THE EFFECTS OF RESPONSIVE WEBSITE DESIGN AND SCREEN SIZE OF TABLETS ON UNIVERSITY STUDENTS' READING COMPREHENSION, COGNITIVE LOAD, AND PREFERENCE OF READING ON TABLETS

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ABSTRACT

THE EFFECTS OF RESPONSIVE WEBSITE DESIGN AND SCREEN SIZE OF TABLETS ON UNIVERSITY STUDENTS' READING COMPREHENSION, COGNITIVE LOAD, AND PREFERENCE OF READING ON TABLETS

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It is known that instructional design principles are used for providing better learning in multimedia environments. E-reading can be thought as a part of multimedia learning and it has become more popular in society with the help of digital technologies. Nowadays, people mostly use handheld devices like tablets for reading and each of them has their own screen resolution. Thereof, online web content should provide ideal viewing for each screen size to support easy reading which is called responsive website design (RWD). Therefore, the purpose of this study is to investigate the effects of RWD and screen size on reading-comprehension, cognitive load, and preference of reading on tablets. For this purpose, matched between-participants after-only true experimental design was conducted. The input variables for used matching are gender and working memory. In the implementation, different website designs (responsive/non-responsive) and different screen sizes (small/large) are used as independent variables. The dependent variables are reading-comprehension, preference of reading on tablets and cognitive load of students. Quantitative data were collected; and descriptive analysis and MANOVA were used to analyze the data. According to the results of the analysis, none of the independent variables yielded

significant results based on the results of the multivariate test. However, between-subject analysis shows that website design has a significant effect on the preference of reading on tablets, and there is a marginal interaction effect of website design and screen size on cognitive load.

Keywords: Responsive Website Design, Screen Size, Reading Comprehension, Cognitive Load, Preference of Reading on Tablets

ÖZ

DUYARLI WEB SİTESİ TASARIMININ VE TABLETLERİN EKRAN BOYUTUNUN ÜNİVERSİTE ÖĞRENCİLERİNİN TABLETLERDE OKUDUĞUNU ANLAMA, BİLİŞSEL YÜKLENME VE OKUMA TERCİHİ ÜZERİNDEKİ ETKİLERİ

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Multimedya ortamlarında daha iyi bir öğrenme sağlamak için öğretim tasarım ilkelerinin kullanıldığı bilinmektedir. E-okuma multimedya öğrenmenin bir parçası olarak düşünülebilir ve dijital teknolojiler sayesinde toplumda daha popüler hale gelir. Günümüzde insanlar dijital medyadaki okumaların çoğunu tabletler gibi elde tutulan cihazlarla yapıyorlar ve her birinin kendi ekran çözünürlüğü, yönü ve düzeni var. Bu nedenle, çevrimiçi web içeriği, duyarlı web tasarımı olarak adlandırılan 'kolay okumayı desteklemek için her ekran boyutu için ideal görüntüleme' sağlamalıdır. Bu nedenle, bu çalışmanın amacı, duyarlı web tasarımının tabletlerde okuduğunu anlama, bilişsel yük ve tabletlerde okuma yapma tercihi üzerindeki etkisini araştırmaktır. Ayrıca tabletlerin ekran boyutunun bu bağımlı değişkenler üzerinde etkisi olup olmadığı da incelenmiştir. Bu amaçla, eşleştirilmiş çiftlerle yansız atama yapılarak gerçek deneysel çalışma yapılmıştır. Kullanılan eşleştirme için girdi değişkenleri cinsiyet ve çalışma hafızasıdır. Uygulamada, farklı web sitesi tasarımları (duyarlı/duyarlı olmayan) ve farklı ekran boyutları (küçük/büyük) bağımsız değişkenler olarak kullanılmıştır. Bağımlı değişkenler; öğrencilerin okuduğunu anlama, tabletlerde okuma tercihi ve bilişsel yük durumudur. Nicel veriler toplanmış

ve bu verilerin analizinde betimsel analiz ile MANOVA kullanılmıştır. Analiz sonuçlarına göre, bağımsız değişkenlerin hiçbiri çok değişkenli test sonuçlarına dayanarak anlamlı sonuç vermemiştir. Ancak yapılan gruplar arası analiz, web sitesi tasarımının tabletlerde okuma yapma tercihi üzerinde önemli bir etkiye sahip olduğunu ve web sitesi tasarımı ile ekran boyutunun bilişsel yük üzerinde marjinal bir etkileşim etkisi olduğunu göstermektedir.

Anahtar Kelimeler: Duyarlı Web Sitesi Tasarımı, Ekran Boyutu, Okuduğunu Anlama, Bilişsel Yük, Tabletlerde Okuma Tercihi

To my family and my twin sister Özge…

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LIST OF ABBREVIATIONS

ABBREVIATIONS

CLT: Cognitive Load Theory

CL: Cognitive Load

ID: Instructional Design

MANOVA: Multivariate Analysis of Variance

METU: Middle East Technical University

ML: Multimedia Learning

RWD: Responsive Website Design

RST: Reading Span Test

SPSS: Statistical Package for the Social Sciences

WM: Working Memory

CHAPTER 1

INTRODUCTION

In this first chapter, the background of the problem is primarily explained by investigating the related literature. Accordingly, the statement of the problem is clearly indicated. Furthermore, to highlight the difference between other studies and show how the results of this study can contribute to the relevant ones, the significance of the study is clarified. In accordance, research questions and a sentence of purpose which are suitable for this intention is explicitly declared. In addition, assumptions, limitations and delimitations of the study are added in this section. Finally, the terms used in this study are defined and a summary of the chapter is given at the end.

1.1. Background of the Problem

Questions about how affects cognitive skills of learners have been examined for the past decades. There are lots of studies on multimedia learning and instruction based on Cognitive Load Theory (Chandler & Sweller, 1991; Mayer, 2001; Mayer & Moreno, 2003; Mayer, 2012; Rogers, 2002, Sweller, Van Merriënboer, & Paas, 1998). With time, while developing instructional design principles according to the Cognitive Load Theory (CLT), researches were done for the contribution to the CLT, and instructional strategies were developed in order to decrease particular types of load (Chandler & Sweller, 1991; Mayer, 2001; Sweller, 1999; Sweller, Van Merriënboer, & Paas, 1998). Here, the important thing in multimedia learning is designing instructional messages by considering how the human mind works (Mayer, 2012). One research study conducted by Moreno (2006) shows how teaching and instruction can provide effective learning which is pointed out by CLT. Van Merriënboer and Sweller (2005) also presented that information structures, human cognition knowledge and their interactions are used by the CLT for determining instructional design. Other

studies indicate that learners should be prevented from being overloaded by providing appropriate amount of cognitive processing via designed lessons considering learners' processing capacity, throughout learners' schooling process (Mayer, 2005; Mayer & Moreno, 2003; Sweller, 1999, 2005). On the other hand, according to Mayer (2012), multimedia instructional messages should be based on learner-centered approaches because it focuses on the human cognitive system. In the light of all of this, in order to provide effective learning, it is necessary that instruction must be designed by regarding strong instructional design principles and multimedia design from cognitive psychology (Rogers, 2002). As a result of these researches, thoughts emerged on the basis that cognitive load is important for multimedia instruction among researchers (Sweller, 1999; van Merriënboer, 1997). Moreover, consideration of evidence-based principles for effective multimedia instruction were taken (Mayer & Moreno, 2003).

Digital reading continues to become more popular in all segments of society (Odabaş, Odabaş, & Sevmez, 2018). With the help of digital technologies, reading activities started to take place through screens and everything about reading started to differentiate. Here, digital reading or e-reading is used for reading skills on screen where text, sound, pictures, and videos are displayed (Maden, 2012). Therefore, e-reading can be thought as a part of multimedia learning. The most distinctive feature that distinguishes digital reading from traditional reading is that the action of reading is performed on a screen (Odabaş, Odabaş, & Sevmez, 2018). In this process, the digital content confuses individuals' minds although it provides new text formats, creates new goals for reading and presents new ways of interacting with these texts for individuals who normally make sense of printed texts (Coiro, 2003). For example, flipping over pages makes it difficult to figure out the structure of a text and for the eye to follow up. It is also more difficult to combine and understand information in sections that are seen on screens and in sections that are not visible (Güneş, 2010). However, mobile devices such as e-readers, tablets and smart phones are getting more popular each day (Tveit & Mangen, 2014). Some studies were conducted to examine e-reading and its advantages, disadvantages or effects on comprehension. One of the

studies shows that the act of reading is complex, and what parts of the brain are involved and how it works when we read (Wolf, 2007). According to Wolf (2009), the brain must create a connection between circuits, designed with former visual, auditory, linguistic, and cognitive operations in order to read. The other study shows that the relationship between working memory and reading is very meaningful (Ferreira, Valentin, & Ciasca, 2013). The studies of Van der Leij and Morfidi (2006) indicate, that problems with reading comprehension involves low storage capacity of information in the working memory. On the other hand, Hook and Jones (2004) present in their study that fluency contains insight of what will come next in the text and that it is especially important for comprehension. Education technology experts are commonly researching on the effects of screen reading on the subjects of 'reading comprehension' and 'other motivational factors that affect reading' (Başaran, 2014). Actually, reading from the screen does not directly affect comprehension, but can affect the variables that directly affect comprehension (Başaran, 2014).

Nowadays, people do most of their readings from digital media via internet. In the latest years, hand held devices including smart phones, tablets, e-readers have become widely used and each of them has their own screen resolutions, orientations, and layouts. If it goes on like this, online web content should provide ideal viewing for each screen size to support easy reading and easy use with minimum resizing and scrolling (Natda, 2013). Responsive website design (RWD) is a solution for the problem of the constant resolution change according to the size of a device and so this new topic has drawn a lot of attention (Turan & Şahin, 2017a). This issue should be taken into consideration as it can affect the variables that directly affect comprehension. That is, since people do not need to zoom or orientate the screen to scale the width, a responsive website provides easy use for people when compared to non-responsive ones (Kim, 2013) and this can affect comprehension.

1.2. Statement of the Problem

Adaptation of today's design approaches to build efficient websites is very important (Oi et al., 2015). There is a need for investigating this issue in terms of the fixation provided by RWD (including core elements: 1- a flexible, grid-based layout, 2- flexible images and media, and 3- media queries) which reduce task-irrelevant eye movements. This approach can be used as a new instructional design principle for e-reading processes, which is one of the types of multimedia learning environments which are based on the CLT. Clearly, there is a need to determine whether the RWD approach as a new instructional multimedia design on e-reading environments, which is one of the multimedia environments, influences reading-comprehension, cognitive load, and preference of reading on tablets. Also, screen size is needed to be investigated in terms of whether it has an effect on these mentioned variables.

1.3. Purpose of the Study

The purpose of this study is to investigate the effects of RWD and size of screen on reading comprehension, CL, and preference of reading on tablets.

This study seeks to answer the following research questions:

1) Is there a significant difference in reading comprehension level between reading a text on a web page with an RWD and reading a text on a web page with a non-RWD?
2) Is there a significant difference in terms of cognitive load between reading a text on a web page with an RWD and reading a text on a web page with a non-RWD?
3) Is there a significant difference in terms of preference of reading on tablets between reading a text on a web page with an RWD and reading a text on a web page with a non-RWD?
4) Is there a significant difference in reading comprehension level between reading a text on a tablet with large screen and reading a text on a tablet with small screen?

5) Is there a significant difference in terms of cognitive load between reading a text on a tablet with large screen and reading a text on a tablet with small screen?
6) Is there a significant difference in terms of preference of reading on tablets between reading a text on a tablet with large screen and reading a text on a tablet with small screen?
7) Does the interaction of RWD and screen size affect the reading-comprehension, cognitive load, and preference of reading on tablet?

1.4. Significance of the Study

Cognitive load theory emerged in the 1980s and was widely studied by researchers in the 1990s. Then, in the light of these studies, it was attempted to find out how it affects learning. There have been many studies related to multimedia learning, based on CLT, and instructional design strategies have been introduced in the light of these. Studies on the use of instructional design strategies in changing learning environments have been initiated. Nowadays, it is obvious that reading actions are influenced by technology and evolves accordingly. If we think that there is a difference in behavior while reading from a book compared to reading from a screen, instructional strategies can be adapted according to people who read on-screens in online environments. The most critical point to consider here is the screen sizes of devices that allow reading on screen (e.g. tablets). It can be thought that online content is shaped according to screen sizes, thus, facilitating the user experience and, thus, relaxing reading. Websites that have a responsive design, have been developed as a result of the studies on this subject, but the effects of this design on reading comprehension, cognitive load, and preference of reading on tablets has not yet been investigated. Also, screen sizes can be a critical point that influences these variables, and so, it was thought that it should be investigated. This study will contribute to the limited literature about the effect of RWD and screen size on variables related e-reading of students and will provide educators and researchers with information on whether using RWD on tablets for

readings impacts reading-comprehension, cognitive load, and preference of reading on tablets or not.

1.5. Assumptions

In the scope of this research, the following assumptions are made:

- The participants have responded accurately and honestly to all questionnaires,
- All scales are reliable and valid indicators of the constructs to be studied,
- In the pre-application process, the input variables have been measured correctly and matched correctly.
- The data have been accurately recorded and analyzed,
- The processes and tools have a degree of applicability and generalizability to the schools in similar circumstances.

1.6. Limitations

Only a few of the potentially confounding variables that may affect the outcomes of this study can be listed as following.

- This study is limited to participants who are the second, third and fourth year students of Informatics Systems Engineering, Computer Engineering and Software Engineering Departments at Atılım University.
- The research is limited to the 2018-2019 academic year.
- On the other hand, when considering the reliability of the instruments which were used for the measurement of preference on tablets and reading-comprehension, the validity of this study is limited.
- Moreover, the honesty of the subjects' responses to the instruments is another limitation.
- Also, the results of this research may be changed by the comparability of results across different school settings.

- Another limitation is that the duration of the experiment may influence the results. The experiment was conducted only one time and in only one week. If an iterative measurement was performed by extending the duration of the experiment (at least 1 month), the outcome could have turned out to be different.
- Number of reading pieces, length of content, number of questions were not considered as the main points in this study but if it is taken into account as important, it may be a contributory variable.
- If an experiment consisting of longer reading pieces (about 1000 words) and at least 10 parts and 10 questions for each piece were applied, the results could have been different.
- This study cannot be generalized to all schools, so, it is limited to be generalized for university students studying within similar school settings.

