensus/consensus+dissidence* formula. The expert was also asked to name each sub-theme and we finally came up to 82 per cent coherence with the thematization.

Results

The results can be reviewed under three main sections: behavioral characteristics of the participants, browsing the Internet for information retrieval and the case of knowledge acquisition for selective learning, respectively. The realities which themes motive were interpreted and participants' quotes included where necessary.

Behavioral characteristics of the participants

The video analyses of the first two weeks' observation procedure revealed that most of the participants did not conduct a detailed search and the number of participants using more than one search engine did not increase weekly. This may not be directly interpreted with a selective learning perspective, because most of the participants tended to search in their own language and in fact the literature in Turkish is quite definitional. There were 22 participants who tried to retrieve more and went towards selective learning process. This problem led them to seek for a more detailed content and some were eager to learn selectively at the beginning of the activities, while some tended to accommodate to the knowledge acquisition due to this problem. On the other side last two weeks' lists showed that participants used online dictionaries and encyclopedias. Participants prefer using translated content, in other words they prefer translators against using online dictionaries. This poses a problem for participants while transferring information into knowledge, and some of them pointed out it in their diaries. Participant 1-D complained about the amount of the resources in English and enounced that he can find limited time to interpret because of translation. On the other hand, participants dealing with an additional translation work make valuable interpretations on the content they collected. In the forthcoming weeks, the group of participants who helped each other looking up words in dictionaries tended to study on their own, and tried to learn the basics for selective learning willingly.

A general look from the viewpoint of gesture-facial expression, both two groups were interested in the process at the beginning of the activities, while SL group took an eager interest in last two weeks' activities. Their gesture and facial expression gave the observers an impression that they enjoy the activities. According to the front camera records, in IR Group when two weeks passed

there was an obvious interest to the participants using dictionaries. Some participants stood up and wondered which sources they were browsing, while others worked on their own, for the rest of the process.

Browsing the Internet for information retrieval

A co-constructed interview was conducted with the participants of the IR Group. Table 2 summarizes the results of the interview, which were interpreted accompanying field notes and diaries:

Table 2.

Interview Results of the Information Search Behavior

Theme	Sub-theme	Concept
Searching for information	*Availability of the resources* -the length of definitional information -author's expertise	• citation • field expertise • trustworthiness
	A specific effort for searching -in search of detailed information -reading the whole content -taking notes	• self-study method • learning task
	Reasons for not conducting a detailed search and the rationale for not going towards selective learning -finding the content enough for learning tasks -finding the work enough for finishing the work (for presentation or a literature report) -being unfamiliar with the field	• motivation • experience • evaluation • content development
	Factors for not going towards selective learning process -unwillingness to search for detailed information -spending most of the time with design issues (presentation and/or report)	• motivation • self-confidence • self-efficacy • design • continuing education • literacy
	Prerequisites for selective learning -tutorial support for a detailed search -digital enhancement for sources in Turkish -changing the method for concept learning	• social learning • coaching • literature • concept teaching • concept learning

As summarized in Table 2, IR Group focuses on suitable citations, field expertise (about themselves) and trustworthiness rather than didactic usability or a possible learning process. They are in a mood that a continuing motivation for a learning process is a bit far away and find their experience not enough for interpreting the content. They therefore need assistance for a detailed search and at least a social learning environment. This may be quite beneficial for getting experience from others; however individualistic approaches are also required since Internet-based content search functions mostly on an individualistic basis both in school settings and also everyday life. Some participants point out this in line with continuing education, and it can be said that they are aware of the future needs about the content on the Internet, which is not a generalizable finding.

Field notes related to IR Group report two different categories of searchers at the end of first two weeks: The ones who gave up searching in very early stages of the activities, focused on designing and saving the final document, and the second sub-group who were interested in other participants' work and tried to learn from them. The last two weeks notes were not something new for the first sub-group, but pointed out that most of the second sub-group's participants began to deal with searching tasks and interpretation parts of the activities.

IR Group had a background on detailed and specified search according to the Observation Criteria List. However the group was not disposed to prepare a detailed document on the topic they were searching, and also benefiting from it. Some participants of this group were interested in other participants' work and evaluated the content in a critical approach. Since the study was not conducted within the scope of a course, some of them felt free about the work and also reflected this convenience in their diaries. Participant 18-D noted this by stating "I would not normally continue with this work, but being free while studying was enjoying and this kept me to interact with others. This was cool, and I will do the next ones.". Moreover, another participant points out an important aspect of using only definitional information: "I am confident with the definition, but when I tried to interpret it there was something missing: How will I do that? (Underlines this question in the diary)". In fact, this raises a question about concept learning: *Do students learn to make critics on concepts?* Participants who found also interpretations or comments in their collection were beginning to notice that this is an essential part of going

towards learning, and also a challenge. During the last two weeks, the participants who are aware of different types of content, making critics and choosing to *deal* with the content with this approach were added to SL Group.

The case of knowledge acquisition for selective learning

The case within the scope of the study was realized through a focus group interview with the participants of SL Group, in company with field notes and diaries. A theme, sub-theme and concept structure was followed as it used to be in previous interview findings, which can be reviewed in Table 3:

Table 3.

Interview Results of the Selective Learning Process

Theme	Sub-theme	Concept
Knowledge acquisition for selective learning	*The strengths and weaknesses of Internet-based searches* -finding more information than hard-copy forms -getting lost in the information overflow -seeking proprietary information for gathering knowledge -waste of time -openness to share knowledge	• information seeking • time • source • openness
	Search strategies (in the field of study) -searching for definitional knowledge -expanding the search strategies -listing the basic headings and re-searching -studying on the results and learning the content	• definition(concept learning) • web redirection • search strategy • self-study method
	Search strategies (in different fields of education) -following the same strategies -using social networks and participating in discussions	• self-study method • search strategy • web redirection • social networks • social network literacy • social learning
	Motivational factors for selective learning -dissatisfaction with the content -a particular tendency to search for detailed information according the previous experiences -ongoing curiosity about the titles in the webpage	• interests • curiosity • experience • expertise • critical thinking

Theme	Sub-theme	Concept
Knowledge acquisition for selective learning	*Realizing the value of web search behavior for learning* -area of interest -transferring knowledge for future learning tasks -expertise in discussions and interpretive strategies	• evaluation • expertise • learning material • literacy
	Making detailed search a habit for selective learning -applied courses -following up-to-date websites -The type of the websites (static websites, discussion forums, groups or pages in SNSs)	• actuality • website evaluation criteria
	Factors for a possible future tendency of selective learning -ongoing experience -foreign language acquisition -increase in applied activities	• foreign language development • experience • habit

SNS: Social Networking Site

As can be seen in Table 3, participants of SL Group are aware of strengths and weaknesses of Internet-based searches. They find the Internet as an opportunity for information seeking, and spending quality time on the Internet opens the gate for gathering knowledge according to their comments. Discussions on the Internet provide valuable content to them. Moreover, they do not let well enough alone and run a self-study process in a habitual manner.

Participants of this group made an impression that was quite different from IR Group in terms of defining concepts on their own, analyzing and mining the valuable content in order to suggest sub-concepts. A more preponderating emphasis on self-study method was echoed by this group. An obvious tendency for selective learning from the beginning of the activities was highly associated with working independently. They pointed out that this was a habit for a long time, and would be long-lasting for future works on search behavior. The reason and motive for such a tendency was enounced as curiosity and seeking for up to date content which is not droning in order not to lose actuality. In brief, as summarized on concepts in Table 3 selective learning tendency was triggered by an arousing interest with current ways of knowledge acquisition, and also valuing and criticizing each part of the content. Field notes for this group mainly reported a high motivation for the activities and participants coming from second sub-group of IR Group who showed similar performance with natural members of this group were quite successful

during the activities. Participants give importance not only to content, but also knowledge acquisition process. These experiences turn into a selective learning habit and come to the fore with repetitious works. Participant 6-G pointed out this by stating “First I looked for the concepts, and tried to interpret them. Then I visited independent forums and Facebook groups for discussions. But these were only for copying content. So I tried to make interpretations. For example you asked us to write a story about a psychological disorder. I began to imagine possible dialogues with patients using the content in both definitions and also forums-Facebook (participants mostly used Facebook groups for learning the disorders in detail).” Similarly Participant 2-F noted websites’ importance in selective learning by stating “I was curious about the titles in an activity. When I tried to search for the most important ones, I found another website and begin to warn myself. I should have produced a document. Then I summarized each website’s examples on derivative and finally could find geometric interpretation of derivative”. It is quite apprehensible that selective learners were motived by organizing knowledge on their own way, and soon building a new content with their own understandings.

Discussion

There are a good number of findings that can be discussed about the current study. IR Group’s search behaviors after finding the source mostly center upon reading the full content and taking notes, and these behaviors lead them not to think about the source, its originality, trustworthiness and authors’ expertise. They just copy the content and use the Internet as a bridge for completing a task, not for learning. These behavioral processes may be discussed in terms of being knowledgeable about searching a topic, but with a lack of knowledge about its functions about future learning contexts. In some contexts, this may be ascribed to individuals’ motivation –as they enounced during the interviews- but another factor is may be a more determinant one: a specific effort for self-efficacy. Selective learners seem already prepared for these processes and they made their choice between information and knowledge not only in this study, but also when they realized this as a general experience that must be acquired for every learning task.

SL Group's awareness about *devising* the searched content gets along with Zhou's (2013) study that high performance level participants formulate a strategy even they were not given any instruction. The reason for paralleling the two studies can be confined to the both two group participants' willingness for using a selective learning strategy for future tasks.

Time is another common factor for not getting through selective learning process as Al-Suqri (2011) found. Similar findings were found and participants state that while searching a topic, spending too much time enounced as a problem. Kabakci et al. (2010) point out an associated issue about time, and a lack of Turkish sources made participants have problems in finding time for interpreting the sources in English, which was found also in the current study. In contrast with the current study's finding about the group work's benefits on IR Group, Hyldegard (2009) found complex problem solving activities seemed to be more complex in a group work setting. When considering that the current study was not organized within the scope of a collaborative research setting, and that especially IR Group's participants grew a natural interest to group work, this finding may partly conflict with Hyldegard's (2009) study.

Conclusion and recommendations

Education faculties not only deal with content-based procedures, but also focus on pedagogy-driven approaches. Pedagogical approaches require staying up to date, since building a knowledge society highly associates with training prospective teachers as selective learners. Although this study did not focus on competencies of teaching profession, especially selective learners' views about future give a positive impression about their potential.

In light of the numerous findings of this study, it is understood that the tendency to a detailed search behavior is a threshold for selective learning. Participants' views show another crucial reality: Apart from homeworks or exams, independent activities which promote specific search behaviors open the gate for habitual learning, and the learner soon enter selective learning process. Some of the participants tended to interact with others while searching, and this finding leads to an understanding that personalized learning activities should be revised in today's world

of collaboration. Making participants feel free to collaborate with others resulted a favorable impression, especially for IR Group without an organized process of the study. Studying in their field of study, participants who freed from topic choice were more eager to learn selectively. However, the interest in proceeding to selective learning could not be same for the participants who were totally free in both two groups. Field dependence was a quite important issue in getting towards selective learning. Besides, participants of both two groups preferred social networks and/or forums for searching an unfamiliar topic. Independently of being a selective learner or not, this result may be another matter of debate for social factors in information retrieval and can be subject of a future research agenda.

The study can be organized in a totally online platform, and choices of information retrieval can be viewed in a different context. Moreover, information search behavior can be revisited in a collaborative manner for investigating the possible reflections of social learning. Teachers and educators can be added to data collection in a more detailed case. For multiple environments (Mobil-lab or print-Web, especially for context dependence), comparative studies can be modeled. In addition to these suggestions, qualitative paradigm may be related to psychosocial variables within the context of mixed-method inquiries. It is thought that applied research on selective learning is truly important for both learning, and diversification of content on the Internet. In this regard, an activity-based and step-by-step practical mechanism originated from this research area will be quite beneficial for transferring information into knowledge.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019: 112-140
DOI: 10.17569/ tojqi.507560

Research Article

On the Track of Emotional Issues in the Design of Multimedia Learning Materials: A Qualitative Approach[1]

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Abstract

The literature suggest that learners' emotions play an important role in educational processes by the means of cognition, motivation, interest, and so, learning. However, emotional design of multimedia learning materials is relatively new for the education literature. Although there are several studies on the effects of emotional design on learning, there is a theoretical gap about how to design multimedia learning tools in order to involve learners emotionally in the learning process. Therefore, this study aims to identify issues that should be taken into consideration for the emotional design of animations as multimedia learning materials. In this direction, a basic qualitative approach was adopted and inquiry was carried out in two phases. At the first phase, semi-structured interviews were conducted with five expert academicians in the field of animation with different areas of interest, in order to gain information about a variety of issues on the design of animations on the emotional base. Data was inductively analyzed and findings were categorized under seven themes. At the second phase, certain emotional issues were identified and, in order to increase the trustworthiness of the findings acquired by semi-structured interviews and obtain the opinions of the practitioners in the field on the issue, findings were restructured as a survey. This survey was conducted on an online platform with field experts working in the animation sector at various positions. A total of 79 expert participated in the survey process. Findings showed that survey results were in line with interview as well.

Keywords: *Multimedia learning, emotional design, emotional transfer in multimedia design*

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[1] This article was generated from the doctoral thesis of the authors, which was supported by Anadolu University Scientific Research Projects. Project No: 1609E615

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Received: 03.01.2019 Accepted: 30.01.2019

Çoklu Ortamla Öğrenme Materyallerinin Tasarımında Duygusal Unsurların İncelenmesine Yönelik Nitel Bir Çalışma

Öz

Alanyazın duygusal süreçlerin biliş, motivasyon, ilgi ve öğrenme üzerinde etkili olduğunu; bu bağlamda duyguların eğitsel etkinliklerde önemli bir rol oynadığını göstermektedir. Çoklu ortamla öğrenme materyallerinin duygusal tasarımı ise eğitim alanyazınında görece yeni bir konu olarak karşımıza çıkmaktadır. Duygusal tasarımın öğrenme üzerindeki etkisini inceleyen birkaç çalışma olsa da çoklu ortamla öğrenme uygulamalarının öğrenenleri öğrenme süreçlerine duygusal bağlamda dahil edecek şekilde nasıl tasarlanması gerektiğine ilişkin alanyazında kuramsal bir boşluk bulunmaktadır. Bu doğrultuda, bu çalışmanın amacı; bir çoklu ortamla öğrenme materyali olarak animasyonların duygusal tasarımında göz önünde bulundurulması gereken unsurları belirlemektir. Bu doğrultuda, temel nitel araştırma yaklaşımı benimsenmiş ve bu bağlamda, iki aşamalı bir süreç yürütülmüştür. Araştırmanın ilk aşamasında, animasyon alanında uzman beş öğretim üyesi ile yarı-yapılandırılmış görüşmeler gerçekleştirilmiştir. Animasyonların duygusal bağlamda tasarlanmasında farklı bakış açılarını görebilmek için farklı ilgi alanları olan uzmanlara ulaşılması hedeflenmiştir. Yarı-yapılandırılmış görüşmelerden elde edilen veriler tümevarımsal olarak çözümlenmiş ve bulgular yedi ana tema altında sınıflandırılmıştır. İkinci aşamada, ilk aşamadan elde edilen bulguların güvenilirliğini sorgulamak ve alanda çalışan uygulayıcıların görüşlerini almak amacıyla, yarı-yapılandırılmış görüşmelerde belirlenen duygusal unsurlar anket maddeleri olarak yeniden yapılandırılmıştır. Oluşturulan anket animasyon sektöründe çeşitli pozisyonlarda görev yapan toplamda 79 animasyon uzmanın katılımı ile çevrimiçi platformda uygulanmıştır. Anket sonuçlarının görüşmelerden elde edilen veriler ile büyük oranda tutarlılık gösterdiği görülmüştür.

Anahtar Sözcükler: *Çoklu ortamla öğrenme, duygusal tasarım, çoklu ortam tasarımında duygu aktarımı*
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Introduction

We live in an era that people have a tendency to trust knowledge that they emotionally connected rather than those based on scientific facts, which is so-called *post-truth society*. In the post-truth era, people may push the facts background and rely on the resources that are in line with their thoughts and personal tendencies (Rider & Peters, 2018). While the society seek emotional connection with informational resources they resort, educational practice seems to be stuck in cognitive approaches and theories for a considerable period of time. Specifically, in the design of and research on multimedia learning materials, cognitive theories such as Cognitive Load Theory (Sweller, 2008) and Cognitive Theory of Multimedia Learning (Mayer, 2009) have led the field for nearly 50 years. Meanwhile, emotional aspects were usually ignored in these practices.

Since the ancient times, philosophers and scientist discussed the precedence of rationality and emotion, and the supremacy of rationality was usually favored while emotions were seen as a negative factor on mental activities (Çakar & Arbak, 2004). Modern theories, however, suggest that emotions guide people through achievement, with their effects on thinking and decision making processes, creative problem solving, information processing, cooperation and motivation (Caruso & Salovey, 2004; Erez & Isen, 2002; Hertel, Neuhof, Theuer & Kerr, 2000; Isen & Baron, 1991; Konradt, Filip, & Hoffman, 2003). Modern cognitive approaches suggest that emotions and learning are firmly and reciprocally connected and that emotions are catalysts for rational thinking (Felten, Gilchrist, & Darby, 2006). As Kolb (1984) emphasizes, learning occurs as a holistic process of an organism, which includes thinking, feeling, perceiving and behaving. In line with these, Stein and Levine (1991) report that a new information is almost always interpreted with emotional experiences of the individual, and that learning always happens in an emotional period of time.

Emotions can foster or restrain learning in various means. Negative emotions, such as anxiety, anger, boredom, embarrassment, frustration and sadness, or positive emotions such as relaxation might cause a decrease in mental performance of an individual and hinder learning (Pekrun, Goetz, Titz & Perry, 2002; Pekrun, Goetz, Daniels, Stupnisky & Perry, 2010). On the other hand, positive

emotions, such as fun, enjoyment, hope, satisfaction, pleasure, curiosity, interest, empathy, love, appreciation, excitement and passion, might have a positive effect on mental activities and learning (Pekrun and Stephens, 2010; Rowe, Fitness, & Wood, 2005). Sansone and Harackiewicz (2000) state that positive emotions like interest, fun and satisfaction have effect on the motivation of the behaviors.

Considering the importance of emotions on educational settings, it is inevitable to make reference to multimedia learning. In line with the prevalence of information and communication technologies in learning and teaching processes, today's learners interact with multimedia learning tools and materials more than ever. Emotions begin with a cognitive evaluation about a stimulus the individual interact with (Arnold, 1960; Desmet, 2002). So, learners' emotional states could be affected by, and even determined by their interaction with a multimedia learning material in educational settings that integrate information and communication technologies in their process.

Despite that emotions play such a crucial role in learning environments, multimedia learning literature ignored emotional variables for a long time and mostly focused on cognitive processes. Yet, in the light of the knowledge on the connection between emotion, cognition, motivation and learning, Moreno (2006) proposed the Cognitive-Affective Theory of Learning with Media, which is an enhanced interpretation of Mayer's Cognitive Theory of Multimedia Learning. According to the Cognitive-Affective Theory of Learning with Media, at the process of the selection of information coming from sensory memory, attention and perception have the key role on whether this information will be transferred to working memory or not. What is crucial at this point is that motivation, affect and self-regulation that derive from the long term memory of the individual are determinative for the attention and perception of the individual at this process (Moreno & Mayer, 2007). The theory supports that affective states of an individual play an important role on what is chosen to be learned.

Recently, the concept *emotional design* has begun to be discussed in the multimedia learning literature, and a few evidence-based study adopting CATML as the theoretical framework were conducted on the effect of emotional design on learning, mood and cognitive load. Within these studies, emotional design elements of the multimedia materials used in the process were explained

to be colors, rounded shapes, anthropomorphism and background music. Um, Plass, Hayward & Homer (2011), Plass, Heidig, Hayward, Homer & Um (2014) and Park, Knörzer, Plass & Brünken (2015) used the same learning materials in their study. They utilized warm colors and rounded shapes, and put eyes and mouths on the objects for the emotional design of the multimedia learning materials. Likewise, Mayer and Estrella (2014) reported that in the learning material, emotional design included appealing colors, rounded and symmetrical face and personification by adding expressive eyes on the illustrations. In their learning material that introduces object-oriented programming, Haaranen, Ihantola, Sorva & Vihavainen (2015) took advantage of anthropomorphism and illustrations were told to be personified by adding faces and gestures to the illustrations. Königschulte's research (2015) was the only one that utilized sound as an emotional element and background sounds were used in the learning material. Although the results of these studies were discussed as the effect of so-called *emotional design*, the design elements used in these learning materials should be approached as preliminary techniques. Besides, it is important to report that Um et al. (2011), Plass et al. (2014) and Park et al. (2015) used positive mood induction before their experimental process, which could be considered to affect other educational variables in an undesired way.

Considering the design elements utilized in learning materials in the researches in the literature, it is questionable whether the use of colors, rounded shapes, sounds or personification *always* evoke positive emotions. With a psychological point of view, it is already known that certain colors may evoke different emotions in different contexts. In a similar way, depending on the context, a triangle might express a knife, which people tend to avoid, or a roof of a house, which people feel safe and happy. While sounds and music are proven to be effective on individuals' moods, incompatible or random use of them might affect individual in an undesired way. Moreover, expression of a certain emotion might not always end up with the realization of that emotion in the audience. Looking at a smiling illustration would not always make the individual smile as well. At this point, main issue in emotional design happens to be the *transfer of emotion*, not to illustrate a certain emotional state roughly.

Design elements to help individuals experience certain emotions might not be limited to those utilized in the multimedia learning literature. In this point of view, an in-depth investigation is

considered to be crucial for the use of these elements and identify further design issues for emotional design of multimedia materials. Plass and Kaplan (2016) emphasize on the advantageous power of emotional issues in digital educational materials, and also state that there is a theoretical gap in the literature about how to design these materials on an emotional base. In accordance with the current direction of multimedia learning literature, and also considering the effect of the artistic perspective of animations on individuals' emotions, this study aims to identify the design issues that could enable emotional transfer in the design of multimedia learning materials through the eyes of experts in animation field.

Method

Within the direction of the aim of this study, a qualitative approach was adopted in order to identify the emotional issues in the design of multimedia materials. Qualitative research intends to analyze, interpret and make sense of a phenomenon within its unique context through the meanings as individuals ascribe to it (Denzin & Lincoln, 2013; Patton, 2002; Van Maanen, 1979). Qualitative researches are usually employed when there is a theoretical gap explaining a certain phenomenon and aims to introduce concepts, hypothesis and even theories utilizing an inductive approach (Merriam & Tisdell, 2016). This study focuses on the emotional transfer in animations as multimedia learning materials, and in this direction, adopts basic qualitative research method. Basic qualitative researches are employed on the purpose of understanding how individuals construct and interpret their experiences and uncovering these constructs (Merriam & Tisdell, 2016).

This study was carried out in two phases. At the first phase, semi-structured interviews were conducted with five expert academicians in the field of animation with different areas of interest. At the second phase, in order to examine the trustworthiness of the findings by the means of the opinions of animation experts in practice, a survey was developed according to the findings acquired from the interviews. This survey was conducted on an online platform with 79 field experts working in the animation sector at various positions.

Participants

In order to identify the design elements that could enable emotional transfer in multimedia learning materials, it is considered to be important to refer to the knowledge and experience of the experts in animation field. It is basically because animations as art forms primarily deals with emotional issues. Besides, most forms of multimedia learning materials such as games, simulations, videos, presentations, animations themselves, and even static pictures illustrating a movement features animations inside them.

The interview process was carried out with the voluntary participation of one academician for the pilot interview and five academicians for the actual semi-structured interviews, who were working at the animation department of a state university in Turkey, in 2016-2017 academic year. The participants of the study were purposefully determined. In order to gain a holistic point of view about a variety of issues on the design of animations on the emotional base, participants with different areas of interest were sought. The participants in this phase of the study were interested in various aspects of animation field such as drawing, texture, staging, modelling, action graphics, character development, animation techniques, animation production, story design and visual expression. Professional experience of the participants in the field ranged between five to twenty-one years. For the protection of personal information, as promised to the participants, demographics are not indicated specifically for each participant in this report.

At the survey process, participants were determined according to the suggestions and with the aid of several academicians at the animation department. A total of 79 experts working in the animation sector throughout Turkey (73) and working in other countries (6) were participated in the survey. Working positions of the participants varied, including concept design (14), character design (13), character animation (12), modelling (11), stage/background design design (8), storyboard (5), 3D animation (5), composition (3), direction (3), art direction (2), technical direction (1), animation direction (1), and scriptwriting (1).

Data Collection

At the first phase of the study, data is collected through semi-structured interviews. Firstly, researchers constructed a draft interview form in accordance with the literature of emotional design in multimedia learning. The draft was presented to an animation expert to ask for his opinion. The interview form was revised on the opinions of the expert. The revised interview form included questions on the visualization of positive emotions and the role of colors, shapes, sounds and anthropomorphism in emotional design.

After the revision of the interview form, a pilot interview was conducted with an experienced academician in animation field. The participant did not give permission to record the interview. So, the interview process was carried out by taking notes by the researcher. Pilot interview showed that the term *emotional design* was not purposeful and meaningful because the idea behind the design of animations was emotions after all. This experience led to a term shift in the study from emotional design to *emotional transfer*. The pilot interview suggested that there is no certain prescription for designing animations on the emotional base because the expression of an emotion is never enough to ensure an emotional reaction from the audience, and it heavily relies on other issues such as the artistic approach of animator, story, context, target group, animation techniques and so on. What's more, interviewee emphasized that it would not be convincing for the audience if an animation consists of only positive emotions because individuals experienced both positive and negative emotions in real life. The experiences from the pilot interview required a revision of the approach to the problem, and so the interview process. After the pilot interview, instead of seeking certain principles of emotional design, the study focused on identifying the issues that might be important for the emotional transfer. Final interview form included questions seeking the importance of emotions of audience in animation field; functional visual elements that might help evoke emotions of audience; techniques of visualization of emotions on an animation character and the effect of these visualizations on audience; attributes of an animation that help audience enjoy and that could arouse curiosity and interest of them; techniques to visualize non-human characters on emotional base; issues about the usage of sounds to evoke emotions of the audience.

After finalizing the interview form, possible participants were determined and contacted via e-mail. A total of five academicians volunteered to participate in the study. Interview dates, times and places were arranged according to the availability of the participants. Interviews were conducted in offices of each participant and with their permission, interviews were recorded with voice recorder. Just before the interviews, questions were presented to the participants in order to let them ease and settle. Interviews lasted between 20 to 45 minutes.