1.7. Delimitations

The study confines itself to surveying the students from a private university in Ankara. The study focuses on the reading comprehension, cognitive load and preference of reading on tablets of university students. All the participants of this study are undergraduate students. Translation to Turkish of the instrument items is another delimitation of this study.

1.8. Definitions of Terms

Cognitive load: The assumptions, limited capacity of working memory (Miller, 1956), knowledge mental representations - schema (Chi, Glaser, & Rees, 1982; Larkin, McDermott, Simon, & Simon, 1980), and unlimited processing capacity of long-term memory are regarded human cognitive architecture and they create a basis for CLT.
Cognitive overload defined by Mayer & Moreno (2012), is when intended cognitive processing from learners do not match their cognitive capacity.
Multimedia learning is described as learning from words and pictures (Mayer, 2012).

Multimedia instruction is presenting these words and pictures to foster meaningful learning (Mayer, 2012).

Instructional method can be defined as a way of presenting a lesson where the medium and the content of the lesson does not change according to selected method (Mayer, 2001; 2009; 2012).

E-reading is described as the action of reading taking place on a screen which includes the utilization of text, sound, pictures and videos (Maden, 2012). (The term e-reading is used in the literature with different designations. While some researchers called it as digital reading, some of them called it as screen reading. Actually, all similar words refer to express the same meaning.)

Responsive website design (RWD) can be basically thought as like this: a website working effectively on any size of screen like desktop computers, notebooks, tablets, or mobile phones (Natda, 2013).

1.9. Summary

In Chapter One, the introduction, background of the problem, statement of the problem, significance of the study, purpose of the study, assumptions, limitations, delimitations, the definitions of terms and organization of the study were presented. Chapter Two is a review of recent literature. Chapter Three presents the methodology used in the study, including a description and rationale of a sample, the data collection procedures, a description of instrument development, and the methods of how the data were analyzed. Chapter Four is a presentation of the study results with visuals of analysis outputs, and explanations of them. Chapter Five includes discussions and suggestions for those interested.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

In this second chapter, review of the literature is primarily given by investigating the related literature. Here are the main topics to create a theoretical framework: Cognitive Load Theory, Multimedia Learning and Instruction, Instructional Design Principles, E-reading, and Responsive Website Design. Afterwards, in order to create foresight, the studies in the literature are mentioned. Finally, a summary of the chapter is given at the end.

2.2. Synthesis of the Literature

2.2.1. Cognitive Load Theory

Cognitive Load Theory (CLT), which emerged in the 1980s, went through a major development by researchers across the globe in the 1990s, providing a framework for research into cognitive processes and instructional designs (Paas, Renkl, & Sweller, 2003). For the past 30 years, cognitive load has been investigated by researchers (Chandler & Sweller, 1991; Johnson-Laird & Wason, 1970; Sweller, 1999). During this period of time, instructional design principles have been developed in accordance with the CLT, moreover, researches have been done for the contribution to the cognitive load, furthermore, instructional strategies have been improved in order to decrease particular types of load (Chandler & Sweller, 1991; Mayer, 2001; Sweller, Van Merriënboer, & Paas, 1998). It is explained by CLT how learning outcomes can be designed by considering the powerful and constraining sides of the human cognitive architecture (Paas et al., 2003). The assumptions, limited capacity of working memory (Miller, 1956), knowledge mental representations - schema (Chi,

Glaser & Rees, 1982; Larkin, McDermott, Simon, & Simon, 1980), and unlimited processing capacity of long-term memory are regarded as the human cognitive architecture and they create a basis for CLT. The fact that human memory is central to human cognition and that memory systems are located in the center of the cognitive systems is obvious (Norman, 1980).

CLT (Paas, Renkl, & Sweller, 2003; Sweller, 1988) is primarily concerned with learners who are often suffocated by the number of information elements and their interactions processed simultaneously which is called the learning of complex cognitive tasks (as cited in Paas, Renkl, & Sweller, 2004). CLT is also concerned with techniques for managing working memory load and it discriminates between three types of cognitive loads which are intrinsic, extraneous, and germane (Paas et al., 2004). This is called the triarchic model of cognitive load (Mayer, 2012). The structure and complexity of the material specifies intrinsic cognitive load (the intension of the cognitive processing of a learner is to the comprehension of materials). The working memory requirements of the instructional activities and the format where information is presented identifies extraneous cognitive load (no intention of the cognitive processing of a learner to learning an objective). Learners' efforts spent for processing and figuring out the material, compose germane cognitive load (deep cognitive processing of the learner is occurred for organizing the material and creating a relationship with prior information) (Gerjets & Scheiter, 2003; Renkl & Atkinson, 2003).

Cognitive load consists of three aspects which are mental load, mental effort and performance (Paas & van Marrienboer, 1994). They believe that mental effort provides more important information about cognitive load rather than mental load and performance measures. According to them, when instructional manipulations are made, it can change the mental load only if people really spend mental effort. On the other hand, cognitive load can be measured by three main different techniques which are rating scale, psychophysiological, and secondary task techniques in the researches.

Most of the studies (Kalyuga, Chandler, & Sweller, 2000; Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Mayer & Chandler, 2001) utilized the rating scale technique (9-point or 7-point scale).

When different studies in the literature are examined, we can see a study was conducted by Kılıç (2009) to investigate the effects of principles aiming to reduce extraneous cognitive load in learning from goal-based scenario designed multimedia learning environment for learners having different capacities of their working memory. Two separate studies were conducted with 82 ninth grade students having very close working memory capacities and 54 eleventh grade students having different working memory capacities. The results of both studies presented that the cognitive load principles can be benefited from to reduce the extraneous cognitive load.

The purpose of the study conducted by Takir (2011) with 7th grade students was to investigate the effect of an instruction, designed by the Cognitive Load Theory (CLT) principles on achievement in Algebra topics and cognitive load. According to the results, there is a significant difference between all tests, which were in favor of experimental groups. That is to say, the instruction designed by CLT principles is effective for teaching Algebra considering the learners' cognitive load.

In a study conducted by Çevik (2012) by 35 university students, it was examined how manipulations in instructional strategies in online learning environments, and the working memory capacities of individuals affect the performance of complex cognitive tasks. According to the study results, complex task performance does not vary according to different instructional strategies, but there is a significant difference between individuals according to the working memory capacity. Moreover, as the complexity of the environment increases, mental effort and task load perceptions increase, while the mental load increases as the task load increases.

Another study was conducted by Aydın (2017) in order to investigate the effects of seductive details and topic interests on learning and cognitive load in hypertext environments. In this study, data were collected from 109 undergraduate students via a topic interest survey and a cognitive load questionnaire. The results of this study showed that higher topic interest led to better transfer performance, however, learning measures and the cognitive load were not affected by the hypertext structure. Actually, none of the independent variables had any effect on the cognitive load according to the results of this study.

It has long been thought that cognitive load is important for multimedia instruction among researchers (Clark, 1999; Sweller, 1999). In other words, while instructional designers design learning environments, the Cognitive Load Theory (CLT) started to become a key point of the process (Sweller et al., 1998). It is necessary to understand the concept of overloaded cognitive load and to eliminate this problem in order to make efficient use of multimedia environments, which are widely used in teaching-learning processes (Kılıç Çakmak, 2007). How teaching and instruction can provide effective learning is pointed out by CLT (Moreno, 2006). In this case, an understanding of the architecture and limitations of working memory should be considered. Also, information structures, human cognition knowledge and their interactions are used by the Cognitive Load Theory (CLT) for determining instructional design (Van Merriënboer & Sweller, 2005).

2.2.2. Multimedia Learning and Instruction

Multimedia technologies are widely used in learning-teaching processes (Kılıç Çakmak, 2007). Multimedia consists of the combination of pictures, videos, sounds, animations and simulations (Rogers, 2002). Mayer and Moreno (2003) defined multimedia learning and multimedia instruction. According to them, learning from words and pictures can be called as multimedia learning. On the other hand, presenting these words and pictures to foster meaningful learning can be named as multimedia

instruction. Mayer (2012) stated that an on-line multimedia encyclopedia, a “live” presentation, a video on a TV, a PowerPoint presentation, a “chalk and talk” presentation (can include an overhead projector), and a textbook can be defined as forms of multimedia instruction by different people. Delivery media like computer screens, presentation modes such as words and pictures, and auditory and visual sensory modalities create the basis of multimedia messages. In the human cognitive system, the sensory-modalities can be used to explain early processing and presentation-modes can be used to explain later processing (Mayer, 2012).

In order to provide effective learning, it is necessary that the instruction must be designed by regarding strong instructional design principles and multimedia design from cognitive psychology (Rogers, 2002). According to Mayer (2012), multimedia instructional messages should be based on learner-centered approaches because it focuses on the human cognitive system. On the other hand, Information Process Theory (IPT) clarifies people’s natural way of learning (Gagne, Briggs, & Wager, 1992). Multimedia and IPT are similar to each other in terms of their structures being based on logic of dual coding, and this situation provides the success of multimedia learning (Rogers, 2002). As the results of conducted studies, evidence-based principles for effective multimedia instruction were built (Mayer & Moreno, 2003).

With the widespread use of multimedia, some problems have started to come up. Dealing with multiple representations (visual, text, sound etc.) may be difficult for learners in terms of creating a relationship between them (Van Someren, Reiman, Boshuizen, & de Jong, 1998). Thus, one of the main problems is the cognitive problems like cognitive overload (Kılıç Çakmak, 2007). The cognitive load challenge is explained like this: Although the learner has a limited capacity for cognitive processing, remarkable amount of cognitive processing is needed for meaningful learning (Mayer & Moreno, 2003). In other words, the biggest challenge encountered in multimedia instruction is cognitive overload where intended cognitive processing from learners do not match their cognitive capacity (Mayer & Moreno, 2003). CLT

argues that when the learning environments exceed the maximum cognitive capacity of the learner, lack of learning happens because of the overload (Moreno, 2010). In such environments, students with excessive cognitive load will have to undergo their performance and spend more time and effort to reach the information they want (McDonald & Stevenson, 1996). It has been proved by research that excessive cognitive overload will prevent success (Mayer, Moreno, Boire, & Vagge, 1999). Cognitive overload can lead to consequences such as affecting, decreasing and preventing cognitive activity and mental resources of students (Kılıç Çakmak, 2007). Therefore, the important thing in multimedia learning is designing instructional messages by considering how the human mind works (Mayer, 2012). In information processing cases, people are assumed to have limited working memory and unlimited long-term memory (Miller, 1956). As a result of the development of mental structures stored in the long-term memory, the load in the working memory decreases. Therefore, the goal of learning-teaching processes should be to help students develop their mental structures (Anglin, Vaez, & Cunningham, 2004).

The aims of instructional strategies are to reduce extraneous cognitive load and to optimize germane cognitive load for learners (Sweller, 1999). In other words, when different instructional strategies are used, different amounts of cognitive load can be caused in the same instructional material due to diverging amounts of extraneous and germane loads (Brunken, L. Plass, & Leutner, 2003). That is to say, at any time of the learning, the learners should be prevented from being overloaded by providing the appropriate amount of cognitive processing via designed lessons considering learners' processing capacity (Mayer, 2001, 2005; Mayer & Moreno, 2003; Sweller, 1999, 2005). Different types of cognitive loads can be caused by different manipulations of the instructional design (DeLeeuw & Mayer, 2008; Mayer, 2001; Sweller, 1999).

Instructional design of the learning material can manipulate both extraneous and germane cognitive load but the intrinsic load of it cannot be manipulated. However, whether different cognitive load measures meet the same goal or not, and how to

measure cognitive loads during learning are not in consensus among researchers (Brunken, L. Plass, & Leutner, 2003; Paas, Tuovinen, Tabbers, & van Gerven, 2003).

It is argued that the cognitive theory of multimedia learning forms basis for three assumptions which are dual channels, limited capacity, and active processing (Mayer, 2012). Namely, two separate systems which are verbal and non-verbal (imagery) systems, are involved in cognition according to the Dual Coding Theory (DCT) (Paivio, 1990). According to the separate stream hypothesis of Penney (1989), auditory and visual processors in the working memory separately processes the auditory and visually represented information. In accordance with the dual channel assumption, working memory is divided into two channels as the visual channel of working memory, and the auditory channel of working memory (Baddeley, 1992; Mayer, 2012; Penney, 1989). On the other hand, limited capacity assumption means that working memory has finite capability to hold on a limited number of information (verbal or auditory) at a time (Baddeley, 1992; Mayer, 2012). The working memory capacity is limited to only seven items (Miller, 1956). Baddeley (1992) characterizes working memory as a structure to recall varied presented information like words, pictures, spatial locations etc. and manage these data simultaneously. All said "working memory" is used instead of short-term memory. Since short term memory is the older concept, the concept of working memory is used nowadays (as cited in Baddeley, 1992). According to the knowledge-construction view, learners are an active sense-maker who makes sense of the presented material and joins them into logical mental schemata (Mayer, 2012). Here, active processing includes five steps of multimedia learning (1- choosing relevant words, 2- choosing relevant images, 3- arranging the selected words, 4- arranging selected images, and 5- associating prior knowledge and the visual and verbal representations).

Long story short, effective instructional design of learning materials is necessary to eliminate cognitive overload problems in order to make efficient use of multimedia environments which are broadly used in learning-instruction processes. For this

purpose, multimedia learning can be supported by efficient instructional design of multimedia environments.

2.2.3. Instructional Design Principles

Understanding and operating information in various presentation modes are included in technology instructional medium, thus, multimedia learning examines and uses CLT implications. Mayer (2001) introduced the generative theory of multimedia learning that is based on CLT for the cognitive processes in multimedia learning (Brunken et al., 2003). In the generative theory of multimedia learning of Mayer, two assumptions which are the dual-coding assumption referring to the presentation mode of the information and the dual-channel assumption referring to the sensory modality of information perception are joined by building associative connections between them (Mayer, 2001). According to Mayer (2012), the presentation mode (e.g., words and pictures) and the sensory modalities (e.g., auditory and visual) can build basis for multimedia messages which can be based on a technology-centered approach or on a learner-centered approach. To process information in the full capacity of cognition is the advantage of presenting material in words and pictures. According to qualitative rationale which is supported by Mayer (2012), words and pictures feed each other to create meaningful pictorial and verbal representations on learners' mental comprehending.

An instructional method can be defined as a way of presenting a lesson where the medium and the content of the lesson does not change according to a selected method (Mayer, 2001; 2009; 2012). In other words, while instructional media does not influence learning, instructional methods affect learning in the same way regardless of the medium type (Clark, 1994). Mayer (2012) explains the twelve instructional methods for supporting multimedia learning in his book. These instructional methods can be listed as: coherence, signaling, redundancy, spatial contiguity, temporal contiguity, segmenting, pre-training, modality, multimedia, personalization, voice,

and image. These twelve principles of multimedia instructional design are organized for decreasing extraneous processing, controlling essential processing, and encouraging generative processing (Mayer, 2012).

Explanations of the instructional methods are given in the followings:

- Coherence: It is about whether the extraneous material is included or not in multimedia instruction. It is related to a seductive details hypothesis where inconvenient prior information as the organizing schema for the lesson is activated (Mayer, Heiser, & Lonn, 2001).
- Signaling: It is about whether essential materials are highlighted or not during multimedia instruction. The seductive details effect can be reduced by using signaling like preview sentences and numbers (Harp & Mayer, 1998).
- Redundancy: It is about using 'animation and narration' combination or 'animation, narration, and on-screen text' combination in multimedia instruction. For example, adding on-screen text can cause learners' visual channels to be affected negatively because of using 2 sources, images/animations and texts. This is related with the dual-channel theory of multimedia learning (Mayer et al., 2001).
- Spatial contiguity: It is about related graphics and printed text are localized near each other or far from each other on the page or screen. Learners can learn better when visual materials placed near to verbal materials. This is called spatial-contiguity effect (Moreno & Mayer, 1999).
- Temporal contiguity: It is about whether related graphics and spoken text are offered simultaneously or not. Learners can learn better when visual and spoken materials are presented temporally synchronized. This is called the temporal-contiguity effect (Moreno & Mayer, 1999).
- Segmenting: It is about creating a multimedia lesson with learner-paced segments or with a continuous presentation. Learners can learn better when the

material is presented in segments under learner control (Mayer & Chandler, 2001).

- Pre-training: It is about whether providing pre-training in the names and characteristics of key components to learners or not. Learners can learn better when they know the main concepts' characteristics and their names (Mayer, 2012).
- Modality: It is about using 'graphics and narration' or 'graphics and printed text' in multimedia instruction. People can learn more deeply when verbal input is offered auditorily instead of visually. This is called the modality effect (Moreno & Mayer, 1999).
- Multimedia: It is about designing a lesson with 'words and pictures' or 'words alone'. Learners can learn better from a multimedia message when a multimedia explanation is offered in words and pictures rather than in words alone. This is called the multimedia effect (Mayer, 2003).
- Personalization: It is about using the words either in conversational style or in formal style during a multimedia lesson. Learners can learn more deeply when words (both spoken or printed) are presented in a conversational style instead of a formal style. This is called the personalization effect (Mayer, 2003).
- Voice: It is about using the words are spoken by a human voice or a machine voice during a multimedia lesson. Interest of learners and transfer performance results of learners in learning are better when a human voice is used rather than a machine voice (Atkinson, Mayer, & Merrill, 2005).
- Image: It is about whether the speaker's image is on the screen in a multimedia lesson or not. Adding speaker's image on the screen does not necessarily provide deep learning from a multimedia message for learners (Mayer, 2012).

2.2.4. E-reading

Nowadays, e-reading is used for reading skills on screen in which there are text, sound, pictures, and videos. The e-reading process, also called reading on screen, is not only

limited to understanding the alphabet or analyzing pictures and graphics, but also includes making sense of what is being heard and being watched (Maden, 2012). The term e-reading is used in the literature with different designations. While some researchers called it as digital reading, some of them called it as screen reading. Actually, all similar words refer to express the same meaning. Digital reading is the act of reading data and / or information through digital means. The action being performed on a screen is the most distinctive feature that distinguishes digital reading from traditional reading (Odabaş, Odabaş, & Sevmez, 2018).

Information technology has an effect on reading as it affects many cases. With the help of digital technologies, reading activities started to be made through screens and everything about reading started to differentiate. Digital reading continues to spread throughout all segments of society (Odabaş, Odabaş, & Sevmez, 2018). With the usage of computers and the Internet, reading behavior of people has dramatically changed and a new reading pattern which includes browsing and scanning has aroused in today's intense digital information era (Liu, 2012). The widespread use of technologies that provide reading on a screen has a great effect on the changing of usual behavioral patterns in the process of acquiring, sharing and using information (Odabaş, Odabaş, & Sevmez, 2018). In this process, digital contents confuse individuals' minds although it provides new text formats, creates new goals for reading and presents new ways of interacting with these texts for individuals who make sense of printed texts (Coiro, 2003).

News, information and visual sharing of people on social media, newspaper writers' publications, instant, travel blogs which is fast and intense digital content increase the diversity and volume of reading. This period, where everyone has influenced reading processes and is also influenced by these processes, brings along new behavioral patterns that are not experienced by previous generations. (H. Odabaş, Z. Odabaş, & Sevmez, 2018). Since today's information-intensive environments are expanding and

people spending time on reading electronic media is increasing, people's reading behavior is being affected by this environment (Liu, 2012).

Reading on mobile reading devices such as e-readers, tablets and smart phones whose number is increasing day by day, are being popular now (Tveit & Mangen, 2014). Smartphones, tablets and electronic book readers lead especially young people living with technology to reading from screens. As a means of providing information, digital technologies which have screens, have led to the emergence of digital reading as a phenomenon unique to this period. (H. Odabaş, Z. Odabaş, & Sevmez, 2018). Various interfaces are presented by technical devices for reading like computers, e-books, and smart phones (Mangen & Schilhab, 2012). With the changing of the reading action via digital media, new reading environments have some advantages like interactivity, providing hypertext media, combination of text, images, audio or video (Liu, 2012). On the other hand, e-reading has some disadvantages. For example, moving pages makes it difficult to figure out the structure of the text and for the eye to stay in focus. It is also more difficult to combine and understand the information in the sections that are seen on the screen and in the sections that are not visible (Güneş, 2010).

The act of reading is complex, and the goal of much research is to determine what parts of the brain are involved and how it works when we are reading (Wolf, 2007). The brain must create a relationship between circuits designed with former visual, auditory, linguistic, and cognitive operations in order to read (Wolf et al., 2009). It is emphasized that the connections among brain systems are important for reading which is a cognitive function (Geschwind, 1974). Phonological processing including memory and phonological awareness is related to cognitive processes required in reading. The relationship between working memory and reading is very meaningful (Ferreira, Valentin, & Ciasca, 2013). Problems with reading comprehension involves the low storage capacity of information in the working memory (Van der Leij & Morfidi, 2006). According to Wolf (2007), humankind got rid of the limitations of the human memory by learning to read. It is characterized how to ensure legibility and

how to present text in order to support fluent reading (Lonsdale, Dyson, & Reynolds, 2006). Fluency contains insight of what will come next in the text and this is especially important for comprehension (Hook & Jones, 2004). In this point, reading comprehension in electronic media is considered to be similar with reading comprehension in printed media because of the lack of sufficient research in this area. However, reading comprehension in electronic media differs from printed texts (Esmer & Ulusoy, 2015). Education technology experts are commonly researching about the effects of screen reading on 'reading comprehension' and 'other motivational factors that affect reading' subjects (Başaran, 2014). Vertical scrolling text affects the reader's eye movements, reducing the speed of reading and decreasing the level of understanding of text on the screen (Güneş, 2010). Actually, reading from the screen does not directly affect comprehension, but can affect the variables that directly affect comprehension. For example, reading from the screen makes the mind more exhausted and so reduces reading speed. Because only a part of the text pages appears on the screen, this may prevent the reader from watching the title, subtitle, and side head relationship in the text; it can make it difficult to catch the main idea of the text (Başaran, 2014).

One of the studies in the literature investigated the impact of technology on reading comprehension. This study was conducted by Margolin, Driscoll, Toland and Kegler from State University of New York in 2013. In this study, 90 individuals took place in three different groups (E-readers, Computer Screens, or Paper). In the scope of the study, 10 reading passages (two types of texts: five expository texts and five narrative texts) were read by the participants and 56 questions were answered accordingly. According to the study results, there is a significant difference between narrative and expository texts in terms of reading comprehension (expository passages had higher comprehension mean scores than narrative passages). However, the results showed that media presentations (e-readers, computer screens, or paper) and the interaction of the two variables had no main effect on reading comprehension (Margolin, Driscoll, Toland, & Kegler, 2013).

Another study was conducted in the literature that was reviewed to examine the effect of medium (tablet vs. paper) on reading performance. This study was conducted by Dundar and Akcayır in 2011. The study consisted of 20 5th grade students, and their reading comprehension and reading speed were compared by the quasi-experimental study. Three reading passages and ten comprehension questions were used. According to the study results, reading comprehension and reading speed did not differ according to the type of medium (tablet vs. paper). Moreover, a question about the preference of using tablets for reading was directed to the participants with conducted interviews. According to the interview results, since books are difficult to carry, participants preferred tablet PCs for reading.

2.2.5. Screen Size

As mobile devices have some constraints in terms of hardware and software, screen size can be thought as a problem for using hand held devices for learning (Maniar, Bennett, Hand, & Allan, 2008). Chen et al. (2003) stated that there may be two factors which are visual perception and attention span that influence the relationship of screen size to learning. Visual perception is affected by the ability to see small details on the small screen. This is also a situation that affects the span of attention. While the user is trying to make sense of all the visual information in his mind, he can try to see more details by zooming the screen. The ability to do this is related to the attention span.

One study conducted by Knoche, McCarthy, and Sasse (2006) demonstrated that experience quality of the viewer is affected by screen size. For the effective learning, screen size is critical (Papanikolaou & Mavromoustakos, 2006). Some experimental studies have shown that screen size may affect the general usability of a mobile device (Jones, Marsden, Mohd-Nasir, Boone, & Buchanan, K., 1999; Sweeney & Crestani, 2006).

Another study conducted by Kılınç at 2016 investigated that the differences between mobile and web interface of ODTUCLASS which is a learning management system in terms of the perceived aesthetics. According to the study results, students expressed that the web interface better and simpler than the mobile interface. Also, the students stated that aesthetics of a learning material can provide contribution to their learning, or motivate them. This conducted study also demonstrated although both of interfaces have the responsive design, same color and content, participants perceived them differently in terms of aesthetics. This difference led us to the idea that the size of the screen is due to the difference. However, there is no study that investigated the interaction effect of screen size and RWD on e-reading comprehension, cognitive load and preference of reading on tablets. The aim of this study is to investigate whether screen size has an effect on reading comprehension, cognitive load and preference of reading on tablets. Also, the interaction effect of screen size and RWD was examined in the scope of this study.

2.2.6. Responsive Website Design

Responsive design can be basically thought like this: a website working effectively on every size of screen like desktop computers, notebooks, tablets, or mobile phones (Natda, 2013). When today's fast and useful technologies are considered, people expect that different device types and platforms can use the same services with the same comfort and speed on the web without any obstacle like screen size (Kim, 2013). During the last couple of years, small screen devices like mobile phones or tablets have become more widespread for web access. Especially, tablets become more popular because of their mode of web access which has the advantages of both “mobiles” and “desktops” (Marcotte, 2011). In the latest years, handheld devices including smart phones, tablets, and e-readers have become widely used and each of them has their own screen resolutions, orientations, and layouts. If it continues to go on like that, online web content should provide ideal viewing for each screen size to support easy reading and easy usage with a minimum need of resizing and scrolling

(Natda, 2013). RWD is a solution of the problem that displays of websites change according to size of the device and so this new topic has drawn a lot of attention (Turan & Şahin, 2017a). Creating a web site that appears evenly well regardless of the screen size of a device is the aim of RWD. However, building web designs providing suitable pixels for screen sizes has become a problematical issue due to the number of mobile devices that have a diversity of screen sizes. (Kim, 2013).

Marcotte (2011) provides three core ingredients for creating a responsive design:

1. A flexible, grid-based layout,
2. Flexible images and media, and
3. Media queries

For the fluid grid layout, percentages are preferred instead of pixels. In order to prevent corruption of the design because of wide ranges of browsers, fluid grids are very important for creating a responsive design (Natda, 2013). Second ingredient includes using flexible responsive images with relative measurements instead of fixed dimensions (Marcotte, 2011). A media query is one of the fundamental techniques in which a media type is included and media features like width, height, orientation, resolution etc. to limit the style sheets are used (Natda, 2013). In order to build a real responsive design, the process should begin with a flexible layout and with media queries basing on a non-fixed foundation (Marcotte, 2011). Here, HTML, CSS & JavaScript are the three basic technologies used for responsive design (Natda, 2013). Especially, using CSS3 is very suitable for RWD in terms of providing aesthetically based features (Frain, 2015). With the help of these three core ingredients (flexible and grid-based layout, flexible images and media, & media queries) and three basic technologies (HTML, CSS & JavaScript), RWD supplies equal and stable user experiences for various usage behavior of different devices and platforms (Turan & Şahin, 2017b).

Moreover, there are two basic components which are 'the website itself which includes the contents' and 'the contents which are inserted into this website'. Here, the resolution

and dimensions of the screen of a used device is considered when building the dimensions of the website by related software. Also, the dynamic content of the website is taken into account for providing a similar appearance of the website to provide similar user experiences (Turan & Şahin, 2017b). However, at the small viewport width, the texts and visuals are adjusted in size, they become smaller. Therefore, since the reading content are stacked in a narrow area, requiring the user to scroll down the page to see following texts. At larger page widths, there is enough space to show all reading texts on screen. Thus it can be summarized as follows: Helping with RWD, a website can be optimally arrange according to the screen size of device.

On the other hand, two approaches, which are 'mobile first' and 'desktop first' methodologies for implementation of RWD can be used. In the former approach, a layout is appropriate for smaller screens and then increases according to the resolution of the device. In the latter methodology, desktop resolution is taken as a starting point and then the design resolution decreases in accordance with the size of the device (Mohorovicic, 2013).