At the second phase of the study, a survey was developed based on the findings acquired form interview process. The survey was conducted on an online platform with the participation of 79 experts in animation sector, in order to enhance the credibility and transferability of the findings. At the beginning, the survey consisted of 41 items in form of 5 level Likert-type. The survey also included two typing areas, one to ask for the participants' working position and the other one to ask if there are any other issues they consider important for the emotional transfer. The survey data was collected via an online platform, and the issues that participants stated in the given area were added into the survey in the shortest period of time while the survey process on. With the items added in the process, a 47 item survey was obtained.

Data Analysis

Data gathered from the semi-structured interviews were inductively analyzed employing content analysis. When there is not an adequate theoretical framework to explain a phenomenon, inductive approach is an effective feature of qualitative research to reveal themes, categories, typologies, concepts, hypothesis and theories based on the data gathered from interviews, observations or document analysis (Merriam & Tisdell, 2016). In order to uncover the emotional issues based on the participants' opinions, firstly, audio recordings were transcribed. Secondly, relevant phrases were detected and subtracted as direct and indirect codes. Thirdly, codes were categorized into themes. Fourthly, the codes and themes were reconstructed after a certain period of time in order to approach to the issue with a clearer mind. Lastly, themes and codes were presented to the opinion of an expert academician to ensure the reliability of the findings. In accordance with the feedbacks, some conceptual revisions were made. The final structure of the findings was descriptively explained under the following title. Data gathered from the survey, on the other hand,

was subjected to quantitative analysis and findings presented in the form of descriptive statistics. Descriptive statistics were interpreted together with the qualitative findings.

Findings

In accordance with the aim of the study, semi-structured interviews were conducted with animation experts in order to identify the issues on the emotional transfer in multimedia learning materials. Data was inductively analyzed using content analysis and findings were presented under seven themes. Each theme and their subthemes were descriptively explained. In this part, in order to protect personal information, direct quotations were presented with nicknames. While the direct quotations were translated from Turkish to English, keeping the main idea behind the scripts has been the primary concern of the researchers. Not every comment on a specific issue was reported but the key ones considering the readability of the article. In this part, findings acquired from interviews presented first, and then survey results were given.

Interviews, in line with the pilot interview, showed that emotional transfer could not be ensured only with character design and visualizing emotions of a character. "*Emotional connection could be established with a consistent and holistic use of characters, environment design, story, music, staging and editing.*" as Tuğba expressed.

Findings also show that any effort to illustrate a movement could be considered as an animation. Taner, on this issue, emphasized that "*Animation is not discrete from cinema. Animation is as well cinema; it is cinema before cinema and, somehow, the ancestor of cinema. Any effort to give the feeling of movement, films made by putting photos after another, or even the bull figure with extra legs in Altamir's cave, which tries to show the movement in one frame, we call it cartoon, motion picture, comic, cinema, and so on*". In this direction, it is possible to say that the findings can be applicable for any multimedia material including games, simulations, presentations, animations and even static pictures illustrating a movement.

On the way of emotional transfer, almost all of the participants emphasized on the *identification* of audience with the characters in an animation, and so the educational nature of the animations

would show up. Emotions and emotional transfer was reported to be the main concern of the animation, such that emotional involvement of the audience determined the *success* of an animation. So, audience must show empathy towards the characters and set up identification with them by means of forms, sounds, events and direction of cinematography in order to ensure emotional transfer. On the issue, participants' comments were as followings:

> *"Emotional transfer is important for us in animations because in visual expressions the important thing is the audience's showing empathy towards the character. We do not want to watch anything that we do not connect emotionally, it is the same in our real lives as well." (Tuğba)*

> *"This (emotional transfer) is very important because, for the success of an animation film, emotions that characters evoke on audience are important. It may cause, like a real film, audience involve in the animation or move away." (Fuat)*

These findings reported above guided the researchers through the interpretation of the data. On the basis of these findings, it was understood that the main function of the emotional transfer is the ensure the voluntary participation of the audience in the animation by showing empathy towards the characters and establish identification with them. In this direction, it could be said that appeal of the animation and audience's motivation depends on the emotional transfer. Findings were constructed in seven themes, in accordance with this approach to the problem, which can be seen in Table 1.

Table 1

Themes and Subthemes Extracted to Explain the Issues on Emotional Transfer

Main themes	Subthemes
Emotional Transfer	
Believability	
	Story
	Character
	Jests and Mimics
	Motion
	Personification
	Factuality
	Abstractness
Exaggeration	
Shape, Size and Texture	
Color and Light	
Sound and Music	
Cinematography	
Target Group	

Emotional Transfer

Findings show that identification is possible through emotional transfer. Audience might share emotions with the characters and feel inside the story emotionally connecting with them only in this way. This might motivate audience to watch and continue watching the animation or not. As Tuğba states, "This kind of expressions makes progress on the basis of empathy. Audience establishes identification with the characters and experiences emotions of those characters during the film, say two hours, five minutes, or fifteen minutes… You even talk to the characters 'Look behind you! Look behind you!' This is an intensive identification.".

In order to ensure emotional transfer, several issues were identified within the study and these issues categorized under seven themes: Believability, Exaggeration, Shapes, size and texture, Color and light, Sound and music, Cinematography, and Target group. According to the findings, emotional transfer might be possible or less possible only if all these issues were used holistically and contextually.

Believability

Findings reveal that designing a believable story and believable characters on the basis of facts in real world, and designing these closer to abstract rather than reality are important issues on the way of emotional transfer. At this point, believability means designing a believable world but not represent the reality as it is. In this part, four subthemes of believability are represented: Story, Character, Factuality and Abstractness.

Story

Participants stated that story of an animation supports the emotional connection of the audience. As Fuat emphasized, "*In a good animation film, story is the most important thing*". On the believability of the stories Tuğba stated that "*For transfer of emotions expressed by a conflict the character faced, the story must be believable and progress through a traditional story structure. So, first of all, an accurate story structure has to be designed... (In a story) we need to have*

supportive and preventive events. These are our indicators to show how much our characters comply with real life." According to these, a story of an animation should be based on the incidents in the real world such as ambitions, problems, conflicts and dilemmas, preventing and supporting processes and side characters.

Character

As it comes to the characters, findings show that believability of the story is reciprocally connected to the believable characters which does mostly rely on the individuality of the character, which could be represented with jests and mimics, motion and personification. As Tuğba indicates, "*The design of the character is important. Good characters, bad characters, supportive characters… those are what carries the story. That depends on how believable your character is of course.*". So, the story could be carried out by the characters successfully or less successfully depending on the believability of the character inside the animation. Audience picks up a character that they identify as the main character and choses to share that character's emotions. Fuat explained the issue this way: "*There are some films that all characters are monsters but you understand that one of them is the good one. How you understand this is its appeal, its facial expressions, comparatively its costume, then its motions and lastly its role in the story.*" At this point, is seems to be important to design main characters visually and mentally distinctive than others. As Tuğba states, these characters should represent connection to real world with both their positive and negative sides, if they are to be believable: "*To create a good animation character, we avoid using idealized, stylized characters and design characters with weaknesses, desires, positives and negatives, contradictions inside … because children and people, as well, are like that in the real world.*". In accordance with these findings, three issues on the design of characters were identified: Jests and mimics, Motion and Personification, which are explained in detail below.

Jests and Mimics: Visualization of the emotions, which support emotional transfer, are found to be mostly depending on jests and mimics of the character. As it is in real life, it is important to express emotions with holistic use of body language and changes in eyes, eyebrows, mouth and nose forms, and relatively squash and stretch on face and cheeks. On the issue, Banu expressed that, "*Here, facial expressions come to the forefront. It is important to observe and represent mimics of face well.*". Selim, in a similar way, emphasized the holistic and universal use of jests

and mimics with these words: "*It may depend on the target group, however, there should be a shared language to express basic emotions … parallelly and synchronously using jests and mimics. The difficult thing here is to simplify (the visualization of emotion) according to the target group.*" Tuğba, on the other hand, emphasized on the labeling of certain emotions: "*… When the character gets upset, its eye fill with tears, a couple of tears drop. Or the character is excited and happy so a star shines in its eye. Those identified visual labels are the ones to help emotional transfer.*". Being similar to the Tuğba's comments, Fuat put emphasis on the importance of eyes for the emotional transfer: "*Especially eyes are the organ to express the entire emotion, like in real films … If you ask how to design to express certain emotions, the focus should be the eyes here*."

Motion: Findings show that, along with the jests and mimics, motion as well must be believable for emotional transfer. Taner, stated that believability of the motion depended on the animators' knowledge of the motion and ability of animator to internalize the movement, make the character move that way and understand if the character could move as desired. Besides, he emphasized on the necessary or unnecessary stops in the animations. On the other hand, Fuat discussed the fluency of the animations: "*For audience to enjoy the animation, we tell our students that movements should be as fluent as it could be. This is an important factor … On the other hand, there are successful films produced as limited animation. So, we cannot certainly say that it has to be so.*"

Personification: In animations, characters do not always represent a human being. It is familiar that objects, non-human living things, imaginary things, and even concepts and phenomena could make a character in an animation. Findings show that personification is a powerful tool to support emotional transfer in visual representations. On the other hand, findings clarify that adding eyes on an object might not always ensure this. Beyond adding eyes on a form, humanizing forms using techniques like squash and stretch, assigning human-based characteristics, jests and mimics, or using objects' natural parts as organs like arms, legs and mouth might better ensure the personification of an object. Below are a couple of opinions of the participants towards personification:

> *"It may be a cube or a sphere to be empathetic, it should perform movements close to human forms, what we call, humanlike, animatic character. How can you turn a sphere*

> *into human form? It can be realized with movement what we call squash and stretch … because the audience will expect it to move like a human being." (Selim)*
>
> *"For example, there was a lot of objects in Beauty and Beast, like table, sofa, teapot, tea cups, all of these, for instance, it was the teapot I think, it was smacking of an old lady. As if the tea cups were her small children. If you can imitate like this, no problem arises, audience can perceive it." (Taner)*

Factuality

Participants especially emphasized on the factuality of the elements in an animation. Here, factuality does not mean creating a perfect copy of things in the real world but a crucial reference that audience find connections with their real lives including events, difficulties, ambitions, problems and such, which would support their identification with characters in an animation. On this issue, Taner reported that "*To enjoy the audience, you need to catch them at somewhere. It is important to add things from their environment; they need to be fed from their lives as much as possible.*". Tuğba, on the same issue, states that "*The story needs to be realistic. There are supportive and preventing events (in the story) and these are the indicators of how well our character is connected to real life … It is same for the sound effects. If I am walking here, I of course want to hear its sound. If not, it would not be realistic.*". Beyond these, Fuat referenced to this issue emphasizing the diversity of emotions people experience in their lives: "*Don't we have any negative emotions? For grownups, only positive emotions might not be enough. They would not consider it realistic.*"

In order to ensure the factuality of characters in animations, participants suggested that *referencing* is commonly used by character designers in the field. As Banu stated "*Expressing the emotion there, is totally (depend on) the ability of analyzing and implying of animator. References are always used, if not, an accurate expression might not be implied. Real recordings, watching them again and again, and express the distinctive characteristics, it is necessary.*". Selim pointed out the importance of referencing saying that "*First, the animator must internalize these (movements) that will ensure emotional transfer. After internalizing, pre-studying on the character drawing and s/he need to make the character feel those emotions, and while doing this, s/he have to use references. We usually do this in this way. One may try to do this recording himself/herself or it may be a real film produced before.*"

Abstractness

Findings show that an important advantage of the animations is that they are able to represent what cannot be performed in real life. When design is too close to reality, this advantage could be wasted. On this issue, Banu expressed that "*Is there a meaning to make it that realistic? The reality is in front of us. … Animation is the representation of what can't be done in real life. It contradicts wit this. This is what arises the attention of audience.*". What is more, participants touched upon the pitfalls of designing animations too realistic, which is so-called *uncanny valley*. According to this, while designs that are closer to abstract are more tolerable to the flaw in an animation, as it gets closer to the reality, even minimal defects could cause troubles, which make audience feel uneasy and threatened. On this issue, opinions of participants are given below:

> *"It is important not to get close to reality. There is this thing called uncanny valley. In animations close to reality, audience find it hard to like it. … I think we need to avoid it because, like in the final fantasy example, if things are not perfect, trouble arise. Audience shy away, take thamselevs off and even do not watch or recommend it to others." (Taner)*

> *"Especially, in recent years, computer animated films that are too close to reality were produced like final fantasy and polar express. These films were unsuccessful at the box office, for instance. The biggest reason of this, there is a theory called uncanny valley, if you know, audience's feeling uncanny. It is said that audience experienced that feeling. There, audience cannot experience the emotions that characters do. It is said that something becomes scary for them. When looked alone, it is static as a picture but when it begins to move, tiniest flaw in its eyes makes the audience get away and scare them. However, in animations (that are closer to abstract), even if there happens a flaw there, because already everything is fictional, it does not become very troubling." (Fuat)*

Exaggeration

Supporting the abstractness advantage of animations, exaggeration was identified as one of the most advantageous issue in animation design. Exaggeration might be used in various manners such as extreme but believable change of forms, dramatization of movements, or exaggeration of facial expressions. Participants' comments on the issue are given below:

"Animation is a visualization from scratch. While doing this, exaggeration is the most important advantage that animation uses. There is a film The Mask, for example, when he is surprised, the mouth falls down, the tongue gets out and such." (Fuat)

"Well, in the heart of animation there is such a thing, exaggeration. For example, I give tasks to students to make them say 'I am an animator, I do everything by exaggerating them.'. I make them to say that they must exaggerate everything, so they do exaggerate. … In order to visualize the emotions the characters experience, we need to exaggerate in any situation." (Taner)

"Here, the advantage of the animation is this, it can be exaggerated. With this exaggeration, (the character) tries to establish empathy and sympathy with the audience." (Selim)

"I can say that exaggeration is important for the enjoyment (of the audience). For example, in real life we simply run but in an animation it can be illustrated exaggeratedly. Here, of course it might be the exaggeration of the change in the form of the character." (Banu)

Shape, size and texture

Finding show that different shapes, textures and sizes might express various emotions or characteristics depending on the context they were used. Generally, based on the findings, while rigid, sharp and cornered forms could cause negative feelings, soft, oval and rounded forms could make the object more positive and more sympathetic. Tuğba explained this as an instinct that was relevant to how these forms were coded to our subconscious in our lives and environments. About the emotional meanings of forms, she stated that "*We feel in need of protection from this kind of things (rigid, sharp objects) … but softer things, rounded and oval things, they are cuddlier, more to be caressed, which would not hurt us, and things we prefer more.*". Similarly, Taner expressed that "*In order to evoke positive emotions, character simply need to be lovable. That's why it needs to be in baby-like forms. For example, why do we like a kitten? A big head, small body, huge pretty eyes… You immediately establish an empathy and sympathy and you want to caress it but when you see a bigger cat you sometimes want to put distance.*". While these are generally acceptable reflections, participants also emphasized the contextual issues on the usage of forms. Selim, appreciating the common use of oval and soft forms in animation, he also stated that "… *this is because we people are not in cornered forms. However, cornered forms like boxes can also be*

animated but this is more about the story and subject. Here, the issue is not being cornered or sharp. It is the relation between the content and the form.". Likewise, Fuat stated that "*It is not true to say it should have smooth lines, colors should be vivid because it can be change according to the style of the film.*". Similarly, Tuğba stated that it might also depend on the story, exemplifying *Transformers* that even though they are made of metal and are in huge sizes, depending on the story and personal traits, the audience is able to understand whether they are good or bad.

Color and Light

All participants recognized the effects of colors on emotional transfer and importance on expression of emotions, however, they also reported that separating it as colorful and black and white would not be a proper approach emphasizing that, *including grayscales*, all colors did serve to visualize various emotions based on the context. On the issue, Banu stated that "*The effects of colors are already known. Colors make it dynamic, support the atmosphere, but black and white may also create a distinctive effect. The choice of colors changes depending on the subject.*". Selim, also emphasizing on the light, explained the issue with these words: "*Use of colors in animation is also related to the content. You may create a very colorful thing or use a monotone color. This is, of course, is about analyzing of colors as an emotional effect. … Light is very important to design a concept with color and content. Space is very important here. You may use vivid colors in a sunny day. You need to harmonize it with the story.*". On the color choice and effect of grayscale toning, Fuat reported that "*Here, we can give the example, Corpse Bride. When you look at the movie, you see that all the colors are pale and in gray tones as much as it can be. Because, why, the name of the movie is Corpse Bride after all. … In a funny scene you do not use gray tones, usually vivid colors used.*".

Finding also show that use of colors depends on the target group as well. While, for pre-school children, designs are mostly simple, colors are vivid and mostly in base colors; the older the age, the more accent, pale and contextual colors should be used.

Sound and Music

Findings show that sounds and music are equally and maybe more effective than visual elements on emotional transfer. In order to perfect a movement or make it more realistic and believable, or strengthen the scene on the emotional base, auditory elements may have an indispensable effect on emotional transfer. However, it is essential to indicate that only consistent and tuneful use of these elements would support the desired effect. On the use of sounds and music, participants' opinions are listed below:

> *"Talking about sounds in an animation, I can say fifty percent is animation and fifty present is sounds. Say that, you may create a very good animation but only if you used the sounds effectively. If you couldn't, it is useless. In this manner, sound has an unbelievable effect on audience." (Selim)*

> *"If you ask me, on the base of emotional transfer, sound and music are equivalent, and sometimes, one step ahead of the visuals. Of course, the sound effects are the same. If I am walking here, of course I want to hear it. … Because they are elements that support the reality, of course the use of sound effects and music are indispensable for both animation films and cinema." (Tuğba)*

Cinematography

According to the findings, cinematographic tools also play an important role for the transfer of emotions. These tools can be stage arrangements and setup, or camera movements, plans, angles and zooms, and they need to be used holistically with other issues to serve emotional transfer. On this issue, Tuğba emphasized that the effect of cinematographic techniques is more than the effect of the movement of the character. As she stated, "*Emotional transfer can be also enabled by the cinematographic tools. What are these? Camera angles, shootings… You need to handle it holistically, considering various technical elements such as zooms, shooting angles or movements of camera, stage arrangements and transitions*."

Target Group

Audience's emotional involvement in an animation depends on the suitable design of story, visuals and sounds for the target group, as the findings reveal. As Selim reported "*Talking about the enjoyment, it differs from person to person, population to population. Here, the features and structure of the character is very important. Audience has to find a contact with these features. Only then they begin to have fun.*". Taner, on the other hand, emphasized on the use shapes and design of the story according to age of the audience: "*At the beginning, we decide on the subject. Actually, we decide on that subject considering the target group. How can I say, let's say a man is leaving home, his story might be told with different side events for adults and different for the kids… For younger ones, let's say, more simple things, for example, we do not draw a star but just draw a triangle, with less edges, I mean, to help them perceive it better… If you are trying to make it for an adult with a high knowledge and experience, you have to avoid such things, in order not to vulgarize the film."*. Besides, Tuğba touched upon the importance of cultural issues on emotional transfer. Exemplifying the Turkish society, she stated that they were more inclined to dram and it was easier to establish identification with melodramatic characters who comfortably shout, cry, and experience all disasters but still stay standing.

In order to enhance the credibility and transferability of the findings derived from semi-structured interviews, findings were restructured as a survey, which was conducted on an online platform to gather the opinions of practitioners in the field. Results of the survey are represented in Table 2. Items were sorted by the mean scores. Six items were added during the survey process according to the comments of the survey participants. Survey results showed that almost all items were considered as important for emotional transfer by the practitioners in animation field ($\bar{x} > 3.00$), which was in line with the findings derived from interviews. While the mean scores of the two items, *designing the story consistent with traditional story structure* and *Using baby-sized design to express positive emotions*, were below 3.00, they are considered to be important at some level after all.

Table 2

Survey items and descriptive statistics

Item	**n**	**x̄**
Effective use of light*	47	4,81
Effective use of cinematographic tools	79	4,80
Use of sounds and sound effects consistent with rhythm and tone of scene	79	4,71
Synchronous use of mimics, jests and sounds that express certain emotions	79	4,70
Creating stage compositions that emphasize on the movement or dialogue *	78	4,69
Characters' being empathetic to audience	79	4,65
Story's being appealing	79	4,63
Temperate use of background music	79	4,63
Using references for the expression of emotions of characters	79	4,61
Expressing emotion through jests (body language)	79	4,61
Postsynching of characters being consistent with its individual traits	79	4,59
Expressing individual characteristics of the characters	79	4,56
Efficient use of depth and contrast to emphasize the object at the front	79	4,56
Using sounds and sound effects to enhance the expression of emotions	79	4,54
Simple and understandable expression of emotions in character design	79	4,44
Attributing a distinctive trait on characters (e.g. a tic, continual slipping down of eyeglasses)	47	4,38
Believable design of follow-through actions	79	4,33
Editing timing with the concern of movement aesthetic	79	4,30
Contextual use of colors in objects and stage design	79	4,29
Identifying the psychological meaning of colors to be used	79	4,28
Expressing emotions through mimics (facial expressions)	79	4,24
Proper use of colors for target group	79	4,20
Creating believable characters	79	4,19
Using *gestus* to represent the personality, status, attitudes of characters*	42	4,19
Designing characters, movements and emotions that audience find a connection with their lives	79	4,18
Designing visuals according to knowledge and experience level of target group	79	4,15
Using secondary actions that express the emotions of a character	79	4,11
Using slow in and slow out for character movements	79	4,03
Using primary actions so that audience could anticipate the following move	79	3,99
Using exaggerations visualizing emotional expressions	79	3,97
Creating appealing characters	79	3,96
Using squash and stretch techniques in character movements	79	3,96
Designing visuals simple and understandable for children audience	79	3,96
Creating a story with supportive and preventive issues	79	3,90
Designing believable movements	79	3,90
Designing average characters with weaknesses and positives, avoiding idealized designs	79	3,89
Using visual labeling that express certain emotions	79	3,86
Personification of non-human characters	79	3,80
Using comedic elements *	47	3,79
Efficient representation of good-bad character contrast*	47	3,79
Preferring detailed visual designs for the satisfaction of adult audience	79	3,73
Using cornered, sharp and rigid forms to express negative emotions	79	3,29
Characters' eye contact with audience	79	3,25
Avoid too realistic designs that might make audience feel uncanny	79	3,13
Using rounded, smooth and soft forms to express positive emotions	79	3,01
Designing the story consistent with traditional story structure	79	2,81
Using baby-sized design to express positive emotions	79	2,65

* Items that are added based on the opinions of participants during the survey process

Closing-up to the mean scores, it can be clearly seen that the highest scores were about the use of light, cinematographic tools, sounds and synchronous use of mimics jests and sounds ($\bar{x} > 4.70$). On the other hand, the items that were much lower than the others were about the emotional effects of shapes and textures, eye contact of the character, uncanny valley and traditional story structure ($\bar{x} < 3.30$). According to these findings, it can be said that, while issues that are emphasizing on the stage and character movements, such as light, sound, direction of cinematography, mimics and jests, were considered as highly important for emotional transfer by the experts, issues about visual design such as using sharp or smooth edges, rigid or soft textures, or using baby-sized measures were considered as less important.

In order to investigate whether mean score differed by positions, each item was analyzed with Kruskal Wallis test. Findings showed that there was a statistically significant difference on the items, "*Using cornered, sharp and rigid forms to express negative emotions"* and "*Using rounded, smooth and soft forms to express positive emotions"* (χ^2: 25.57, $p<.001$; χ^2: 27.1, $p<.001$). In order to find out which positions differed significantly. Multiple comparison tests were conducted. Mann Whitney U tests showed that mean score of the participants who heavily work on 3D animation design were significantly higher than all other positions for both items ($p < .01$). This might be because the realism is at forefront in 3D designs. It can be interpreted that shapes and textures might become more important for emotional transfer when the design gets closer to reality.

Discussion and Result

This study aimed to identify emotional issues for designing multimedia learning materials, specifically for animations. In this direction, semi-structured interviews with academicians in the field of animation, and survey with practitioners working in animation sector were conducted. In this part of the article, findings were discussed along with the literature. Although the study specifically focuses on animation design, the findings are considered to be applicable for any kind of multimedia materials at some level.

This study clarifies that, beyond all other aspects extracted within the study, using appealing or warm colors, or rounded or smooth shapes in visual design do not guarantee emotional transfer, however, using these meaningfully and contextually might help achieve it. In the literature of emotional design of multimedia, six research were identified that uses emotionally designed multimedia learning materials. Three of these were replication of their first research and used almost the same learning material in their research designs. These studies explained the emotional elements as colors, shapes and personification –or anthropomorphism-, and background sounds.

Um et al. (2011), Plass et al. (2014) and Park et al. (2015) used the same learning materials in their studies and based their emotion design on warm colors, rounded shapes and anthropomorphism. Likewise, Mayer and Estrella (2014) preferred appealing colors, rounded shapes and personification by adding eyes that express certain emotions. Haaranen et al. (2015), on the other hand, emphasized anthropomorphism on emotional design of their learning material. Sound was only used in one study as an emotional element; Königschulte (2015) investigated emotional effects of background sound in the learning material. According to the findings of this study, even though they are important at some level, emotional design of multimedia materials was based on the emotional transfer and issues on emotional design is not limited with those elements. What's more, those may only support emotional transfer when they are used meaningfully and contextually.

For each research identified in the literature, it is clearly seen that positive emotions were the main focus of the studies. In this way, findings of the study, somehow, do not comply with the direction of these studies. According to the findings, in order to ensure emotional transfer, design of the animations should be believable and should establish a bond with real life. Considering that people experience various positive and negative emotions in their lives, focusing only positive emotions might not be believable or satisfying, and emotional connection might not be established, which may cause an unsuccessful design on emotional base.

Um et al. (2011) used a warm color palette that includes yellow, orange and pink in the design of their learning materials in order to create positive emotions. Likewise, Mayer and Estrella (2014) used vivid and appealing colors. Both studies used grayscale designs for their control group,

considering to create so-called neutral designs. While findings of this study showed that color use was an important issue on emotional transfer, findings also strongly emphasized that if colors were used meaningfully and contextually, they would help emotional transfer in a desired way. Since the psychological meanings and effects of certain colors could change depending on the context, using random colors and categorizing them as simply appealing or warm, which were supposed to create positive emotions, might not be enough to establish an emotional connection. What is more, Findings showed that black and white –or grayscale- design might not specifically represent a neutral mood, and they, depending on the context and the content, they may induce various emotions.