RWD has been developed as an approach to solve hardware and software compatibility problems. Since it is maintainable and easy to use, this approach is used both by individuals and companies (Turan & Şahin, 2017b). There is a number of advantages of RWD for webmasters, developers and end users (Mohorovicic, 2013). One of them is that there is no need to sustain and update more than one group of content. Another one is that, since websites automatically adjusts their layout to be mobile-friendly, people do not have to use mobile websites separately developed for specific sites. Moreover, all offerings like download links, commenting areas, hypertexts, videos, pictures etc. provided by websites can be used effectively without experiencing any difficulty. That is, since people do not need to zoom or orientate the screen to scale the width, a responsive website provides easy use for people when compared to non-responsive ones (Kim, 2013). Besides, since the RWD provides easy

readability on hand held devices like smart phones or tablets, it increases the preference of a website (Syawal & Rahim, 2014). However, according to Kim (2013), when considered from a negative side, responsive websites are likely to take much more time to load than a simplified separate mobile website, since the receiving and processing request time for a mobile web is longer than a desktop web, loading a website on a mobile device is slower.

Briefly, differences between RWD and non-RWD can be said like that in RWD flexible content (texts and images) resizes proportionally by moving and scaling their flexible container according to screen size, by creating multiple versions of content for different resolution and by cropping images if necessary. In non-RWD, the user sees the same content on the large and small screen as it is, so it cannot provide a readable and usable screen especially for smaller screen.

A study conducted by Syawal and Rahim in 2014 investigated whether user cognitive load on mobile websites can be reduced by responsive design. In this study, they looked at the readability of RWD in the scope of the usability variable. The survey results showed that 93% of the participants found that the readability of website text is easy. Also, 93% of them identified the major heading clearly and thought that the visuals stay consistent throughout the website. According to the results of this study, whenever the user response towards the website interface, which is a responsive website, is understandable, the website design can provide benefit for the users (Syawal & Rahim, 2014).

Various researches propose that control operations of eye movements have an important role in sustaining spatial information in working memory. It is shown that in most studies, that task-unrelated eye movements handicap on spatial working memory. Fixation as an eye movement is useful for maintaining spatial working memory (Oi et al., 2015). On the other hand, RWD reduces the cognitive load by preventing unnecessary extra effort for viewing the website on mobile devices

(Syawal & Rahim, 2014). There is a need for investigating this issue in terms of the fixation provided by RWD (including core elements: 1- a flexible, grid-based layout, 2- flexible images and media, and 3- media queries) which reduces task-irrelevant eye movement and cognitive load. This approach can be used as a new instructional multimedia design principle for the e-reading process which is one type of the multimedia learning environments based on the Cognitive Load Theory.

2.2.7. Summary

In Chapter Two, review of literature and studies in the literature were presented. Chapter Three presents the methodology used in the study, including a description and rationale of the sample, the data collection procedures, a description of instrument development, and the methods of analysis of the data. Chapter Four is a presentation of study results with visuals of analysis outputs and explanations of them. Chapter Five includes discussions and suggestions for those interested.

CHAPTER 3

METHODOLOGY

3.1. Introduction

In this Chapter, the research design of the study is primarily explained by specifying the related information. After that, participants of the study are introduced. Then, in order to be clearer about the experiment, data collection instruments (Reading Span Test (RST), Cognitive Load Measurements, Preference of Reading on Tablets Measurement, and Comprehension Tests) of the study have been clarified under separate subheadings one by one. Here, the usage of the scale that was mentioned in the literature previously was utilized, and the structure and content of the scales were explained accordingly. Afterwards, the implementation process has been explained step by step. This part is divided into two sub-sections as pre-treatment and actual implementation and, thus, the steps are shown more clearly. Visualization of the experiment process has also been presented. Moreover, the reading passages used in the study and the software developed within the scope of the research are briefly explained. Finally, a data analysis of the study has been clarified and a summary of the chapter is given at the end.

3.2. Research Design

In this research, matched between-participants after-only true experimental design was conducted. Population of the study was limited to participants who are the second, third and fourth year students of Informatics Systems Engineering, Computer Engineering and Software Engineering Departments at Atılım University. Based on voluntary participations basis, participants were randomly selected from this population. Then, the participants were randomly assigned into two equivalent groups.

The assurance of equality between the groups was provided by assigning participants to the groups randomly. Enough number of participants (over thirty participants for each group) were included for randomization, so that extraneous variables could be controlled. To avoid any doubt for equivalence between the groups and to provide more sensibility for experiments, each participant was matched with another participant according to input variables prior to the random assignment. The input variables for used matching are gender and working memory. In the actual implementation process, different website designs (responsive and non-responsive) were used as independent variables. Also, different screen sizes (small and large) were used other independent variables. The experimental group experienced reading on tablets, supplying responsive website design (RWD) environment, while the control group participated in the non-RWD environment, reading for approximately half an hour. The dependent variables are reading comprehension competences and cognitive load situations of the students. Besides, during the actual experiment, students' preference of reading on tablets is measured as another variable. An application developed for this study was used for reading on tablet sessions. Figure 3.1 shows the steps of the research design process.

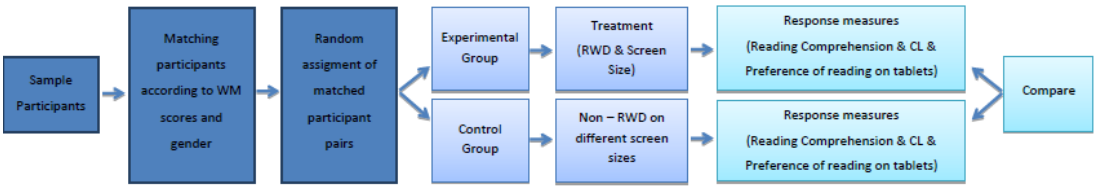

Figure 3.1. Visualization of the research design process

3.3. Participants

Since sample size is very important for reliability, a relatively large sample size was used in this study. Another thing that should be considered is to select a sampling type. Convenience sampling is a terminology used for nonprobability or nonrandom sampling in which members have been selected from the target population that meet

the purpose of the study with some criteria like accessibility to the researcher, presence at a given time, geographical closeness or the willingness to join (Dörnyei, 2007; Ross, 1978). In this study, convenience sampling was used because the targeted group is chosen from the convenience University which is easy to access in terms of official permit conditions and the willingness of students to participate in studies. Participants were invited to this study by their course instructor. Additional credit was given to the participants by the instructor for their participations.

The sample consisted of 74 university students from Atılım University. 47 of the participants were male and 28 were female. In fact, although a total of 75 people could be reached, one participant was excluded from the sample during the pre-treatment by learning that he has dyslexia. A 37-person (males 23, females 14) experiment and 37-person (males 23, females 14) control groups were formed. Students were included in the study based on their voluntary participation and they were signed a consent form (see Appendix E) at the beginning of the treatment. Students with similar past experiences (Information systems engineering, computer engineering, software engineering etc.) joined the study.

3.4. Data Collection Instruments

In the scope of this study, quantitative data collection was used in order to measure the quantity of data and to generalize results from a selected sample to population. As data collection instruments, reading span test (RST), cognitive load measurement, preference of reading on tablets measurement and comprehension tests (for three different reading passages) were used during the study. While some of the data collection instruments (comprehension tests for three different reading passages) were developed by researchers in the scope of the study, some of them were already available in the literature.

Ethics committee approvals were obtained for the conduct of the research and the ethics committee approval notification is presented in Appendix G. Information Details about data collection instruments are explained respectively below.

3.4.1. Reading Span Test (RST)

Reading Span Test (RST) is used for measuring working memory. The capability to keep and operate information in the mind for a short time can be defined as working memory. It is a flexible mental workspace and requires attention. It is also an extremely fragile system and its capacity is limited but this differs from person to person (Gathercole & Alloway, 2004). Its interaction with other cognitive capacities is important (Rouder, Morey, Morey, & Cowan, 2011). One of the tests for investigating central executive in adults is RST (Gathercole, Pickering, Ambridge, & Wearing, 2004). Therefore, RST was used to measure executive and complex working memory of participants to be able to create homogenous groups by correct matchings according to their RST scores. The Turkish version of Reading Span Test which was created by Ünal (2008) was used in this study.

This test was applied in a computer environment. It consisted of 5 main sentence sets between 2 and 6 sizes. Each sentence set had also 6 patterns of sentences. To explain the process briefly, participants were supposed to read these sentences aloud and then say “Yes” or “No” by judging the truthfulness of them. They were also expected to remember underlined and red color words located in each sentence at the end of each set of sentences. To be more understandable, a “2 sentence set” for the Turkish Reading Span Test is given below as an example. (see Appendix A for the whole stimuli list):

1. Bir insanda 46 çift kromozom bulunur.
2. Türk Hukuk Kurumu THK ile kısaltılır.

The evaluation of the results can be done in two ways. One of them is that the participants correctly complete the largest set size which can be taken as a score. On the other hand, the total number of the target words correctly remembered by a participant which can be taken as a score (Daneman & Carpenter, 1980). The first scoring method was used in this study.

3.4.2. Cognitive Load Measurement

A 9-point Likert scale was used for measuring cognitive load in this study. This instrument is based on the self-reporting technique where participants evaluate their cognitive load by them according to how they perceive. It is suggested and recommended by (Paas, 1992), and it is assumed that people can examine their own thoughts and feelings in terms of their cognitive processes and notify the rate of mental effort spent. This self-rating scale is an empirical method used for estimating the mental performance. The empirical methods are used widely to measure mental effort studies in literature (F. Paas, Tuovinen, Tabbers, & van Gerven, 2003). Why cognitive load is measured by the rating scale is examined by Paas et al. (2003) and the reason is explained like this: this measurement types are inexpensive, useful, sensitive, reliable and valid (in terms of convergent, discriminate and construct). Moreover, Kirschner, Ayres and Paul (2011) pointed out that the subjective rating scale measures cognitive load as one concept instead of distinguishing cognitive load components (intrinsic, extraneous, germane). The total cognitive load (intrinsic, extraneous, and germane load) is measured as one concept in this study because in the studies, the measurement techniques which can distinguish precisely between cognitive load components do not exist in literature (different aspects of cognitive load can be measured by different measurement instruments). In order to see the measurement used in this study, look at Appendix B.

3.4.3. Preference of Reading on Tablets Scale

In this study, a 5-point Likert scale was used for measuring preferences of participants about reading on tablets. This measurement is developed by the researchers. For this process, firstly, the Tablet PC Acceptance Scale (Güngören, Bektaş, Öztürk, & Horzum, 2014) in the literature was reviewed. Then, the items that were appropriate for this study were added to the pool of substances directly or by editing. The item pool created by the researcher included 8 items. This 5-point Likert scale (ranging from “strongly disagree” to “strongly agree”) is used to rate for all these items (see Appendix C).

3.4.4. Comprehension Tests

Comprehension tests were prepared by the researchers according to reading passages. Questions of comprehension tests are conducted according to related passages and there are four questions for each reading passage. Actually, at the beginning, six reading passages were chosen and 24 multiple choice questions where four options for each were prepared. Then expert opinion was received for these reading passages and questions. The person whose opinion was received by is a Turkish/literature teacher in a state high school. During the experimental process, three of the six readings were selected, considering the expert's advice about them. Also, the questions were revised according to his opinions and suggestions. As a result, we ended up with twelve multiple choice questions in total to measure the reading comprehension of participants (see Appendix D). The final version of the questions and chosen readings were embedded into a reading software tool.

3.5. Implementation Process

This study is a true experimental process. Two groups were established in order to realize the experimental process and some steps of this process were followed while these two groups were formed. Firstly, some input variables (working memory and

gender) were used for classifying participants and these variables were measured by conducting a pre-treatment. The details of one-to-one measurements made with the invited participants were explained under the pre-treatment procedure title. Secondly, according to the measurement results of these input variables, student characteristics were determined, and matchings were made. The input variables for used matchings were gender and working memory. After the matchings, all participants were randomly assigned into two groups (experiment and control groups). The details of the measurement of dependent variables (reading comprehension, cognitive load and preference of reading on tablets) according to independent variables (RWD/non-RWD and small/large screen sizes for reading on tablets) were explained under the actual implementation procedure title.

3.5.1. Visualization of Treatment

The steps of experimental design are diagramed as follows:

O1 R X O2

O1 R O2

Pre-treatment was applied, and two groups were formed by making the matching accordingly before a random assignment. Input variables for pre-treatment; working memory and gender. This diagram can be expanded upon as in the Table 3.1.

Table 3.1. *Visualization Diagram of Treatment*

1st observation (measurement) of the dependent variables O_1 = Pre-test	**Scientific Random Assignment of Subjects to:**	**Exposure to the Treatment (X) (independent variable)**	**2nd observation (measurement) of the dependent variable O_2 = Post-test**
Participants' average score on the input variables (WM & Gender)	Experimental Group	X (RWD & Screen Size)	Experimental Group's average score on the dependent variables (Reading Comprehension, CL & Preference of reading on tablet)
	Control Group	(Non-RWD & Screen Size)	Control Group's average score on the dependent variables (Reading Comprehension, CL & Preference of reading on tablet)

a. Dependent variables = Cognitive Load & Reading Comprehension & Preference of Reading on Tablets, Independent variables = Responsive / Non-responsive Website Design & Small / Large Screen Size, Input variables = Working Memory and Gender

3.5.2. Pre-treatment Procedure

During the pre-treatment procedure, participants were taken to a room one by one for one-to-one measurements. Measurements were performed with a total of 75 participants and each participant session lasted 15 minutes on average. One of these participants was informed that he had dyslexia and for that reason his results were excluded from the study and was not included in the real practice. (However still he was awarded by the extra credit.) When the participant was taken to the room, first they were asked to write their information (name, surname, department, student number, date, signature, and phone number) on a paper on the table. Then the

participant was placed in front of a laptop screen and the instruction paper about the experiment process was told to be read. If the participant who was going to firstly participate in the reading span test application questions, they were answered, and a trial set was applied. After the trial set, the actual reading span test was applied. This test was based on presenting series of sentences one at a time and participants read each sentence aloud and then said “Yes” or “No” by judging the truthfulness of them. They also tried to remember underlined and red colored words located in each sentence at the end of each set of sentences in the presented order. According to the participant's speed of reading and answering the sentences, the on-screen sentences were displayed one by one by the researchers. In order to prevent data loss during the Reading Span Test (RST), the answers were noted on a paper by the researchers as well as a voice recorded. The test was terminated when the participant made more than 2 mistakes in a set. When the RST was completed, the voice recording was closed and recorded according to the participant's name. The participant who correctly completed the largest set size was taken as a score.

When the pre-treatment session was completed, the participants were reminded not to share detailed information about the application. The next participant who was waiting outside was taken into the room and the same procedures were repeated one by one with a total of 74 people. Steps of pre-treatment procedure are shown at Figure 3.2.

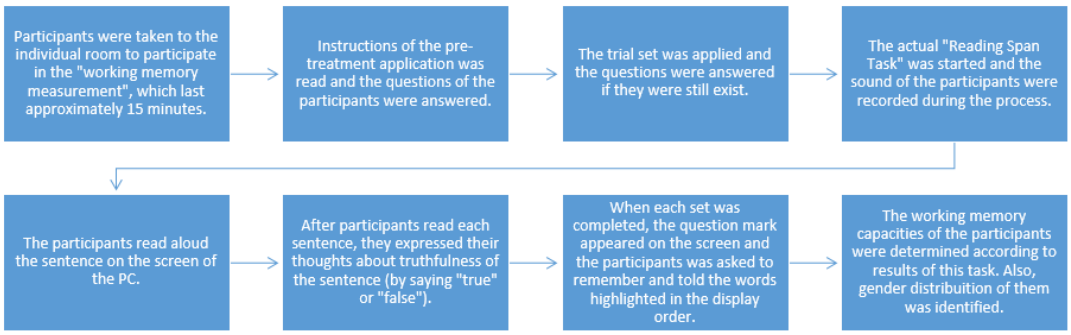

Figure 3.2. The steps of pre-treatment procedure

3.5.3. The Actual Implementation Procedure

Before the actual implementation, a pilot test was conducted with 5 people to be able to see if any mistakes about the software was overlooked. According to this pilot test, the software was optimized, and real implementation process steps reviewed. After that, the steps of the true experimental study were followed, and the matchings were performed according to the working memory and gender distribution of the participants. According to this, the actual implementation was performed with two groups formed by random assignment. Participants were taken into the room in groups of 5 or 6. In this way it was thought that it would be easier to observe and control the process. They were seated in their places and a voluntary participation form was distributed and asked to sign. Then the instruction explaining what to do during the actual implementation process was read. If any participants asked any questions they were answered. Each student was given one tablet and the students were asked to hold the tablets in a vertical position at the beginning. On the tablet screen, the participants were expected to write their name and student number and to select one of the "Group 1" or "Group 2" buttons. The correct group selection number of the students on the tablet screens was provided by the researchers according to the groups determined in the random assignment. After that, participants started reading from the tablet screen while the time was being kept by a stopwatch. During the reading, the ‘Flip Display’ command was given to the participants every 60 seconds. Throughout the experiment, the behaviors of the participants were monitored and observed by the researchers. If there is a participant who did not flip the tablet screen suitable, intervene of the researcher was occurred to flip the screen. The student who finished the reading was not allowed to stand up and talk until the other friends finished the reading. When everyone finished reading, the questionnaire including items about cognitive load and reading on tablets preference was distributed to the participants to fill it on a paper. For detailed information about the experiment, it was stated that the information form will be distributed after the actual implementation process is completed with all

participants. It was said that they can leave the room by thanking the participants. The total spent time for the actual treatment was 30 minutes in average. Approximately 20 minutes was spent by the participants for reading passages (about 7 minutes for each). Participants also spent 5-10 minutes to fill the questionnaire including self-rating cognitive load scale and preference of reading on tablets scale. All of the process of the actual implementation is shown in Figure 3.3.

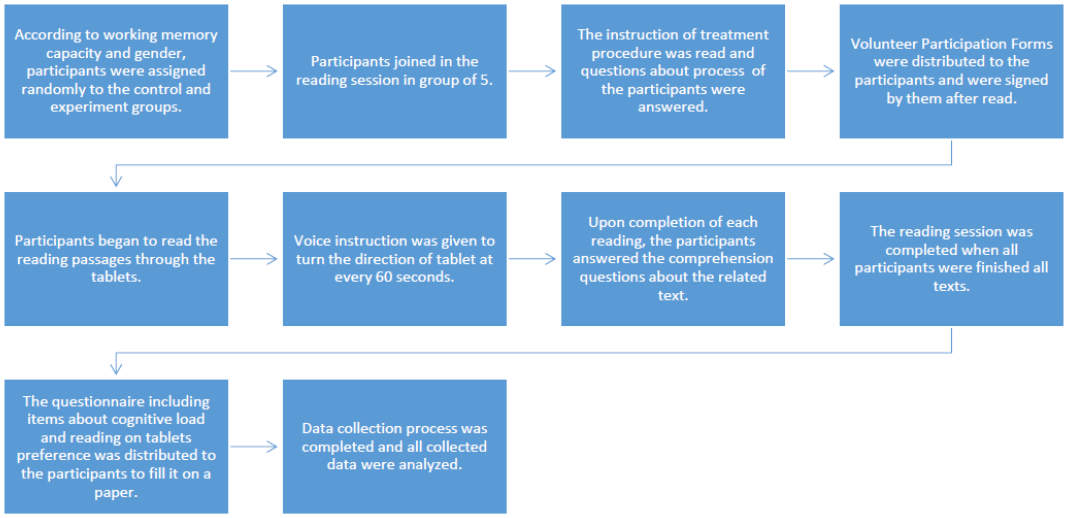

Figure 3.3. The steps of the actual implementation procedure

3.5.3.1. Reading Materials

During the actual implementation process, three different reading materials were used. These reading passages were selected from the technology pages on the internet. They were about technology and they also included some pictures. The visuals in the content explain the writing. The topics of the readings were: “Li-Fi Nedir, Yoksa Wi-Fi’ın Yerini mi Alacak?” which is 690 words long, “9 Etkileyici Fotoğraf ile Teknolojinin Evrimi” which is 440 words long, and “Dünya’nın Gerçek Şekli: Geoit” which is 406 words long. The third reading part contained more terminological expressions.

3.5.3.2. Reading Software Tool

A reading software tool was developed for this study. This tool provided two different website designs which are responsive and non-responsive. During the development of the software process, steps of the RWD approach were followed and ready block codes and a specific set of codes were used. Also, participants' answers to the questions and group information were kept in the background via this software. A breakdown of these data is provided on a screen that can only be seen by the researchers. To be clearer, the screenshots of RWD and non-RWD interfaces were given Figure 3.4 and Figure 3.5.

The participants used this tool with different screen sizes (small or large) and on both tablet position (vertical and horizontal). According to these conditions, design of the interface was changing by adjusting texts and visuals in size (smaller or bigger view of them). The difference between designs in terms of text and visual sizes can be seen from Figure 3.4. and Figure 3.5.

Figure 3.4. RWD interface

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Bölüm 1 : Li-Fi Nedir, Yoksa Wi-Fi'ın Yerini mi Alacak?

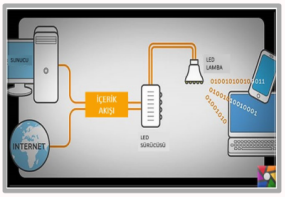
Eğer Harald Haas haklıysa, sadece birkaç yıl içinde internetimizi ampuller aracılığıyla elde edeceğiz. Haas İskoçya'daki Edinburg Üniversitesi'nde mobil iletişim profesörü. Kendisi yıllardır verinin LED ampuller aracılığıyla aktarılabileceği fikrine sahip ve şimdi ise Li-Fi sisteminin çalışan modelini yarattı. En son TED konuşmasında Haas bir mağazadan aldığı LED ampul aracılığıyla güneş pilinden dizüstü bilgisayara video aktarabilen Li-Fi prototiplerinden birini gösterdi.

'Li-Fi temel olarak Wi-Fi ile aynı, sadece küçük bir fark var; biz radyo sinyallerini kullanmak yerine veriyi kablosuz bir şekilde aktarabilmek için LED ışıkları kullanıyoruz.' diyor Haas. Geleneksel Wi-Fi veriyi cihazlara aktarmak için radyo sinyallerini kullanır. Şu an Wi-Fi dünyanın internet ileticilerinin neredeyse yarısını taşıyor. Bu yüzdenin insanlar daha çok online olmaya başladıkça ve nesnelerin interneti büyüdükçe gelecek yıllarda bu oranın artması bekleniyor. Haas dahil olmak üzere bazı uzmanlar bunun Wi-Fi ağlarının ağır talep altında yavaşlamasına sebep olacak olan spektrum çatlağına neden olacağından endişeleniyorlar.

'Radyo spektrumu yeterli değil' diyor Haas ve devam ediyor 'Çok yoğun bir şekilde kullanılıyor, çok kalabalık. Bunu havaalanlarına ve otellere; insanların mobil internete erişmek istediği ve internetin korkunç derecede yavaş olduğu yerlerde görüyoruz. Böyle olacağını 12-15 yıl önce tahmin ettim ve dedim ki veriyi kablosuz olarak transfer etmenin daha iyi yolları nelerdir?'

Veriyi görünebilir bir ışık spektrumu ile iletme fikri yeni değil. Alexander Graham Bell sesi, güneşle çalışan kablosuz bir telefona benzeyen bir cihaz olan fotofon aracılığıyla 1880 yılında güneş ışığı demeti aracılığıyla iletti. Son yıllarda da birçok araştırmacı veriyi ışık kullanarak iletmeyi denedi. Ama Haas, Li-Fi'ın anahtarının veri aktarımı için basit bir şekilde LED ampuller kullanmak olduğunu vurguladı.

Haas, ilk defa alternatif kablosuz sistemler kullanmaya başladığında LED ampuller evlerde daha çok kullanılmaya başlanmıştı ki bunda geleneksel akkor ampullere kıyasla çok daha az enerji harcamaları etkili oldu. LED ampuller ışığı hızlı bir şekilde loşlaştırabilen veya kapatıp açabilen bir sürücü tarafından kontrol edilir. Bununla birlikte Haas anladı ki veri insan gözünün algılamadığı ışığın parlaklığında ve değişiminde ince aralıklarla şifrelenebilir. Bu sebeple Haas, LED ampulünü akkor ampul ile değiştirerek deneylere başladı. Son olarak güneş paneli ve ampul ile çalışan bir iletici ve de alıcı sistemi elde etti. Araştırma İskoçya doğumlu olan Alexander Graham Bell'in anısına isim verilen Edinburg üniversitesinde tamamlandı.



Li-Fi; Wi-Fi'dan çok daha hızlı

Son deneylerde araştırmacılar Li-Fi hızında saniyede 224 gigabayta kadar ulaştı. Bu hızlarda bir insan bir saniyede 20 film uzunluğunda veriyi indirebilir. Haas'ın araştırmasına göre, Li-Fi, Wi-Fi'a oranla 1000 kat daha fazla veri yoğunluğuna ulaşabilir çünkü Li-Fi sinyalleri daha dağınık olan radyo sinyallerinin aksine küçük bir bölgede toplanmıştır.

Wi-Fi'dan daha hızlı olmanın yanında, Li-Fi Haas'ın belirttiğine göre daha güvenli. Wi-Fi sinyalleri duvarlardan geçebilirken bir evde Li-Fi sinyalleri perdeler aracılığıyla ev içinde tutulabilir. Bu sistem ışıklarınızı devamlı açık tutacağınız anlamına da gelmiyor. Haas ampullerin çok kısık ayarda bile hala veriyi aktarabileceğini belirtiyor.

Figure 3.5. Non-RWD interface

3.6. Data Analysis

In this study, there are several dependent variables which are reading-comprehension, preference of reading on tablets, and cognitive load and also two independent variables which are website design (responsive vs. non-responsive) and size of screen (small vs. large). Because of the existence of several dependent variables, multivariate analysis of variance (MANOVA) was used to analyze the data. That is, it was preferred to use one MANOVA test instead of conducting several analysis of variance tests. According to Field (2013), this decreases the chance of Type I error. MANOVA is used when we are interested in several dependent variables' circumstances (Field, 2013). MANOVA can be used when there is only one or several independent variables and interactions between independent variables which can be examined to compare them (Field, 2013). Namely, the important point in here is that there are more than one dependent variables to be examined. Moreover, Field (2013) states that MANOVA shows the relationship between dependent variables by using them in the same analysis and this analysis method has the power for detecting whether a combination of dimensions affects groups. So, in this study, whether the interaction of website design and screen size has an effect on dependent variables or not, was examined by this analysis method. In short, for all these reasons, MANOVA was preferred to use in the data analysis.

3.7. Summary

In Chapter Three, the introduction, research design, participants, data collection instruments, implementation process, data analysis and organization of the study were presented. Chapter Four is a presentation of study results with visuals of analysis outputs and explanations of them. Chapter Five includes discussions and suggestions for those interested.

CHAPTER 4

RESULTS

4.1. Descriptive Analysis

As demonstrated in Table 4.1, the sample of the study consists of 74 undergraduate students in total. These participants were divided into two groups (experimental group and control group) by random assignment. The experimental group has the responsive website design (n=37) and the control group has the non-responsive website design (n=37). According to the matchings of the participants, they used tablets with small screens (n=36) or with large screens (n=38). The descriptive table of these variables is given at Table 4.1 and Table 4.2.

Table 4.1. *Between-Subjects Factors*

		Value Label	N
Website Design	1	Responsive	37
	2	Non-responsive	37
Screen Size	1	Small screen	36
	2	Large screen	38

Table 4.2. *Descriptive Statistics*

	GroupNo	TabletSize	Mean	Std. Deviation	N
Reading Comprehension	Responsive	Small screen	8,44	2,26	18
		Large screen	7,58	2,22	19
		Total	8,00	2,25	37
	Non-responsive	Small screen	8,11	2,45	18
		Large screen	8,21	1,62	19
		Total	8,16	2,04	37
	Total	Small screen	8,28	2,33	36
		Large screen	7,90	1,94	38
		Total	8,08	2,13	74
Preference of reading on tablets	Responsive	Small screen	24,33	7,20	18
		Large screen	25,26	5,88	19
		Total	24,81	6,48	37
	Non-responsive	Small screen	19,67	5,95	18
		Large screen	23,63	6,95	19
		Total	21,70	6,70	37
	Total	Small screen	22,00	6,93	36
		Large screen	24,45	6,40	38
		Total	23,26	6,73	74
Cognitive Load	Responsive	Small screen	4,94	1,31	18
		Large screen	5,53	1,22	19
		Total	5,24	1,28	37
	Non-responsive	Small screen	5,78	1,35	18
		Large screen	5,32	,75	19
		Total	5,54	1,10	37
	Total	Small screen	5,36	1,38	36
		Large screen	5,42	1,00	38
		Total	5,39	1,19	74

4.2. Multivariate Results of MANOVA

Equality of covariance matrices is one of the assumptions that should be provided before a multivariate analysis. Therefore, Box's test of equality of covariance matrices was run and according to the results, [Box's M=15.19, F (18, 17205.79) =.78, p=.73] the assumption was not violated. After this assumption had been provided, multivariate analysis was conducted to examine the effects of the two nominal variables (website design and size of screen) on dependent variables (reading comprehension, cognitive load and preference of reading on tablets). The multivariate tests of these variables are given in Table 4.3.