Another emotional design element used in researches was use of shapes according to the literature. Um et al. (2011) and Mayer and Estrella (2014) used sharp and cornered shapes for their control design and smooth and rounded shapes for the emotional design of their multimedia learning materials. As the findings of this study reveals, cornered, sharp and rigid forms, as developmental reflexes, might have a negative effect on individuals and lead them move away. Similarly, oval, soft and baby-like forms are usually perceived as appealing, cuddly and lovable. In this way, it is possible to say that findings comply with the literature at some level. However, as it is on the use of colors, use of shapes and their meanings and so, the emotions they might induce could depend on the context as well. Besides, on the basis of believability, depending on the degree of reality in animation design, some objects may need to be designed based on their nature. If not, audience might not be satisfied and lost emotional connection.

Königschulte (2015) was the only design using sounds as an emotional element in the literature. In the design, background sounds were presented in the learning material as an emotional variable. Findings of this study comply with this study at some level. According to the findings, if used contextually and temperately, sounds might be one of the most effective instrument in order to enhance emotional transfer. However, excessive use of background sounds, or inconsistent and random use of sound effects might not end up as desired.

One of the most popular emotional design element in the literature was identified as personification. Um et al. (2011), Mayer and Estrella (2014), Plass et al. (2014) and Park et al.

(2015) used this technique by adding only eyes or eyes and mouth on the forms. Haaranen et al. (2015), on the other hand, used this method by adding agents that reacts with certain moves in their design. The findings of the study showed that personification was a powerful instrument for emotional transfer when the characters are non-human things. At this point, the findings comply with the literature. What does the findings of this study add on this issue is that personification might be ensured in various effective and more believable forms than only drawing face-like lines on forms, which are to be attributing personalities, human-like traits, mimics, jests, movements, sounds to them. By creating a believable character using these elements, emotional transfer might be much probable to happen. For example, drawing a smiling face inside a circle would not always mean that individuals looking at it would smile as well, unless they establish an emotional connection with the figure, which could be achieved using various techniques of personification.

Beyond the emotional elements used in the literature, this study brings out various emotional issues for the design of multimedia learning materials. These issues are, in brief, designing believable characters with personalities and human-like traits; proper use of mimics, jests and movements; designing a believable story; making connections to real life; designing visuals closer to abstract that support the flexibility and exaggeration; exaggerating emotional expressions; and using cinematographic tools, sounds, music, colors, light, shapes, texture, and the most importantly, considering all of these issues holistically and use them in harmony. While this study aimed to identify emotional issues in multimedia materials through the eyes of animation experts, and intended to serve to a theoretical gap in the literature, findings of this inquiry should not be considered as principles of emotional design but a guide for multimedia designers and researchers through an emotional perspective. Future research should address evidence-based investigations on emotional and educational effects of the issues presented in this study.

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Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 10, Issue 1, January 2019: 141-179

DOI: 10.17569/ tojqi.506439

Research Article

Designing a Usability Assessment Process for Adaptive Intelligent Tutoring Systems: A Case Study[1]

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Abstract

This study aims at examining the usability evaluation process of ArtiBos, an adaptive intelligent tutoring system specifically designed for teaching of problem solving, and proposing usability evaluation recommendations accordingly. The study group consists of 90 students selected from 3 different secondary education institutions and 30 experts from the fields of Computer Education and Instructional Technology and Mathematics Teaching. The usability of ArtiBos is evaluated according to the criteria of effectiveness, efficiency, and satisfaction included in the definition of usability by the International Standards Organization (ISO). In this study, quantitative and qualitative data were used for triangulation. Study data included users' screenshots during performance of the instructed tasks in ArtiBos, sound recordings taken from the think aloud technique, interviews with students, and opinions of experts. The study elaborates the procedure of usability tests of ArtiBos and makes suggestions for usability evaluation processes of similar systems. The results are expected to guide researchers planning to carry out similar systems' usability studies.

Keywords: *Usability, intelligent tutoring systems, expert based evaluation, user based evaluation*

[1] This research is supported by The Scientific and Technological Research Council of Turkey (Project Number: TÜBİTAK-215K029)

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Received: 03.01.2019 Accepted: 30.01.2019

Uyarlanabilir Zeki Öğretim Sistemleri için Kullanılabilirlik Değerlendirmesi Süreci Tasarım Önerisi: Durum Çalışması

Öz

Bu çalışmanın amacı, problem çözme öğretimi için tasarlanmış bir uyarlanabilir zeki öğretim sistemi olan ArtiBos'un kullanılabilirlik değerlendirmesi sürecini incelemek ve benzer sistemlerin kullanılabilirlik değerlendirmesi süreçlerine yönelik öneriler sunmaktır. Çalışmaya, 3 farklı ortaöğretim kurumundan seçilen 90 öğrenci ile Bilgisayar ve Öğretim Teknolojileri Eğitimi-Matematik Eğitimi alanlarından 30 uzman katılmıştır. ArtiBos'un kullanılabilirliği, Uluslararası Standartlar Enstitüsü (International Standards Organization – ISO) tarafından yapılan kullanılabilirlik tanımında yer alan etkililik, verimlilik ve memnuniyet kriterlerine göre değerlendirilmiştir. Çalışmada veri çeşitlemesi sağlanarak nicel ve nitel veriler birlikte kullanılmıştır. Kullanıcıların ArtiBos'da istenen görevleri gerçekleştirme süreçlerindeki ekran görüntüleri, sesli düşünme tekniği (think aloud) sırasında alınan ses kayıtları, öğrencilerle yapılan görüşmeler ve uzmanların görüşleriyle veriler elde edilmiştir. Çalışmada, ArtiBos'un kullanılabilirlik testleri süreci detaylı bir şekilde açıklanmış ve kullanılabilirlik değerlendirme süreçlerine yönelik öneriler sunulmuştur. Elde edilen sonuçların benzer sistemlerin kullanılabilirlik çalışmasını yapmayı planlayan araştırmacılar için yol gösterici olması hedeflenmektedir.

Anahtar Sözcükler: *Kullanılabilirlik, zeki öğretim sistemleri, uzman temelli değerlendirme, deneysel değerlendirme*

Introduction

Today computers are being used in every area of life by people from all walks of life. For this situation, a big share is owed to software interfaces. Until the 1970s, computers could only be used by experts for military, academic, and commercial experts chiefly because computers were designed for specific tasks and it was experts only who had a command of the tasks required for those tasks. However, the situation began to change upon introduction of Simula and SmallTalk in 1967 and 1971, respectively, the first object-oriented programming languages. As such programming languages and derivatives were put into use, software products which did not previously have an interface started to be replaced by versions that are easier to use and can be understood by all. Interface design has become quite advanced and become one of the most important elements of software since then (Reilly, 2003). Norman (1988) points out that the most important feature of a software program is a convenient design and minimized probability of errors. This might be possible if the interface is evaluated together with stakeholders from each segment of users and the design is made usable for those people. Myers and Rosson (1992) found out that the interface accounts for 48% of satisfaction with a program developed in their study. This result shows that the interface design is as important as the content in a software.

The field which studies the relationship between interface design of computer programs and users is called Human-Computer Interaction (HCI). The discipline works ensure effective use of technology and to create, upgrade, and evaluate technology to facilitate human life (Özdemir, Atasoy, & Somyürek, 2007). HCI is regarded interdisciplinary because it is borrows from a variety of disciplines (Carroll, 2003; Çağıltay, 2011; Lazar et al., 2010). Of the procedures referred to in definition of HCI, studies on usability at design stage come to the forefront. The concept of usability, which is also known as easy to use, user-friendly, and transparent to the user, is difficult to measure and has a complex structure; therefore, it currently lacks a scientific definition agreed upon by all sectors (Hertzum, Hansen, & Andersen, 2009). Nonetheless, frequent everyday brand slogans highlighting ease of use can be examples of semantic definition; such as “Easy to connect”, “programmed easily”, and “easy-open bag”.

According to Nielsen (2012), a veteran of studies on usability, usability refers to a quality indicator that measures how easily the interfaces are used, and to methods developed to

increase the ease of use during design. Another important standard related to usability comes from the definition by ISO, which targets two aspects as quality of use and software quality. The former means the capability of the software product to enable specified users to achieve specified goals with effectiveness, productivity, safety and satisfaction in specified contexts of use (ISO 9241-11, 1998). Software quality refers to the capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions (ISO/IEC 9126-1, 2001). In other words, usability of a developed system must meet the criterion of satisfaction besides effectiveness and efficiency.

Usability tests to assess the usability of a product consist of 4 different approaches. These are expert-based approach (heuristic evaluation), approach based on design guidelines, experimental approach (user test), and model-based approach (Çağıltay, 2011).

In addition to approaches, there are also test types: in-process tests and end-of-process tests. In in-process tests, the product evaluation starts as soon as the product is designed, whereas the evaluation takes place after the product is designed in the other type. In-process tests are quite important to predetermine design problems in the product and to discover aspects that could be hardly modified later. Still, those tests are not fault-proof. End-of-process evaluation must be also performed as a pre-caution. Considering pros and cons, it seems more robust as an approach to use both types together (Çağıltay, 2011).

Usability studies have generally been done for commercial and academic purposes on websites. Examples of studies on usability of public web sites (Durmuş & Çağıltay, 2012; Arsoy, Kalıpsız, & Öztürk, 2013; Yavuz, Çınar, & Çağıltay, 2016), university web pages (Cevher, 2015; Çebi, Durucu, & Kayhan, 2013), university libraries (Cockrell & Jayne, 2002; Cengiz, 2016; Iqbal & Ullah, 2016), and e-commerce sites (Lee & Koubek, 2010; Zviran, Glezer, & Avni, 2006), and academic systems Özdemir, Atasoy, & Somyürek, 2007) and academic databases (Çetin & Şendurur, 2016). Besides web pages; usability studies exist about educational environments (Bayram & Yeni, 2011; Beymer, Orton, & Russell, 2007; Can, Atalay, & Eraslan, 2017; Pala, Arslan, & Özdinç, 2017; Erdoğdu & Şahin, 2018) and mobile applications (Dönmez, Yaman, Şahin, & Yurdakul, 2016; Oyibo, Ali, & Vassileva, 2016). There are also usability studies with different purposes such as investigating the effect of the ads appearing along with search results on the Internet on users (Buscher, Dumais, & Cutrell, 2010).

The main goal of usability studies in education is to make educational softwares more student-friendly with the aim of easing the cognitive burden that may arise from the design of the material, thus increasing the efficiency and efficiency of the educational environments through increased focus on the content. Today, a number of innovations are introduced to improve the effectiveness and efficiency of digital learning environments. Blending of new technologies and approaches in the design of user-centered learning environments is gaining importance. A number of new technologies are on the ground to provide a richer learning experience for students. They include distance learning technologies for time and space-independent learning, digital game-based teaching to ensure lasting and effective learning, individualized teaching to provide customized training, adaptive teaching, and intelligent tutoring systems.

Intelligent tutoring systems (ITS) are computerized teaching environments based on artificial intelligence technology to support learning and teaching processes (Bernacki et al., 2014). These systems give support to the student throughout the teaching process by simulating the instructor's teaching style (Magnisalis, Demetriadis, & Karakostas, 2011). ITSs are comprised of 4 modules as user interface module, student module, teaching module, and information module (Koedinger & Corbet, 2006; Victorio-Meza, Mejialavalle, & Ortiz, 2014; Vos, 1995). The main task of ITSs is to evaluate students' knowledge acquisition throughout the process. Evaluation is necessary to adapt learning materials and activities to student data (Ramirez- Norigea, Juarez-Ramirez, & Martinez-Ramirez, 2017). Adaptation refers to the task of designing content or navigation suggestions according to the data of individual user characteristics in view of the objectives of the training (Radenkovic, et al., 2011). Adaptive systems aim to tailor learning environments for learners (Reniers & Dreher, 2009). Such systems are rapidly becoming widespread nowadays and software and technology products developed in this field are increasing (Tuna & Öztürk, 2015).

Adaptive tutoring systems discover the needs and wishes of the student and customize the system in this direction, while intelligent systems simulate the style of the real teacher and provide support to the individual learner during the teaching period (Magnisalis, Demetriadis, & Karakostas, 2011). In broad terms, adaptive intelligent tutoring systems (AITSs) are systems based on artificial intelligence technology, which can be used to support learning and teaching processes, by saving a student's preferences during the use of the software, which

can determine the student's competencies and deficiencies, and then use this information to adapt itself and guide the student (Bernacki et al., 2014).

Aim of the Study

In the literature, there are abundant interface design usability studies concerning computer-aided materials, while this number is quite low for adaptive intelligent teaching systems. In general, research focuses on architectural design rather than interface design (Chughtai, Zhang, & Craig, 2015). It is thought that recommendations to follow the evaluation of the system interfaces and the results will bring about design of more efficient and efficient learning environments. Therefore, this study intends to assess the design and usability of ArtiBos, an adaptive intelligent teaching system, was made. The aim of the study is to provide guidance for usability evaluation of systems similar to ArtiBos while performing the usability tests of ArtiBos, and to make recommendations accordingly. For this purpose, the study seeks answers the following research questions.