Table 4.3. *Multivariate Tests*

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power[c]
Intercept	Pillai's Trace	,98	956,06[b]	3,00	68,00	,00	,98	1,00
	Wilks' Lambda	,02	956,06[b]	3,00	68,00	,00	,98	1,00
	Hotelling's Trace	42,18	956,06[b]	3,00	68,00	,00	,98	1,00
	Roy's Largest Root	42,18	956,06[b]	3,00	68,00	,00	,98	1,00
Website Design	Pillai's Trace	,08	2,02[b]	3,00	68,00	,12	,08	,50
	Wilks' Lambda	,92	2,02[b]	3,00	68,00	,12	,08	,50
	Hotelling's Trace	,09	2,02[b]	3,00	68,00	,12	,08	,50
	Roy's Largest Root	,09	2,02[b]	3,00	68,00	,12	,08	,50
Screen Size	Pillai's Trace	,05	1,22[b]	3,00	68,00	,31	,05	,31
	Wilks' Lambda	,95	1,22[b]	3,00	68,00	,31	,05	,31
	Hotelling's Trace	,05	1,22[b]	3,00	68,00	,31	,05	,31
	Roy's Largest Root	,05	1,22[b]	3,00	68,00	,31	,05	,31
Website Design * Screen Size	Pillai's Trace	,08	1,89[b]	3,00	68,00	,14	,077	,47
	Wilks' Lambda	,92	1,89[b]	3,00	68,00	,14	,077	,47

Hotelling's Trace	,08	1,89[b]	3,00	68,00	,14	,077	,47
Roy's Largest Root	,08	1,89[b]	3,00	68,00	,14	,077	,47

Based on the results of the multivariate test, none of the independent variables yielded a significant result. For website design (responsive vs. non-responsive), Wilk's λ=.92, F (3,68) =2.02, p=.12, partial η^2=.08 indicating %8 of variance. For screen size, Wilk's λ=.95, F (3,68) =1.22, p=.31, partial η^2=.05 indicating %5 of variance. For interaction effect of website design and size of screen, Wilk's λ=.92, F (3,68) =1.89, p=.14, partial η^2=.08 indicating %8 of variance.

4.3. Between Subject Analysis Results of MANOVA

After multivariate analysis had been run, a subject analysis was conducted to see details about each independent variable effect on each dependent variable. Here, equality of error variances is one of the assumptions to be provided of this analysis and Levene's test was conducted for this reason. The results of Levene's test are F (3,70) =.68, p=.57 for reading comprehension, F (3,70) =.44, p=.73 for preference of reading on tablets, and F (3,70) =1.59, p=.20 for cognitive load. The assumptions for each dependent variable were not violated (see Table 4.4).

Table 4.4. *Levene's Test of Equality of Error Variances*

	F	df1	df2	Sig.
Reading Comprehension	,68	3	70	,57
Preference of Reading on Tablets	,44	3	70	,73
Cognitive Load	1,59	3	70	,20

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + GroupNo + TabletSize + GroupNo * TabletSize

4.3.1. Website Design

According to the results, website design (responsive vs. non-responsive) has no significant effect on reading comprehension F (1,70) =.09, p=.77, partial η^2=.00 and on cognitive load F (1,70) =1.30, p=.26, partial η^2=.02. However, website design has a significant effect on preference of reading on tablets F (1,70) =4.31, p<.05, partial η^2=.06. This means that using different website designs affects people's preference of reading on tablets by indicating %6 of variance. Figure 4.1 shows the effect of website design on preference of reading on tablets.

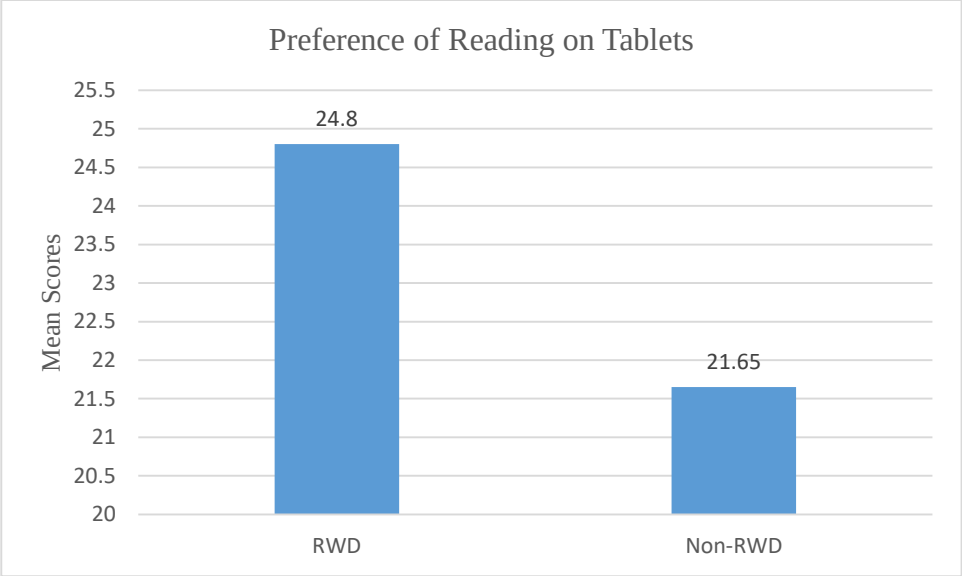


Figure 4.1. The effect of website design on preference of reading on tablets

As it can be seen in Figure 4.1, the participants who used RWD had higher mean scores than the participants who used non-RWD in terms of preference of reading on tablets.

4.3.2. Screen Size

According to the results, screen size (small screen vs. large screen) has no significant effect on reading comprehension F (1,70) =.59, p=.45, partial η^2=.01, on preference of reading on tablets F (1,70) =2.60, p=.11, partial η^2=.04 and on cognitive load F (1,70) =.05, p=.83, partial η^2=.001.

4.3.3. Interaction of Website Design and Screen Size

The results of the test show that website design and screen size have no interaction effect on reading comprehension F (1,70) =.93, p=.34, partial η^2=.01 and preference of reading on tablets F (1,70) =1.00, p=.32, partial η^2=.01. However, there is a marginal interaction effect on cognitive load F (1,70) =3.64, p=.06, partial η^2=.05. This means that interaction of website design and size of screen affects marginally people's cognitive load by indicating %5 of variance. The interaction effect on each dependent variable was analyzed with the graphs presented separately as follows.

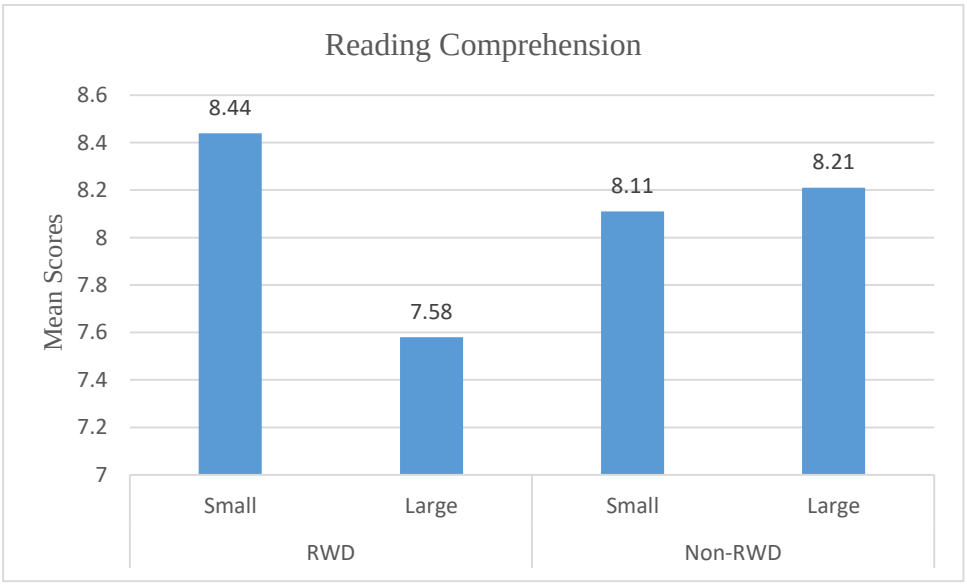


Figure 4.2. The interaction effect of website design and screen size on reading comprehension

Figure 4.2 demonstrates that the participants who used RWD had higher mean scores than the participants who used non-RWD on small screen tablets in terms of reading comprehension. Conversely, the participants who used RWD had lower mean scores than the participants who used non-RWD on large screen tablets in terms of reading comprehension. This shows that RWD has an advantage on small screen in terms of reading comprehension. In other words, it can be said that RWD has an important role on small screens when considered reading comprehension.

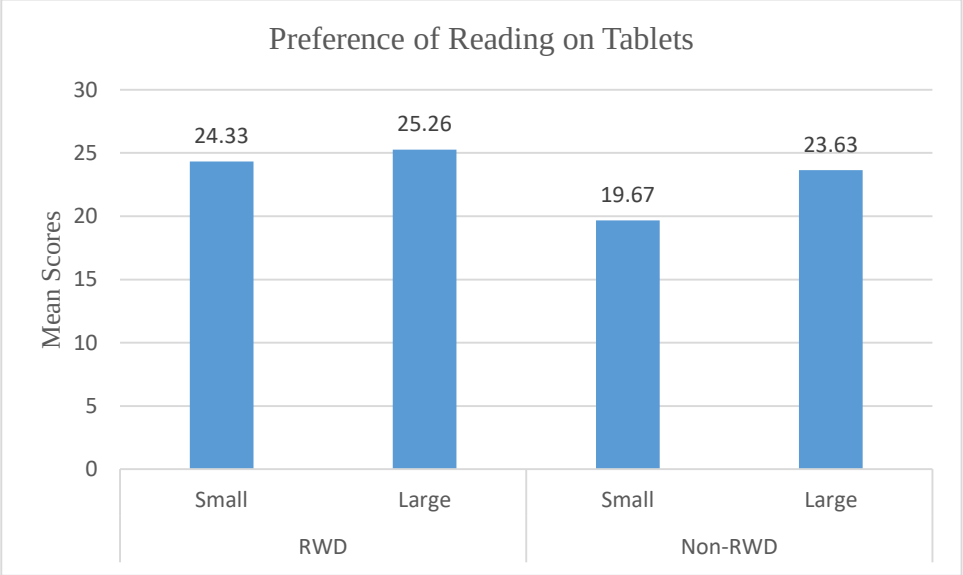


Figure 4.3. The interaction effect of website design and screen size on preference of reading on tablets

As it can be observed in Figure 4.3, it is clear that the participants who used responsive website design obtained a higher mean of score than the participants who used the non-responsive website design on both screen sizes in terms of preference of reading on tablets. Here, while responsive website design has almost no difference according to screen size in terms of the preference of reading on tablets, non-responsive design, which was preferred, increased noticeably in direct proportion with the screen size.

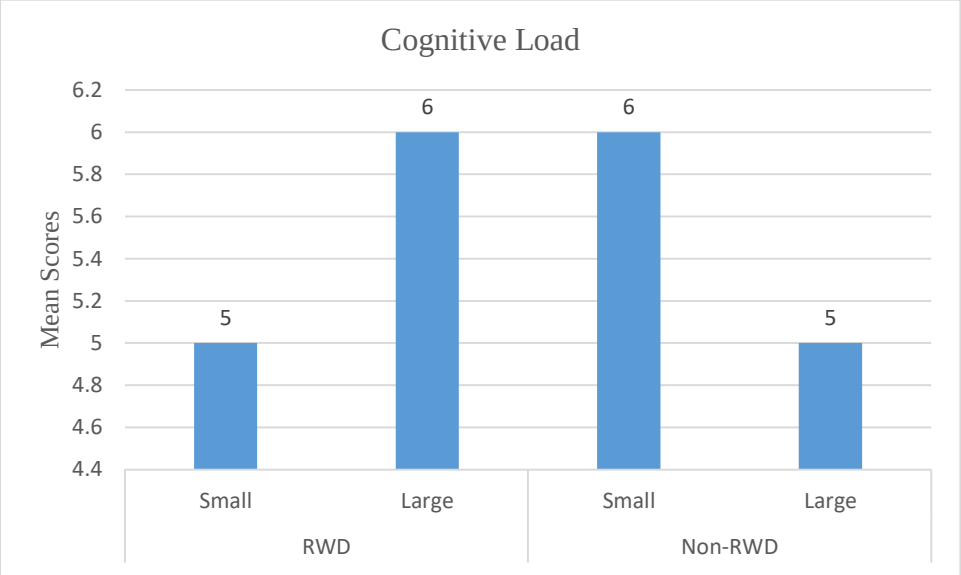


Figure 4.4. The interaction effect of website design and screen size on cognitive load

Figure 4.4 shows that the participants who used responsive website design got lower mean scores than the participants who used non-responsive website design on small screen size in terms of cognitive load. However, the former group acquired a little higher score than the latter group on the larger screens in terms of cognitive load. Here, the lower cognitive load when using the small screen in responsive website design means that responsive website design is more effective on small screens by not increasing the cognitive load. This is a result in the same direction with reading comprehension.

4.4. Summary

In Chapter Four, the results of the data analysis were presented with tables and graphics and explanations of them were given. Chapter Five includes discussions and suggestions for those interested.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1. Cognitive Load

In this study, it is investigated whether responsive website design (RWD) and screen size has an effect on cognitive load. There is much research in the literature about cognitive load, but only a few of them used similar variables as our study. No other study using exactly the same variables with this study could be found. In this regard, the studies which are not the same but with similar variables in the literature are examined and common and different points are explained.

In other studies, in the literature, some of them found that there is a significant effect of used different independent variables (e.g. CL principles, goal-based scenario designed multimedia learning, instructional strategies in online learning environments, the working memory capacities etc.) on the cognitive load. However, one of the studies conducted by Aydın (2017) had achieved similar results in a very similar context to this present study. The study investigated the effects of seductive details and topic interest on learning and cognitive load in hypertext environments. The results revealed that cognitive load was not affected by hypertext structure. Actually, any of the independent variables does not have any effect on the cognitive load according to the study results. Although reading in hypertext environments requires more complex cognitive tasks, it has no effect on the cognitive load. Consistent with this finding, in our study, reading on the website with responsive design, requires some easy cognitive tasks but still there is no effect on the cognitive load. In fact, this was conflicted with our expectation was that the responsive design would decrease the cognitive load.