1. How can the process of usability evaluation be planned for AITSs?

1.1. What has been done in the usability evaluation processes of the AITSs?

1.2. What has been done in the usability evaluation process of ArtiBos?

2. How is ArtiBos's usability?

Method

In this study, findings on usability studies related to adaptive tutoring systems and intelligent tutoring systems were analyzed by using document analysis method and then the steps to be taken in ArtiBos's usability study was determined. After that, according to these steps, a usability evaluation of ArtiBos was carried out with both expert and student views. In study,

- Document analysis was performed on databases with specific keywords in order to determine the steps to be followed during the usability studies.
- Experimental approach was applied for the usability test by conducting user tests and interviews with students. Moreover, data collected from students by means of think aloud were recorded and screen recording was made;

- Expert-based approach was utilized where experts were interviewed about intuitional analysis and system design evaluation.

In order to obtain detailed information in this process, various tools of data collection were used such as article review form for document analysis, usability test tasks for the usability test with the students, a semi-structured interview form for the system evaluation interview with the students, Nielsen's (1994) heuristic rubric for the heuristic analysis with the experts, and system design evaluation form for the design evaluation interview with the experts.

Considering the procedures, data collection tools, and the analysis methods in this study; it can be said to be implemented with embedded design as a type of mixed research. Embedded design is a mixed-method pattern which brings together quantitative and qualitative data concurrently or sequentially (Creswell, 2008). Basically qualitative methods are used in the study; yet, quantitative data were also collected for variety in accordance with the embedded mixed research design.

Data Collection and Analysis

In the process of examining the studies, articles published after 2000 were examined in Google Scholar, Eric, Sciencedirect and National Thesis Center databases by using "intelligent tutoring systems", "adaptive systems" and "usability" keywords. The title, summary and keywords of the articles were examined in order to determine whether the studies obtained during the search process will be evaluated within the scope of the research. When the information in these sections is not sufficient, other sections of the articles are examined. 13 articles providing the criteria for preliminary examination were selected for further analysis and included in the study. These articles were analyzed and coded according to the criteria of the purpose, type, study group, data collection tool and usability approach. The selection and coding of the articles was carried out by two researchers. The results of the analysis were presented as a table. The collection and analysis of data on the usability process were described under Data Collection and Data Analysis.

Population and Participants

The population in the document analysis process of study are article published in refereed journals about adaptive tutoring systems, intelligent tutoring systems and adaptive intelligent tutoring systems. The participants in the usability evaluation process is explained under selection of participants.

The Media Used – ArtiBos as an Adaptive Intelligent Tutoring System

Developed as an adaptive intelligent tutoring system, ArtiBos consists of 7 main modules and sub-modules placed under them. There are 7 modules which can be accessed by users by logging in ARTIBOS home screen with their user name and passwords. They are Lecture Module, Problem-Building and Editing Module, Problem Solving Module, Problem Asking Module, Users Account Modul, Problem Level and Score Determination Module and Adaptive Module.

Lecture module is designed in a way to include the basic concepts related to the topic to be taught. The design of Problem-Building and Editing Module allows students to configure problems on their own. Problem Solving Module is the module that allows solving the problems to be built by students and then to be stored on a common server to be provided by the students and their peers. In Problem Asking Module where problems are sent, created problems can be asked to all other online users or to one specific competitor as a challenge or duel. In Users Account Module, students edit their personal information and view questions they added and their score. Problem Level and Score Determination Module is used for scoring in the system. And in Adaptive Module, Adaptation is performed as adaptation of the content for the scene, object pools and applicable difficulty level, taking into account the student's success level. Figure 1 shows the general view of ArtiBos.

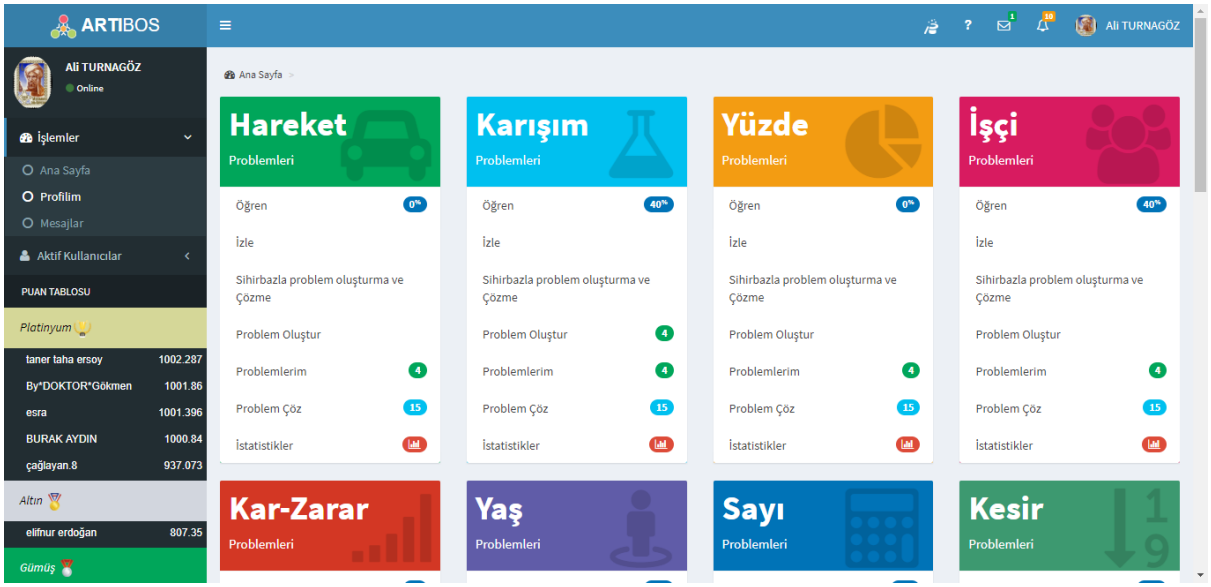

Figure 1. General view of ArtiBos

Scenes to be created in the system are recorded as video and text. When the student wants to ask the problem, the problem is sent to the other side as an animating object (video) together with the problem text. As the student wishes to address the problem; such data are accompanied by various paths to solve the problem, the operation steps required for the solution and the result of the problem are uploaded to the Web server. ArtiBos features an audio and visual educational calendar in order to follow the students' steps and give the appropriate feedback during the problem formation activities. In order to carry out an inclusive evaluation while determining the usability test tasks, efforts were made to include all of the user-interactive modules of ArtiBos.

Results

In this study, firstly, the usability evaluation processes of ITSs and AITSs were examined. Then, it was explained that what is done in the usability evaluation process of ArtiBos. Finally, an improved usability evaluation process was applied.

Usability Evaluation Processes of ATSs and ITSs

Although there are few direct studies on interface design of ITSs and adaptive systems, examples are available that examine the effectiveness and efficiency of the overall structure and content of the system (Roscoe, et al., 2014; Dexheimer, et al., 2017), investigate users'

thoughts and satisfaction with the system (Lin, Wu & Hsueh, 2014; Sanchez, et al., 2014; Verkuyl, et al., 2016), and offer models for a more useful system design (Arevalillo-Herrarez, et al., 2017; Ramirez-Norigea, Juarez-Ramirez & Martinez-Ramirez, 2017).

Below Table 1 displays the usability studies employing various methods for the evaluation of interface and contents both during and after design of intelligent tutoring systems and adaptive teaching systems.

Table 1

Usability Studies on Adaptive and Intelligent Tutoring Systems

Study	Aim	Type	Research and Characteristics		
			Work Group	Data Collection Instrument	Usability Approach
Writing Pal Affective Tutoring System (Roscoe, et al., 2014)	Mobile application prepared to improve students' writing competence	Gamified Intelligent Mobile Application	Performance monitoring with 141 tenth graders	Built-in user test to use the entire system	Experimental approach
			Interviews with 2 experts (English language teachers)	Semi-structured interview form	Expert-based approach
Virtual gaming to develop students' pediatric nursing skills: A usability test (Verkuyl, et al., 2016)	Prepare a better-quality and alternative learning environment for nursing students	Game-based Intelligent Learning Environment	Evaluation of the system with 2 experts	Nielsen (1994) Experts' intuitional evaluation test	Expert-based approach
			6 students of nursing and 5 nurses	Data recorded by voice thinking technique, 16-item usability scale	Experimental approach
Evaluation module based on Bayesian networks to Intelligent Tutoring Systems (Ramirez-Norigea, Juarez-Ramirez, & Martinez-Ramirez, 2017)	Add an evaluation module to an existing intelligent teaching system to perform usability work	Adaptive Intelligent Tutoring System	62 students	Student performance monitoring and student reports	Experimental approach
Affective Tutoring System (Lin, Wu, & Hsueh, 2014)	System prepared for teaching of accounting	Intelligent Tutoring System	80 students	Interviews with students (80 students), student observation form (80 students) and scale of usability for students (45 students)	Experimental approach

Study	Aim	Type	Research and Characteristics		
			Work Group	Data Collection Instrument	Usability Approach
Self-Monitoring Activity-Restriction and Relaxation Treatment (SMART application) (Dexheimer, et al., 2017)	Intelligent Mobile Application for Patients Treated due to Brain Injuries	Intelligent Mobile Application	4 children (aged 11 to 18) and 4 parents (average age of 41)	Think aloud data recorded in 60-minute free use and 5-likert scale of usability	Experimental approach
Ax2ELS (Adaptable-Adaptive English Learning Support) – Teaching of Foreign Language (Sezer, 2011)	Improve foreign language learning	Adaptive Intelligent Tutoring System	Experts of foreign languages (indefinite number of experts)	Field experts evaluating the usefulness and effectiveness of the system	Expert-based approach
Episodic Learner Model Adaptive Remote Tutor (ELM-ART) (Weber & Brusilovsky, 2001)	Present all learning materials as an online interactive textbook	Adaptive E-book Application	Primary school pupils	Questionnaire given to students in order to learn about the effectiveness and usefulness of the application	Experimental approach
INSPIRE (Papanikolaou & Grigoriadou, 2003)	Propose a model to meet students' needs, to evaluate their learning style preferences, and to provide their interactions	Intelligent Tutoring System	66 students	Participants divided into two experimental groups of 33 eachh in order to check usefulness of the application based on students' feedback	Experimental approach

Study	Aim	Type	Research and Characteristics		
			Work Group	Data Collection Instrument	Usability Approach
Style-OLM (Open Learner Modelling) (Dimitrova, 2003)	Test and evaluate the cognitive capacity of students in order to design and evaluate a tutoring system for them	Game-based Adaptive Intelligent Instruction System	7 graduate students in computer department	Usability questionnaire	Experimental approach
AES-CS (Adaptive Educational System Based on Cognitive Styles) (Triantafillou, Pomportsis, & Georgiadou, 2003)	Design a teaching system with elements for cognitive styles to improve student interactions and learning outcomes	Intelligent Tutoring System	5 experts	Semi-structured interview form	Expert-based approach
			10, 4th graders	Semi-structured interview form and usability questionnaire	Experimental approach
PEL-IRT (Personalized E-Learning System Based on Item Response Theory) (Chen, Lee, & Chen, 2004)	Design an instructional system that offers course materials and increases individual learning skills	Adaptive Intelligent Tutoring System	210 graduate students	Usability questionnaire	Experimental approach
Personalized Intelligent Tutoring System (PITS) (Chen & Duh, 2008)	Develop a customizable web-based course system application on the classical test theory	Adaptive Tutoring System	High school students (in an indefinite number)	5-point Likert type scale of usability	Experimental approach
Developing an Adaptive Web-Based Intelligent Tutoring System using Mastery Learning Technique (Kularbphettong, Kedsiribut, & Roonrakwit, 2015)	Develop an adaptive web-based intelligent tutoring system using mastery learning technique	Adaptive Web Based Intelligent Tutoring System	67 university students	Usability questionnaire	Experimental approach

When Table 1 is examined, it is seen that the experimental approach is predominantly preferred in evaluation of the usability of adaptive intelligent tutoring systems and the approach is often applied with scales and questionnaires on usability. Some other studies are carried out with think aloud and performance monitoring techniques under experimental research. Apart from the experimental approach, in some studies, expert-based approach is preferred for the evaluation of the systems. In some of these studies, expert-based approach accompanies experimental approach, while it is used as the only method in some others.

The Usability Evaluation Process of ArtiBos

The procedures carried out in ArtiBos's usability evaluation process and similar procedures in the literature regarding the usability evaluation of the AITSs are given in Table 2 and Table 3.

Table 2

Usability Evaluation Approach Applied in ArtiBos

ArtiBos	Literature
Experimental Approach	Roscoe, et al., 2014; Verkuyl, et al., 2016; Ramirez-Norigea, Juarez-Ramirez, & Martinez-Ramirez, 2017; Lin, Wu, & Hsueh, 2014; Dexheimer, et al., 2017; Weber & Brusilovsky, 2001; Papanikolaou & Grigoriadou, 2003; Dimitrova, 2003; Triantafillou, Pomportsis, & Georgiadou, 2003; Chen, Lee, & Chen, 2004; Chen & Duh, 2008; Kularbphettong, Kedsiribut, &Roonrakwit, 2015.
Expert-Based Approach	Roscoe, et al., 2014; Verkuyl, et al., 2016; Sezer, 2011; Triantafillou, Pomportsis, & Georgiadou, 2003.

Table 3

Usability Evaluation Tests Used in ArtiBos

ArtiBos	Literature
User Test	Roscoe, et al., 2014; Ramirez-Norigea, Juarez-Ramirez, & Martinez-Ramirez, 2017; Lin, Wu & Hsueh, 2014; Dexheimer, et al., 2017; Weber & Brusilovsky, 2001; Papanikolaou & Grigoriadou, 2003; Dimitrova, 2003; Chen, Lee, & Chen, 2004; Chen & Duh, 2008; Kularbphettong, Kedsiribut, & Roonrakwit, 2015.
Think Aloud Technique	Verkuyl, et al., 2016; Dexheimer, et al., 2017.
Student Interview	Triantafillou, Pomportsis, & Georgiadou, 2003.
Expert Interview	Roscoe, et al., 2014; Sezer, 2011; Triantafillou, Pomportsis, & Georgiadou, 2003.
Heuristic Analysis	Verkuyl, et al., 2016.

According to table 2 and table 3, in this study, we used experimental approach and expert-based approach as a usability evaluation approach; we used user test, think aloud technique, student interview, expert interview and heuristic analysis as a usability evaluation test. Besides, tables show that in most studies, experimental approach and user test were used. In a few studies, expert-based approach, think aloud technique, student interview, expert interview and heuristic analysis were used. These results show that, most of usability approaches and usability tests were used in this study.

Figure 2 shows that what is done for ArtiBos's usability evaluation process.

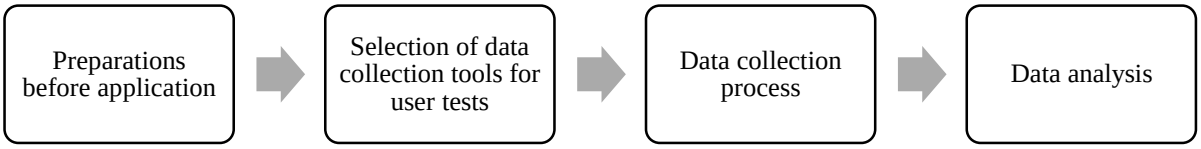

Figure 2. Usability evaluation process

Preparations Before Application

Figure 3 shows that pre-application procedures related to the evaluation process with the students.

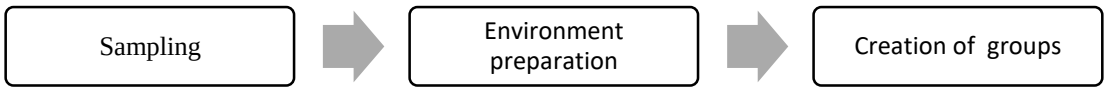

Figure 3. Preparations with students before application

Selection of Participants

In order to encourage focus on the usability rather than the content on ArtiBos, students in the 10th grade were preferred. That is, we preferred purposive sampling technique. In this scope, 90 students attending the 10^{th} grade were selected from 3 Anatolian High Schools (30 students from each of Yavuz Sultan Selim Anatolian High School (YSSAHS), Fatih Sultan Mehmet Anatolian High School (FSMAHS), and Cumhuriyet Anatolian High School (CAHS) school) who had been taught types of problems during the 9^{th} grade (having knowledge of "Applications on equations and inequalities"), and they were assigned tasks on

ArtiBos. Later, the design of the interface of the system was evaluated with 30 design experts comprising of 8 faculty members from the department of Computer Education and Instructional Technologies (CEIT) and 16 PhD students and 6 graduate students majoring in the same department. The reason why all of the participants are not faculty members is that the number of faculty members of the CEIT department is low and the data collection process takes a long time. For this reason easily accessible sampling method was preferred. When choosing experts, their professional experience has been considered. Two of the researchers in the data collection process are graduate students in the Department of Computer Education and Instructional Technologies and a person is a PhD student in the same department.

Environment Preparation

In order to prevent interruption by noise, the libraries of the schools were made available to the researchers during data collection. The researchers also took laptops to the schools so that the students could perform their tasks. All of the laptops are equipped with identical hardware and software features that run at an equal speed. In addition, an application called Camstudio 2.7.4 was installed for screen recording.

Creation of Groups

The students took part in tests as groups of maximum 10 people in each school. The teachers were asked to appointing students from different levels of success as much as possible. The school administration was asked about the students' idle classes, the computer lesson teachers were consulted, and the best time was arranged for the tests.

Selection of Data Collection Tools for User Tests

The procedures for determining the data collection tools for user tests are shown in Figure 4.

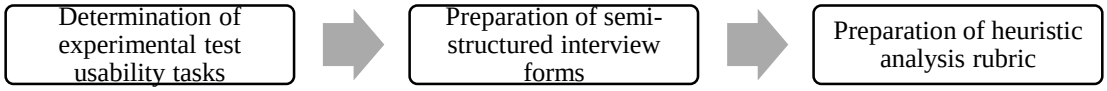

Figure 4. Selection of data collection tools for user tests

Determination of Experimental Test Usability Tasks

In the preparation of usability test tasks, students were able to use general system usage and all menus in detail. The selected tasks were checked and assessed by 4 design experts who are knowledgeable about the system. Then the tasks were updated and finalized. The final version of the tasks was completed by 3 different people who can use a computer fairly and have a command of the system. The average completion duration was prepared as a model for use in the analysis.

Preparation of Semi-Structured Interview Forms

For the students and design experts to evaluate the usability of the system, the semi-structured interview form was prepared by the researchers by paying particular attention to include items covering the entire interface and content of the system.

Preparation of Heuristic Analysis Rubric

As for the rubric targeting the experts, it was drawn up as a 5-point Likert type scale based on the 10 heuristics of Nielsen for usability.

Data Collection Process

In this study, the usability process of the designed system was carried out in 3 distinct schools. Throughout the implementation process, diaries were kept by the researchers to give information about the environment, participants, tests, and challenges. The usability study was completed with both in-process and end-of-process tests. As soon as the system design was launched, it was started to continuously examine and revise its interface by the design experts. The process was carried out with expert-based approach only because the product was not fully ready at that time. However, both of expert-based and experimental approaches were applied when the product was ready. The latter approach was preferred during the testing by users, which consists of tasks for active use of all menus in the system. During the test, the users were asked for their opinions via screen recording and voice thinking. This approach provides more valid and valuable data as it allows access to data from primary users

(Çetin & Şendurur, 2016). As a part of expert-based approach, a rubric was prepared by borrowing items in Nielsen's (2010) heuristics as one of the most important heuristics and the rubric was filled by the design experts for evaluating the system. The number of experts was kept at a maximum level as a precaution for validity of the results. Apart from this, design guidelines and model-based approach were not preferred because design guide approach is often taken by large companies for evaluating their own products and results of this approach are not considered objective enough. The other approach, model-based, seems to be particularly useful for step-by-step systems. Also, practically it is difficult to find an experienced expert in models.

In this scope, experimental approach was taken first and the system was tested by 90 students attending three Anatolian high schools as end users. The study was implemented by recording screen shots and think aloud notes of users while carrying out the assigned tasks. It lasted one week to complete data collection in each school, totaling to 3 weeks. Inside the schools, it took approximately 80 hours to set up computers and media, introduce the system, motivate the students, and to answer the usability test by each group of 10 students.

Screen shots were collected from 30 students using Camstudio 2.7.4, and think aloud data were collected from 90 students by 3 different observers by means of keeping detailed notes. After the tasks, semi-structured interviews were conducted with all of the participants in order to get extensive views of the students about the designs when the students were asked to evaluate each module separately. During the test, the students were told to use the modules of ArtiBos to perform a number of tasks such as sending messages, updating information, creating problems, and solving problems. Photo 1 shows some images taken during the application of the test.

Photo 1. Implementation of the Usability Test

90 Students selected from 3 different high schools were regrouped in groups of maximum 10 people. The test was carried out in the library in each school as the quietest place. All of the participant students were provided with computers with equal hardware and software features. During the data collection, 3 field experts monitored the students in groups of two or three to help them as they needed and record the students' views as they were thinking loudly. At the same time, the researchers noted down the students' views in case the voice recordings were not clear enough. Approximately 80 minutes were allocated for collecting data from each group of students. In order to properly organize the days and times for data collection, the relevant school administration was contacted earlier and appointments were made when the participant students had idle classes or when the teachers planned to teach nothing new as a part of the ordinary classes.

For expert-based assessment, 30 experts completed the rubric covering Nielsen's (1994) heuristics. After filling these rubrics, the experts completed a design evaluation form consisting of 30 questions face to face. While doing the latter, the researchers inquired the

design evaluation questions on the ArtiBos screen and noted the answers. The rubric was designed for scoring between 1 and 5.

The faculty members, research assistants, and postgraduate students in Computer Education and Instructional Technologies were appointed on a volunteer basis. First of all, the experts were trained about the system. Then they answered some open-ended questions after receiving guidance on all menus of the system. Finally, they filled in rubric built on Nielsen's heuristics. The experts carried out the evaluation individually by using their personal computers in an average duration of one hour.

Data Analysis

The usability of the system was judged against the effectiveness, efficiency and satisfaction criteria in the definition by ISO (9241-11, 1998). The effectiveness of the system was checked through the completion status of the tasks, efficiency was judged against the completion time of the tasks, and user satisfaction was evaluated by interpreting checking the notes taken during aloud thinking and the semi-structured interviews with the students following the test. Finally, interviews with experts and rubric results were evaluated for system design.

In order to examine the design and usability test process of the system, the researcher logs were analyzed by content analysis. While analyzing the screen recording data obtained from the students, task completion times and task completion times in the cam studio program were examined. Think aloud data and interview data obtained from the students and interview data analysis from the experts were made with content analysis. The rubric data of the experts were calculated by scoring 1-5.

Usability of ArtiBos

In this study, the findings collected from experts and students are organized under two headings: design and usability. The data sources and data collection tools benefitted during the process are outlined in Figure 5.

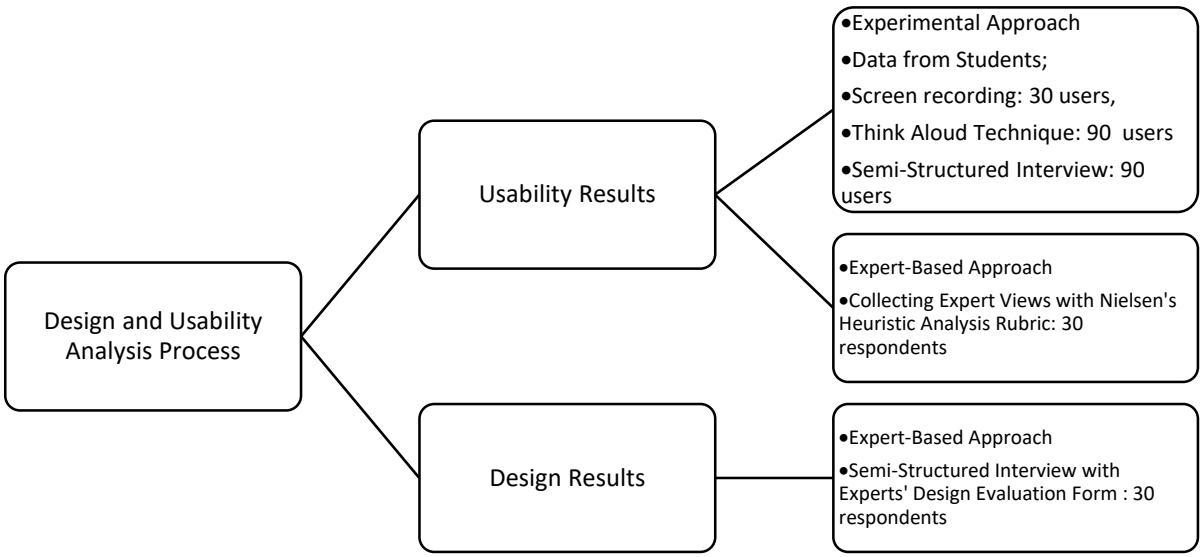

Figure 5. Process of design and usability analysis

As seen above, the results obtained from the implementation process are divided into two as design and usability. The tools indicated in Figure 5 were used while collecting data from the participating students and experts.

Usability Results

The usability of the system interface design was assessed by using experimental and expert-based approaches. For this reason, data were collected both during and at the end of the process.

Within the scope of experimental approach, usability tests and interviews were conducted with students who are the primary users of ArtiBos. As for expert-based approach, interviews were held with field experts to learn their evaluations about ArtiBos.

Expert-based approach was used during the practical implementation stage. Therefore, the experts kept questioning the usability of the system and required made necessary updates starting from the begining. At the end of the process, both expert-based and experimental approaches were utilized. In this way, it became possible to evaluate the system from the perspective of both design experts and students as the main users.

Data from Students

In order to be able to evaluate the effectiveness and efficiency of the system, quantitative data on completion status and average completion time of the tasks were used, as set out in Table 4.

Table 4

Quantitative Data regarding Effectiveness and Efficiency of ArtiBos

Task	Task Completion Status (%)	Average Completion Duration (sec)
Task 1	76.6	51.3
Task 2	100	5.5
Task 3	90	16.3
Task 4	93.3	8.8
Task 5*	-	-
Task 6	93.3	320
Task 7	46.6	407
Task 8	100	6.5

* Evaluated with qualitative data.

Task 1: Update your e-mail account

It was found out that 23 out of 30 users could complete Task 1. The average completion time was recorded as 51.3 seconds. Below are quoted some comments made by users who failed to complete the task at all or do it on time. The notes were taken via think aloud and interviews:

"Where will I updated the e-mail, there is not an option." (CAHS - S2)

"I cannot update my e-mail, teacher.." (CAHS - S5)

"The changes we write are not being saved" (YSSAHS - S8)

Task 2: Send a message

On task 2, all users were seen to quickly reach the message menu, which is conveniently accessible and visible by users at all levels. As an exception, the users were not able to send messages due to a technical problem that occurred on the day the data was collected.