If we examine the results of our study on this variable, the present study results revealed that none of the independent variables have an effect on the cognitive load. That is to say, website design (responsive vs. non-responsive), screen size (small vs. large) and interaction of these two independent variables have no significant effect on the cognitive load of participants. Even though there is no significant difference, the participants who used RWD on small screens obtained lower mean scores than the participants who used non-RWD on small screen in terms of cognitive load. This means that RWD and small screens combined provide lower cognitive load, and this situation indicates that a meaningful result can be reached by making some arrangements in the study. For example, extending the duration of the experiment may be one of the arrangements that need to be done.

When considered the reason of the results in more detail, it can be said that intervention time, length of reading passages, and quality and quantity of comprehension questions may affect the results. In other words, if the treatment was conducted in a longer period of time or repeated more than once, the results could be different from now. On the other hand, if the reading passages had more than thousands of words and the comprehension questions were more than ten for each passage, the analysis could show different results.

Cognitive load can be assessed by measuring mental load (the interaction between task and subject characteristics), mental effort (the actual cognitive load), and the performance of a learner (learner's achievements) (Paas et al., 2003). We may not had achieved the result we expected because we attempted to measure cognitive load in a single dimension and measured mental effort at a self-rating level.

5.2. Reading Comprehension

This study investigated whether the RWD has an effect on reading comprehension and whether the screen size of tablets affects reading comprehension. Moreover, whether

the interaction of these two independent variables show a significant effect on this dependent variable was examined. In the literature, there are lots of researches about reading comprehension, however only a few of them used similar variables in our study. No other study using the RWD as independent variable, and using the reading comprehension as dependent variable could be found. Therefore, the studies which are not the same but have similar variables were investigated, and common and different points were clarified.

Previous researches demonstrate different results on this topic. Reading comprehension was affected by media presentation type (paper or electronic) in early studies (e.g., Bevan, 1981; Gould et al., 1987), however, recent research shows the opposite results (smaller or less consistent differences) in text memorization and reading comprehension (e.g., Green, Perera, Dance, & Meyers, 2010; Huang, 2006). Our study results are consistent with these recent findings but this was not our expected situation. It was thought that the decreasing difference between media types over time in terms of comprehension could arise from design of digital media like responsiveness. Nevertheless, in our study, the absence of a significant difference can be attributed to the intervention time, length of reading passages, and quality and quantity of comprehension questions. The other study in the literature had used three reading passages and ten comprehension questions (similar to our study), and its results showed that reading comprehension and reading speed did not differ according to tablet or paper (Dundar & Akcayır, 2011). This result raises the possibility that the shorter treatment of time might affect our results more instead of the length of reading passages or number of questions.

One of the studies, showed that media presentations (e-readers, computer screens, or paper) had no significant effect on reading comprehension (Margolin, Driscoll, Toland, & Kegler, 2013). It was stated that comprehension differences may exist, but were not found in the study, furthermore, if it were to exist, it is likely to be very small or moderated by other factors. We thought that one of the factors can be design of the

interface or content of the test. Even though we could not find any significant difference, the experimental process can be modified in terms of 'intervention time' or 'passages' content and length' to be able to reach significant results. This result shows also that the necessity for using of the device did not significantly limit readers' comprehension during reading. The underlying reason for this needs further research.

5.3. Preference of Reading on Tablets

This study investigated whether RWD affects the preference of participants for reading on tablets, and whether the screen size of tablets has an effect on their preference. Also, whether the interaction of these two independent variables has a significant effect on this dependent variable was researched. In the literature, a number of researches about tablet preference for reading or studying is present, however, only a few of them considered similar variables to our study. No other study using the RWD as an independent variable and the preference as a dependent variable was found. Therefore, the studies which are not the same but have similar variables were investigated to see similar and different results.

One study was conducted by Dundar and Akcayir in 2011 and an interview was conducted with participants to specify preference of reading on tablets. According to the interview results, since books are difficult to carry, participants preferred tablet PCs for reading. In this study, tablets and paper were compared in terms of reading comprehension and preference. However, in our study, we were focusing on material design rather than device. That is, we intended to determine whether website designs (responsive vs. non-responsive) and screen sizes (small screen vs. large screen) affect the preference of reading or not. In our study results, while screen sizes had no significant effect on reading comprehension and on preference of reading on tablets, website design had a significant effect on preference of reading on tablets. The participants who used RWD had higher mean scores than the participants who used non-RWD in terms of preference of reading on tablets.

Another study conducted by Lombard, Amadieu, Bråten, and van de Leemput at 2018 aimed to investigate whether using two different applications affect comprehension in a multiple document reading task. Also, the effect of strategic guidance on performance and acceptance of tablets was tested in the scope of this study. The results showed a performance-preference paradox. This means that although the strategy group obtained a better comprehension mean scores than the scores of participants in the control group freely used Adobe Reader, this group did not prefer tablets as a tool for studying multiple documents. When we consider our study results, a similar dilemma can be seen in our study. Namely, we obtained results which indicated that reading comprehension levels are higher in responsive website designs when compared to non-responsive website designs. In contrary, the preference of reading on tablets which include a responsive design resulted in lower means of score than of the non-responsive website design. This situation shows that while comprehension level increases, preference decreases, and this is consistent with the reviewed literature.

Another study was conducted by Huang, Chen, and Ho (2014), and its results showed that tablet reading systems differ from other digital reading systems in terms of behavior patterns and context of use. Also, the results demonstrated that tablet reading systems need to be redesigned in terms of some aspects to improve reading situations. Finally, this study stated that behavioral intention about tablet reading systems can be developed when redesigned. We thought that one of the methods that could be utilized to redesign the interface is the employment of responsive website design, which is a different method from the method used by in this study. Our study intended that preference of reading on tablets instead of behavioral intention can be developed when redesigned via RWD. And as we predicted, this method (RWD) had a significant effect on the preference.

5.4. Implications

It is thought that this study may contribute to the improvement or renewal of screen designs of electronic books according to the results of the study and thus increase the use of electronic reading tools. It is also thought that the study will bring a different dimension to electronic reading habits and support efficient electronic reading by changing usage habits. Thus, in order to prevent cognitive overload by decreasing extraneous cognitive load, these different usage habits for e-reading may be guiding to develop multimedia design of this type of environments. Considering the instructional design principles of multimedia learning, it is believed that responsive website design can contribute to expanding the principles by bringing different dimensions to multimedia teaching.

Although previous researches showed that instructional design principles make a difference on multimedia learning, more research should be done on RWD as a new instructional strategy on multimedia environments like e-reading devices. Researchers should try to use various instructional methods to provide better learning. With this information, a researcher should decide how to ease reading on tablets for developing reading comprehension, decreasing cognitive load and ensuring the preference of reading on tablets. Then, the researcher may choose the RWD approach to improve usefulness of reading on tablets. Therefore, the students will be able to effectively learn at the appropriate reading comprehension and cognitive load level and may prefer reading on tablets. Information needs to be available for those who are interested regarding how they can use RWD, and how they can implement it on their websites if they cannot use technology effectively. Moreover, further research is needed on university students in longer reading passages, more questions and a long-term experiment environment in order to assess their reading-comprehension, cognitive load, preference of reading on tablets.

5.5. Conclusion

It should be paid attention that this study has limitations. First of all, the participants of this study were university students and they were familiar with technology (e.g. they are required to do digital reading). If the study was conducted with participants who are less familiar with technology like older individuals, the results may differ in terms of reading comprehension, cognitive load or preference of reading on tablets. Familiarity with technology and frequency of using hand held devices for reading were not taken into account in this study. Secondly, if each participant had done reading on both responsive and non-responsive website designs, and on both tablets with small and larger screens, it would be more helpful to reach reasonable results on one participant's comprehension scores. (But by applying all the steps of a true experimental study, the results were quite comparable by measuring the specific input variables of the participants, making the correct matches according to these variables and assigning them to random groups.) Thirdly, the effort of the participants may not be the same as a classroom setting, and for this reason the data might not have been accurately collected to reach accurate results. Fourthly, the comprehension measure, which is unidimensional including comprehension questions, may not be sufficient to measure exact results. Also, the cognitive load measure is a type of self-reporting one and it may not show the real mental effort because of it basis itself on the honesty of participants. Finally, intervention time, length of reading passages and quality and quantity of comprehension questions may affect the results.

Future research should investigate the effects of RWD on comprehension, preference and cognitive load in a long-time setting. Longitudinal researches can be conducted by allocating longer periods of time for collecting data, more reading passages (may be different types like informational or narrative), longer reading passages (e.g. more than thousands of words), and more comprehension questions (more than 6 for each). That is, future studies can aim to improve e-reading environments by using a variety of screen sizes and improving website design, thus, finding the optimal screen size

and website design for screen reading. Finally, more detailed studies can be performed to obtain meaningful results about the performance-preference paradox situation.

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APPENDICES

A. READING SPAN TEST (RST)

Deneme seti

1. Kışın en soğuk zamanına zemheri denir.
2. Çorum İç Anadolu Bölgesi'nde yer almaktadır.
3. Almanya'da on iki milyon Türk yaşamaktadır.

2'LİK SETLER

1

1. Senin kardeşinin çocuğu yiğenindir.
2. Trabzon mısırı ile ün salmıştır.

2

1. Haritada Türkiye Fransa'dan daha fazla yer kaplar.
2. 30 Eylül'de doğanlar akrep burcu olurlar.

3

1. Zorunlu eğitim ülkemizde 8 yıldır.
2. Uzağı iyi göremeyen hipermetrop gözlerdir.

4

1. Bir yumurta 80 kalori barındırır.
2. İnsan susuzluğa haftalarca dayanabilir.

5

1. Bir insanda 46 çift kromozom bulunur.
2. Türk Hukuk Kurumu THK ile kısaltılır.

6

1. Osmanlı İmparatorluğu 1299 yılında kurulmuştur.
2. Yapraklar ilkbaharda sararır.

3'LÜK SETLER

1

1. Salon sporlarından biri de bowlingdir.
2. Sebzeler bol miktarda B vitamini ihtiva eder.
3. Osmanlı Devleti dünyadaki en uzun süren imparatorluktur.

2

1. Boza içeceği Arap kökenlidir.
2. Bir bardak şekersiz çay sıfır kaloridir.
3. Sol ele söz yüzüğü takılır.

3

1. Lodos güneybatıdan esen rüzgara denir.
2. İskambil kağıdı ile briç oyunu oynanabilir.
3. Haritada Bulgaristan Yunanistan'dan daha fazla yer kaplar.

4

1. 1920 yılında cumhuriyet ilan edilmiştir.
2. Trampet nefesli bir çalgı türüdür.
3. Kıvırcık saçlı olmak kalıtımsaldır.

5

1. Uranüs güneşten en uzak olan gezegendir.
2. Rüştiye lise dereceli eğitim kurumuna denir.
3. Mozart Viyana'da doğmuştur.

6

1. Bir yıl üç yüz altmış beş gündür.
2. Çarparken çıkarmayı, bölerken toplamayı kullanırız.
3. Seksen tane şehir ülkemizde bulunmaktadır.

4'LÜK SETLER

1

1. 30 adet taşla tavla oyunu oynanabilir.
2. Etkisiz elemanı sıfır olan işlem toplamadır.
3. Türkiye'nin üçüncü cumhurbaşkanı Cemal Gürsel'dir.
4. İyot tiroit bezinin çalışması için gereklidir.

2

1. Baklagil türlerinden biri de mercimektir.
2. Dama ve satranç aynı sayıda taşla oynanmaktadır.
3. İzmir Muğla'dan yüz ölçüm bakımından daha küçüktür.
4. Bir araba için hız sınırı otoyolda 90 km'dir.

3

1. Salep bir Türk içeceğidir.
2. Epik şiir kahramanlıklardan bahseder.
3. İç Anadolu Bölgesi Türkiye'nin en geniş bölgesidir.
4. 30 Mart'ta doğanlar kova burcu olurlar.

4

1. Tavşanlar ot yiyerek yaşar.
2. Sarı ve kırmızı birlikte karışırsa yeşil olur.
3. Yılan ve timsah sürüngendir.
4. % 74 oranında su çiğ yumurtada bulunur.

5

1. Kuş türlerinden biri de devekuşudur.
2. Teyzenin çocuğu senin yiğenindir.
3. 35 kalorilik enerji havuçta vardır.
4. Telli çalgılara örnek olarak akordiyon verilebilir.

6

1. Dünyanın yüzölçümü en büyük olan ülkesi Amerika'dır.
2. Ev telefonları elektrikle çalışır.
3. Azerbaycan Türkiye'ye komşudur.
4. Ay dünyanın üçte biri büyüklüğündedir.

5'LİK SETLER

1

1. Tuzlu su daha kısa sürede kaynamaktadır.
2. Bolu'nun yüzölçümü Sivas'ın yüzölçümünden büyüktür.
3. Oyun kartları 52 adet karttan oluşmaktadır.
4. Bir gözleri açık uyuyan hayvan yunuslardır.
5. Yirmi dört tane diş çocuklarda bulunmaktadır.

2

1. İstanbul 1453'de fethedildi.
2. İskambil kağıtlarındaki kupa ve sinek kırmızıdır.
3. C vitamini domateste bulunur.
4. Bir ünlem cümlesine örnek olarak aman tanrım verilebilir.
5. Jupiter güneşe en yakın gezegendir.

3

1. Rafting akarsuda yapılan bir spordur.
2. 15'şer adet siyah ve beyaz taş satrançta bulunur.
3. Dünya'nın en uzun insanı iki metre doksan cm boyundadır.
4. Fıstık fındıktan daha yağlı bir kuruyemiştir.
5. Roma rakamında C harfi ile 100 sayısı gösterilir.

4

1. Bir kilometre bir milden daha uzundur.
2. Tatlı su balıklarından biri de alabalıktır.
3. Bir yıl elli dört hafta sürmektedir.
4. Altı kişilik iki takımla voleybol oynanabilir.
5. Haritada Rusya Çin'e göre daha fazla yer kaplar.