Although users had no problems with the interface, they brought the following criticisms because the operation could not be performed:

"I don't think it is writing a message." (CAHS - S2)

"When I write a message, it gives an error, so I cannot send a message." (CAHS - S11)

"It is not sending a message, teacher." (FSMAHS – S4)

"Messaging gives an error." (YSSAHS – S1)

Task 3: Access to the instruction content for mixture problems

It was seen that task 3 was completed by 27 students, while the rest of the 3 students did not start the task at all. The average duration of access to the instruction content by students was calculated as 16.3 seconds. Below are quoted some of the users' comments noted during the implementation via think aloud technique:

"I enjoyed the lecturing. It is OK, I mean." (CAHS – S5)

"Teacher, I can't go to the other page, the same stuff keeps blinking." (CAHS – S8)

"How will I access to the instruction content? Via learn?" (CAHS – S20)

"How can one access to the instruction content?" (FSMAHS – S10)

"A bit complicated, I don't understand where to click" (YSSAHS – S10)

Task 4: Watch the video tutorial on how to create the problem

It was seen that the video mentioned in the task and placed under the menu "Watch" on the system could be accessed by 28 of the students leaving only 2 unable to perform the task. The average duration of task completion was noted as 8.8 seconds. Below are noted some opinions regarding the task in question:

"In the place titled watch, something can be put, like learn to create a problem." (CAHS – s4)

"How did you play the video?" (CAHS – S10)

"Video texts are streaming fast, they should be slower." (CAHS – S8)

"Video texts could be more active." (CAHS – S5)

"It zooms in and out, it is clear I suppose." (CAHS – S7)

"I think things in the video might be more active." (CAHS – S4)

"I think the colours and so on are very lovely." (FSMAHS – S5)

Task 5: Learn how to use the system with the wizard

As a result of completing this task, it is planned that students will have learnt how to use the system by means of the wizard. It was identified as a qualitative task in order to find out whether the learning outcome took place. The data concerning task 5 were obtained by analyzing the interviews and screen records.

The screen recordings show that when students first logged in the system, they tended to use it randomly and discover it on their own. However, those who noticed the wizard could reach the menus they want easily as a result of reading the wizard's instructions. Also, they recommended using the wizard for those having difficulty in surfing the system. As an example, one student was heard to warn a peer as following:

"Look, it writes what it is next to the wizard." (FSMAHS – S9)

"You can learn what you cannot do by looking at the wizard." (YSSAHS – S9)

During the subsequent interviews, the students were asked for their opinions about the function and design of the wizard. Most of the students stated that the wizard was useful.

"Teacher, the wizard explains what they are for, so it helped me well." (CAHS – S12)

Yet, there were some students who find the text field next to the wizard complex and the succession of the informations as confusing. Some of the comments and remedies mentioned in this regard are given below as an example:

> *"I think the part next to this wizard is unclear, teacher. For example, it would be better if it explained loudly when one gets into it. It's messing up now." (CAHS – S1)*

> *"If instructions for the menus are given within the menus, rather than through the robot, they will be more understandable. Instead of all of the information in a consecutive way, I think it would be better to give in the relevant menus." (CAHS – S17)*

It was seen that the students hold an overall positive view about the wizard design. In particular, it was pointed out that the colour and the design are nice besides having an appeal to the target group of users.

> *"Teacher, the colour of the wizard is beautiful in my opinion." (FSMAHS - S1)*

Reviews and recommendations of some students regarding the wizard design are quoted below:

> *"I think there might be something moving inside the character, teacher." (FSMAHS - S3)*

> *"The character could have been a bit flashier. For example, it may have a metallic look." (FSMAHS – S7)*

Task 6: "25 kg of salty water with 16% salt is mixed with 15 kg of salty water with a ratio of 4%. What is the resulting percentage of salt of the resulting mixture?" Create the problem.

All of the 30 students were observed to attempt the task, while 28 of them could successfully complete it. The average duration of building the problem was 320 seconds, which is longer than expected because the students used the system for the first time and they took their time to recall their previous information about mixture problems. Thus, it does not sound unfair to expect a decrease in the duration as students become more experienced in using the system

and the system interface is updated as required. Some of the students' criticisms about the problem creation page are quoted below:

"How will I add the substances?" (CAHS – S3)

"What will we select and create now." (YSSAHS – S8)

"I can't undo the thing I add." (FSMAHS – S4)

Task 7: Choose and solve a mixture problem

It was found out that while 14 students managed to complete the task, 16 others could not. The average task completion duration was saved as 407 seconds. Considering the data obtained from think aloud technique and interviews, these two findings can be explained with the assumption that the students had not experienced this particular kind of problem solving operation before, they had been expecting a multiple choice question as they were used to solve that kind of problems, and they were not able to fully understand the problem and the missing facts in the problem. The citations below might better highlight this case:

"The list of given and missing facts is too complicated." (YSSAHS-S7)

"I was confused by the existence of too many options." (YSSAHS-S15)

"At first I didn't understand anything, it was confusing, but when I read it, I understood and could solve it." (YSSAHS-S20)

"I was expecting a multiple choice test. I did not understand how to solve, it's very complicated for me." (YSSAHS-S21)

Task 8: *Check out the help menu*

It was found out that all of the participants could successfully complete this task. As a result of the usability assessments, a number of availability issues were detected in the system as listed in Table 5. Other issues are given in Table 6. In summary, 70 of the 90 evaluating students articulated several issues, while 20 people stated that the system was smooth.

Table 5

Usability Problems Encountered in Access to ARTIBOS

Usability Problems	n=70	%
Design		
Functions of menus are not explicitly stated	50	71.42
Spelling mistakes	7	10
Colour, visuality, font and size problems	29	41.42
Menu and button size and positions	21	30
Technical (hardware-related)		
Failure to send messages	48	68.57
Hardware-related technical	36	51.42

According to Table 5; among usability problems, the interface design problems are generally caused because some of the menus could not be understood by the primary users, the text in some menus are too small, and guidance is not enough. Though less important, there were found some problems with illustration and colouring such as inadequate images and pale colours. In relation with technical problems under usability, the first rank is seen to be occupied by the problem with sending messages. Although the positioning of the message button seems usable enought, messages could not be sent due to the technical problem on the day of the test. Technical problems such as the slow running of the web site and halting video were caused by the Internet infrastructure. Similarly, loudspeakers did not work because of the testing computers. As a result, it was planned to update the web site as needed to eliminate the problems with the web interface.

Table 6

Other Problems Encountered in Access to ARTIBOS

Problem	n=70	%
Content		
Difficulty in solving problems	14	20
Confusing weight units	32	45.7
Lecture module does not contain sufficient sample problem solutions	4	5.7

Other problems concerning the system were reported as difficulty of the questions, confusing the weight units, and lack of sufficient sample questions. In order to solve these problems, the mathematics experts changed the content and necessary updates were made in the system.

Expert Views

The evaluation findings of the rubric prepared according to the design experts and Nielsen (1994) heuristics are shown in Table 7.

Table 7

Expert Evaluation

Heuristics	Average
Users are able to receive instant notification about where they are and what they do as long as they are online.	2.43
Information in the system is expressed with familiar and common concepts, text, and pictures.	3.90
The system does not restrict user freedom, so users are at liberty to log out or restart the system whenever they wish.	3.30
The system is standard and consistent in itself. For example, a specific design and font is used throughout the system.	3.80
Possible errors in the system are estimated and taken precaution. For example, when an object is deleted, it is done after the confirmation as "Are you sure that you want to delete this item?"	3.23
When the user is using the system or switching from one place to another, s/he does not have to remember the previous part.	2.83
The system can be easily used by users of all levels.	2.86
Error messages in the case of system errors while using of the system are expressed with a simple language for everybody.	3.23
The system has a help menu, which is focused on solving problems that might come up while using the system.	3.70
The system is aesthetic and simple.	3.73

The rubric based on Nielsen (1994) heuristics consists of five options for each item as "Totally disagree", "Disagree", "Not sure", "Agree", and "Completely agree". The items are scored between 1 and 5. When the average score values of the answers given by the experts are considered, the lowest score is seen to refer to two heuristics, which are "Users can get instant feedback in the system" and "The system can be used comfortably by users at all levels". Conversely, the heuristics referring to the system interface were rated highly:

"Functional help menu of the system", "Simple and aesthetics interface design", and "Expressing the content with familiar pictures and concepts".

Design Results

After the experts' evaluation based on Nielsen's (1994) heuristic rubric, the design evaluation form of open-ended questions was responded by the same experts for in-depth discussion of the results. The frequency of answers for each item is given in Table 8.

Table 8

Frequency of Problems Referred in Design Evaluation

Problem	n=30
Colour, size and positioning problems concerning text and images	10
Lack of feedback	3
Screen usage, alignment, and symmetry problems	4
Object problems used during problem-building	9
Functionality problems regarding processes used during problem solving	8
Deficiencies on the personal information page	3

The table above implies indicates that the criticism about the design of the web site are attributed to text and images, feedbacks, screen usage, alignment and symmetry, objects used in problem-building, operations used in problem solving, and menus on the personal information page. Some of the opinions expressed by experts about design problems are cited as follows:

> *"The feedback given to the questions is not enough. Sufficient feedback should be given for correct and incorrect answers." (U5)*
>
> *"Telephone number can be added to the profile menu. It can work for collective messaging." (U21)*
>
> *"The font size should be increased or an option should be added for customizing." (U18)*
>
> *"When solving a problem, feedback must be given after entering the given-missing facts." (U2)*
>
> *"What is written next to the main container when writing a problem is not clear. It can be within the box." (U7)*

Necessary updates were made on the system in the light of the criticism brought by the participants.

Discussion and Conclusion

In this study, the usability evaluation process is designed for AITSs. Firstly, the usability evaluation processes of ITSs and AITSs were examined. Then, it was explained that what is done in the usability evaluation process of Arti Bos. Finally, an improved usability evaluation process was applied. The data obtained in the study were discussed for the usability evaluation process.

In seeking answer for research question “How can the process of design and usability tests be planned for AITSs?", exhaustive research was carried out about the features, pros and cons of the usability test approaches including the review of the literature on usability studies along with their results. The review of the existing literature shows that usability of digital educational environments, intelligent tutoring systems, and adaptive teaching systems are mostly with experimental method (Beymer, Orton, & Russell, 2007; Bayram & Yeni, 2011; Weber & Brusilovsky, 2001; Dimitrova, 2003; Lin, Wu, & Hsueh, 2014; Dexheimer, et al., 2017; Pala, Arslan, & Özdinç, 2017; Ramirez-Norigea, Juarez-Ramirez, & Martinez-Ramirez, 2017; Erdoğdu & Şahin, 2018). It is seen that other usability studies targeting the same type of systems are conducted with expert-based approach (Sezer, 2011; Trintafillou, Pomportsis, & Georgiadou, 2003). However, there seems a scarcity of studies combining both approaches (Roscoe, et al., 2004; Verkuyl, et al., 2016).

In this study, the usability of Artibos was carried out with both user-based and expert-based approaches. Consequently, highly detailed and inclusive findings were yielded. Furthermore, the results are considered even more realistic because the user-based approach was used in the normal classroom with the main users of the system in the natural classroom environment. Although the literature suggests that usability test with expert-based approach could unveil most problems concerning the system, an application involving the real users of the system conducted with user-based approach seems highly promising for appraising effects of the problems (Hollingsed, 2007). This combines the advantages of both approaches

since expert-based approach is capable of predetermining problems and the other approach identifies effects of the problems found previously (Verkuyl, et al., 2016).

As a result, it can be said that design of such systems by both design experts and the evaluation of the system through eyes of end users would increase the usability of the system. Another strength of our usability test is the rationale of the rubric given as a part of expert-based approach, that is Nielsen's (1994) heuristics as one of the most established grounds in this area. Moreover, the advantages of expert-based approach as shorter time of application and practicality of reporting were enjoyed in this study (Allen, 2006).This implies that researchers had better decide on the research approach through a comprehensive fact-finding trial of not only study participants but also the advantages and disadvantages of the approach such as time and cost.

Apart from the testing approaches, the present study on the usability of Artibos also resembles a potent example as it combines in-process and end-of-process test types. In-process testing proved helpful in spotting and correcting design problems from the very beginning of the process. Thanks to this aspect, problems that are normally difficult to correct later could be overcome more easily and systematically. As for the end-of-process test, problems that were ignored in the process were exposed and removed. It can be inferred that mutual use of the testing models offers a significant advantage. Çağıltay (2011, p. 98) also stated that both types should be used together for more effective results.

Departing from the logs carefully kept during the design and usability assessment of the system, we would like to add the following recommendations for the design evaluation of a similar system in the future:

- Before applying the test, a letter of consent should be obtained from all participant students' parents and also the school of data collection in case of any complaints. The ethics committee report should also be enclosed.
- It should be made sure that computers to be used in testing and facilities such as the Internet connection, mouse, keyboard, camera, etc., are fully in operating state.

- Participants should be selected on a complete volunteer basis, reminding their liberty to leave the test at any time they wish, and substitute users should be identified just in case of drop-outs.
- Due diligence should be shown to time planning as it is a complicated stage to select users, obtain the necessary permissions, and prepare the test environment.
- It would be in the interest of researchers to make the testing environment and equipment ready in a timely manner in case of down-time in data collection.

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