5

1. İsim tamlamasına örnek olarak balın peteği verilebilir.
2. Futbol on iki kişilik iki takımla oynanır.
3. Sigara sağlığa yararlıdır.
4. Doğu Anadolu Bölgesi Malatya'yı da içermektedir.
5. Miyop gözler yakını iyi göremez.

6

1. Kemençe telli bir çalgı türüdür.
2. Mor doğada nadir bulunan renklerdendir.
3. Suriye'nin yönetim şekli cumhuriyettir.
4. Bir karınca kendi ağırlığının 20 katını taşıyabilir.
5. Çorum leblebi ile ünlüdür.

6'LIK SETLER

1

1. Gökkuşağının ortasında bulunan renk yeşildir.
2. 30 gün çeken aylardan biri de Mayıs ayıdır.
3. Bir şişe maden suyu bir kaloridir.
4. Osmanlı Devleti'nin para birimi akçedir.
5. Türkiye'nin en uzun akarsuyu Kızılırmak'tır.
6. Güneş dünyamızdan daha küçüktür.

2

1. Kediler sadece siyah beyaz görebilirler.
2. Elektrik akımı ölçüm birimi volttur.
3. Otizmde zekada gerilik yoktur.
4. Patates asit oranı yüksek bir sebzedir.
5. Bu yıl cumhuriyetin 84. yılını kutluyoruz.
6. Dünya'nın en yoğun nüfuslu ülkesi Hindistan'dır.

3

1. Poyraz sıcak bir rüzgar türüdür.
2. Antalya'nın nüfusu İstanbul'unkinden daha fazladır.
3. A vitamini göz sağlığı için gereklidir.
4. Türkiye Avrupa Konseyi'ne üye olmuştur.
5. Yeşil ve siyah renkler karışırsa kahverengi olur.
6. Toplam 184 ülke dünyada bulunmaktadır.

4

1. Elma asit oranı yüksek olan meyvelerdendir.
2. Kanın pıhtılaşması için kalsiyum gereklidir.
3. 8 kalorilik enerji salatalıkta vardır.
4. Mustafa Kemal Selanik'te doğmuştur.
5. Zebraların siyah üstüne beyaz çizgili derileri vardır.
6. Bursa'nın nüfusu Sivas'ın nüfusundan eksiktir.

5

1. Ankara'nın yüzölçümü Konya'nınkinden büyüktür.
2. Sıfat tamlamasına örnek olarak kapının kolu verilebilir.
3. Kılıçla yapılan sporlardan biri de eskrimdir.
4. Çiçekler kış mevsiminde açar.
5. Pirinç bir tahıl türüdür.
6. 26 tane harf İngilizlerde bulunmaktadır.

6

1. Mimar Sinan Türk soyundan gelmektedir.
2. Peynirde D vitamini bulunur.
3. Beş kişilik iki takımla basketbol oynanabilir.
4. Güneş sisteminde dokuz tane gezegen bulunmaktadır.
5. Malatya kayısı ile ünlüdür.
6. Ege Bölgesi Balıkesir'i de bulundurur.

B. COGNITIVE LOAD MEASUREMENT

Bilişsel Yük Anketi

Bu anket, tabletten okuma yaptığınız sırada harcadığınız zihinsel çabayı ölçmektedir. Bu görevi yerine getirirken ne kadar zihinsel çaba sarf ettiniz?

Verilen görevi tamamlarken ne kadar çaba sarfettiniz?

Çok çok az	Çok az	Az	Kısmen az	Ne az ne fazla	Kısmen fazla	Fazla	Çok fazla	Çok çok fazla
1	2	3	4	5	6	7	8	9
○	○	○	○	○	○	○	○	○

C. PREFERENCE OF READING ON TABLETS SCALE

Tablet Bilgisayarda Okuma Kabul Ölçeği

Maddeler	Tamamen katılıyorum (5)	Katılıyorum (4)	Kararsızım (3)	Katılmıyorum (2)	Katılmıyorum (1)
Tablet bilgisayarda okuma yapmak iyi bir fikirdir.					
Tablet bilgisayarda okuma yapmak eğlencelidir.					
Tablet bilgisayarda okuma yapmak motivasyonumu geliştirebilir.					
Tablet bilgisayarda okuma yapmak konuyu anlamamı kolaylaştırır.					
Tablet bilgisayarda okuma yapmak öğretimi etkili hale getirmeyi sağlar.					
Tablet bilgisayarda okuma yapmak süreyi etkili kullanmayı sağlar.					
Tablet bilgisayarda okuma yapmak kolaydır.					
Tablet bilgisayarda okumayı tüm derslerimde kullanmaya niyetliyim.					

D. COMPREHENSION TESTS

1. LiFi - Okuduğunu Anlama Soruları

1. Bu parçada aşağıdakilerden hangisine değinilmemiştir?

A) İnternetin ampuller aracılığı ile iletilebileceğine

B) Li-Fi teknolojisinde radyo sinyalleri yerine LED ışıkların kullanıldığına

C) Araştırmanın Kolkata'daki St. Xavier Koleji'nde tamamlandığına

D) Li-Fi'ın daha hızlı ve daha güvenilir olduğuna

2. Bu parçadan, aşağıdaki yargıların hangisine ulaşılabilir?

A) Haas ve takımı Li-Fi'ı test eden tek ekip olduğuna

B) Li-Fi teknolojisinin, Wi-Fi'a oranla 1000 kat daha fazla veri yoğunluğuna ulaşabildiği

C) Wi-Fi teknolojisinin Nesnelerin İnterneti dönemini daha hızlı gerçekleştireceği

D) Wi-Fi teknolojisinin saniyede 224 gigabayta kadar ulaşabildiği

3. Sadece Li-Fi'ın ne kadar hızlı yaygınlaşacağı belli değil. Hindistan, Kolkata'daki St. Xavier Koleji'nden araştırmacılar şöyle diyor: ''Li-Fi teknolojisi sayısız yarar sunmasına rağmen bu teknolojinin yaşamlarımızın bir parçası haline gelmeden önce aşması gereken belirli bariyerler var.'' Bu bariyerler hava durumuna bağlı olarak sis gibi koşullarda Li-Fi'ın ışık engellendiğinde gücünün azaldığı gerçeğini ve benzerlerini içeriyor.

Bu parçada altı çizili cümlede, Li-Fi teknolojisinin hangi yönü üzerinde durulmaktadır?

A) Li-Fi teknolojisinin yeterince gelişmediği

B) Li-Fi teknolojisinin bazı dezavantajlarının olduğu

C) Li-Fi teknolojisinin Wi-Fi teknolojisinin yerini alamayacağı

D) Li-Fi teknolojisinin avantajları olduğu kadar belli sınırlılıklarının da olduğu

4. Bu parçada aşağıdaki sorulardan hangisinin yanıtı yoktur?

A) Li-Fi teknolojisinin Wi-Fi teknolojisinden farkı nedir?

B) LED ampullerin geleneksel akkor ampullere kıyasla tercih edilmesinin nedeni nedir?

C) Nesnelerin interneti nedir?

D) Harald Haas kimdir?

2. 9 Etkileyici Fotoğraf ile Teknolojinin Evrimi - Okuduğunu Anlama Soruları

1. Bu parçadan aşağıdaki ifadelerden hangisi çıkarılamaz?

A) Aya ilk inen bilgisayardaki işlemci gücünün oldukça yüksek olduğu

B) Günümüzde 100 terabayt boyutunda SSD'ler olduğu

C) Bilim insanlarının DNA'ya terabaytlarca veri kaydedebildiği

D) Pek çok cüce gezegenler ve Dünya benzeri gezegenler keşfedildiği

2. Aşağıdakilerden hangisi parçada bahsedilen teknolojik gelişmelerden biri değildir?

A) Bilinen ilk sabit disk yine IBM tarafından 1953'te üretilmişti.

B) Plüton, New Horizons (Yeni Ufuklar) adlı uzay aracı sayesinde çok daha net bir şekilde görüntülenmişti.

C) Apollo 11 adlı görev, Ay'a ayak basma amacını taşıyordu.

D) Alexander Graham Bell sesi, fotofon aracılığıyla 1880 yılında güneş ışığı demeti aracılığıyla iletti.

3. Bu parçada asıl vurgulanmak istenen aşağıdakilerden hangisidir?

A) Teknolojik araçların boyutsal değişimi

B) Geçmişten günümüze teknolojinin nasıl geliştiği

C) Bilgisayar alanındaki gelişmelerin çok hızlı olduğu

D) Teknolojinin gelişmesine katkı sağlayan bilim insanları

4. Bu parçadan aşağıdaki yargıların hangisine ulaşılabilir?

A) Apollo 11 adlı görevin amacının, Ay'a yüksek işlemcili bir bilgisayar götürmek olduğuna

B) Yıllar geçtikçe evrenin daha küçük bir yer haline geldiğine

C) Bill Gates'in CD-ROM'ları tanıtırken etkili olmayan bir reklam yaptığına

D) ENIAC'ın bugün kullandığımız bilgisayarların en eski atası olduğuna

3. Dünya'nın Gerçek Şekli Geoit - Okuduğunu Anlama Soruları

1. Bu parçadan aşağıdaki ifadelerden hangisi çıkarılamaz?

A) Çekül doğrultusunun tanımı

B) Geoit'in neden üzerinde hesap yapılamayan fiziksel bir yüzey olduğu

C) Dönel elipsoid ile hesap yapılamayan fiziksel bir yüzey üzerinde nasıl hesap yapılabileceği

D) Ülkelerin yerel referans yüzey değerleri

2. Bu parçadan, aşağıdaki yargıların hangisine ulaşılabilir?

A) Dünyanın asıl şeklinin geoit olduğuna ne zaman karar verildiğine

B) Med-cezir olayının etkilerine

C) Merkezkaç kuvveti ve çekim kuvvetleri farklılığının neden oluştuğuna

D) Elipsoit normalinin tanımına

3. Geoit, med-cezir olayının etkisi olmadan büyük okyanusların üst yüzeyinin karaların altından da devam ettiği varsayılarak oluşturulan soyut kapalı yüzeydir. Bu ismi Johann Benedict Listing koymuştur. Çekül doğrultusu (Yerçekimi doğrultusunu belirtmek için kullanılan doğrultu) yeryüzünün her noktasında geoit'i dik keser.

Bu parçada altı çizili cümlede, Geoit şeklinin hangi yönü üzerinde durulmaktadır?

A) Bir takım varsayımlar yapılarak şeklin tanımlandığı

B) Geoit'in med-cezir olayından nasıl etkilendiği

C) Çekül doğrultusunun Geoit'i dik kestiği

D) Geoit'in yerçekimi doğrultusunu belirtmek için kullanıldığı

4. Bu parçada aşağıdaki sorulardan hangisinin yanıtı yoktur?

A) Dünya'nın şekline Geoit ismi kim tarafından verilmiştir?

B) Dönel elipsoid'in yüzey hesaplama denklemi nedir?

C) Geoit'in Dünya üzerinde farklı yerlerde farklı şekil almasının sebebi nedir?

D) Geoit'in fiziksel yüzeyi kaçıncı dereceden bir denklem ile tanımlanabilir?

E. CONSENT FORM

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu araştırma, ODTÜ araştırma görevlilerinden Merve Aytekin tarafından ODTÜ öğretim üyelerinden Prof. Dr. Soner Yıldırım danışmanlığında yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Araştırmanın amacı, duyarlı ekran tasarımının elektronik ortamda okuduğunu anlama ve bilişsel yük durumlarına nasıl etki ettiğine dair bilgi toplamaktır.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmayı kabul ederseniz, sizden öncelikle çalışan bellek kapasitenizi ölçmeye yönelik bir çalışmaya katılmanız beklenecek ve bu süreçte sizden ses kaydı alınacaktır. Sonra belli konu başlıkları verilerek, konulara olan ilginizi belirlemeye yönelik kısa bir anketi cevaplamanız beklenecektir. Daha sonra 5 kişiden oluşan gruplar halinde bir web sayfası üzerinden metin okuma oturumuna katılarak parçaların tamamını okumanız beklenmektedir. Yaklaşık olarak bir saat sürmesi beklenen bu oturumda sizlere elektronik ortamda tabletler aracılığıyla okuma parçaları okutulacak ve okuma sırasında sesli yönerge ile ekranı çevirmeniz istenecektir. Yine tablet üzerinden okuduğunuz parçalarla ilgili soruları cevaplandırmanız beklenecektir. Okuma sırasında araştırmacılar tarafından süre tutulacak, gözlem yapılarak not alınacak ve sorulara verilen yanıtlar elektronik ortamda otomatik kayıt edilecektir. Okuma parçaları bittikten sonra okuma formatı tercihi, okuduğu metni anlama ve bilişsel yükünüzü ölçmeye yönelik hazırlanan kısa anketler doldurmanız beklenecektir. Oturum sonunda ise elektronik ortamdaki okuma deneyiminize yönelik sorular yöneltilecektir. Sorulara verilen yanıtlar araştırmacılar tarafından ses kaydına alınacaktır.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Elektronik okuma oturumunda sizden kimlik veya çalıştığınız kurum/bölüm/birim belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak, sadece araştırmacılar tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır. Sağladığınız veriler gönüllü katılım formlarında toplanan kimlik bilgileri ile eşleştirilmeyecektir.

Katılımınızla ilgili bilmeniz gerekenler:

Çalışma, genel olarak kişisel rahatsızlık verecek sorular içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye, çalışmadan çıkmak istediğinizi söylemek yeterli olacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için ODTÜ öğretim üyelerinden Prof. Dr. Soner Yıldırım (E-posta: soner@metu.edu.tr) ya da araştırma görevlisi Merve Aytekin (E-posta: mervea@metu.edu.tr) ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad	Tarih	İmza
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F. ETHICS COMMITTEE APPROVAL

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11 ARALIK 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu
(İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Soner YILDIRIM

Danışmanlığını yaptığınız Merve AYTEKİN'in **"Duyarlı ekran tasarımının, öğrencilerin tabletlerdeki okuduğunu anlama ve bilişsel yük durumları üzerine etkileri"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-EGT-166** protokol numarası ile araştırma yapması onaylanmıştır.

Saygılarımla bilgilerinize sunarım.

Prof. Dr. Tülin GENÇÖZ
Başkan

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Prof.Dr. Yaşar KONDAKÇI (4.)
Üye

Ali Emre TURGUT
Üye

Doç. Dr. Emre SELÇUK
Üye

Doç.Dr. Üyesi Pınar KAYGAN
Üye