UNDERGRADUATE STUDENTS' PERCEPTIONS ABOUT ANIMATION BASED MATERIALS USED IN BASIC ELECTRONIC AND ELECTRONIC COMPONENTS COURSE

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

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Multimedia materials are considered to be an essential component of the educational process. As information technologies evolve, new types of animation-based multimedia learning materials have emerged and taken its place in the educational arena. This study investigates first-year undergraduate students' perceptions towards the animation-based learning of basic concepts of electronics. The case study research was adopted for the study. Twelve students engaged in using multimedia learning materials, which were developed by the researcher, as supplementary to a one-semester course titled "Basic Electronic and Electronic Components." The in-depth analysis of the data stemming from interviews and survey resulted in six themes: design components of the animation-based multimedia materials, implementation to other electronic subjects, appropriateness of the animation-based multimedia materials, challenges, benefits of using animation-based multimedia materials, and suggestions. Animation-based multimedia materials prove to be beneficial, interactive and engaging in helping students learn basic concepts about electronics. The findings of the study might have important implications for the instructors, multimedia content developers, and instructional designers.

Keywords: Multimedia Learning, Animation-Based Learning, Interactive Learning

ÖZ

LİSANS ÖĞRENCİLERİNİN ELEKTRONİK DEVRE ELEMANLARI DERSİ İÇİN HAZIRLANAN ANİMASYON TEMELLİ ÖĞRENME MATERYALLERİNE KARŞI ALGISI

Türköz, Necdet
Yüksek Lisans, Bilgisayar ve Öğretim Teknolojileri Eğitimi
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Çoklu ortam materyalleri eğitim sürecinin önemli bir bileşeni olarak kabul edilir. Bilgi teknolojileri geliştikçe, yeni tip animasyon tabanlı çoklu ortam öğrenme materyalleri ortaya çıkmış ve eğitim alanında yerini almıştır. Bu çalışma, birinci sınıf lisans öğrencilerinin elektronik devre elemanları dersinde kullanılan animasyon temelli öğrenme materyalleri ile ilgili algılarını incelemektedir. Bu araştırmada vaka çalışması metodu kullanılmıştır. Bir dönemlik derse ek materyal olarak, araştırmacı tarafından geliştirilen animasyon tabanlı çoklu ortam öğrenme materyalleri 12 öğrenci tarafından kullanılmıştır. Görüşme ve anketlerden elde edilen verilerin detaylı analizi sonucunda altı tema ortaya çıkmıştır: Animasyona dayalı çoklu ortam materyallerinin tasarım bileşenleri, çoklu ortam materyallerinin diğer elektronik konularının öğretiminde uygulanması, animasyona dayalı çoklu ortam materyallerinin uygunluğu, zorluklar, animasyon tabanlı çoklu ortam materyallerini kullanmanın yararları ve öneriler. Araştırmanın nicel sonuçları, animasyon tabanlı çoklu ortam materyallerinin, elektronik devre elemanları kavramlarını öğretmek için faydalı, interaktif ve ilgi çekici olduğunu göstermiştir. Bu çalışmaya ait bulguların öğretim elemanları, çoklu ortam içerik geliştiricileri ve öğretim tasarımcıları için önemli katkıları olacağı düşünülmektedir.

Anahtar Kelimeler: Zengin İçerikli Öğrenme, Animasyon Tabanlı Öğrenme, Etkileşimli Öğrenme

To My Profession

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ABBREVIATIONS

LMS: Learning management system

CEIT: Computer Education and Instructional Technology

METU: Middle East Technical University

CHAPTER 1

INTRODUCTION

1.1. Overview

Within the last two decades, there has been a rapid expansion in the use of multimedia learning within science education, particularly animation-based learning (Mnguni, 2014). Animation illustrates structures that are generally not seen, or which are hard to show in the class, let alone in the lab (Fleming, Hart, & Savage, 2000). A meta-analytical analysis showed that animation has essential benefits in supporting active learning (Höffler & Leutner, 2007). The increased use of visualizations to enhance learning has raised the interest and motivation (Jamet, 2014).

Over the last couple of years, animation-based education has continued to expand, mainly because students and academic leaders accepted it more (Allen & Seaman, 2013). There are now dozens of animation-based training platforms. Academic members are also acquiring greater acceptance of animation-based learning. In 2013, the proportion of leading educational experts who believe online education is key to their long-term strategy increased to 66 %, that figure was below 50% in 2002 (Allen & Seaman, 2013). It is believed that the number of online students will continue to grow (Allen & Seaman, 2014).

Recent developments have resulted in influential learning systems with educational elements in digital video and information technologies. Digital technology not only gets to knowledge but also is collaborative ecosystems where the output of data is tracked and shared. It is one of the most desired aim to create and deliver quickly, effectively, and economically training or educational content in a configurable infrastructure that integrates learning material, tools, and services in one single solution. Moodle is a course management system, a software package designed to help

educators easily create quality online courses. Such e-learning systems are sometimes also called Learning Management Systems (LMS). Moodle is one of the most popular LMS. Moodle was originally an acronym for Modular Object-Oriented Dynamic Learning Environment, which is mostly useful to programmers and education theorists. Moodle runs without modification on Unix, Linux, Windows, Mac OS X, Netware and any other system that supports PHP (which includes almost every web-hosting provider). Moodle is designed in a modular way and allows a great deal of flexibility to add (and remove) functionality at many levels. Moodle is used as an educational management system by many state universities in Turkey.

A new course the Basic Electronic and Electronic Components has taken place in all Computer and Instructional Technology Departments program since the academic year 2018-2019. The aim of this course is to provide students with basic information about electronic and electronic components. The course instructor used Moodle to give away some of the course presentations and sources. The researcher prepared four different interactive course materials for this course which works on Moodle.

1.2. Background of the Study

Paper-based educational materials are less effective at improving skills compared with practical experience and training than computer-based animation materials. Animation based interactive educational materials, offer an engaging educational experience for students. There is very limited literature about animation-based learning materials on the subject of electronics learning, however, studies that examined the effectiveness of animation-based learning environments, compared with static pictures produced mixed and even contradictory results. On one hand, a meta analytic findings show that dynamic animations have significant advantages in promoting of learning success (Höffler & Leutner, 2007). Some researchers have claimed that students learning from animated graphics outperformed those learning from static graphics, for example for understanding the circulatory system (Large, Beheshti, Breuleux, & Renaud, 1996), Newton's laws of motion (Lloyd P. Rieber,

1989, 1991), and electronic circuits (Park & Gittelman, 1992). On the other hand, there are however, limitations concerning with the use of animations in teaching and learning. Morrison, Tversky, and Betrancourt (2000), for example, remarked that fast-paced animations would impose difficulties to the students in observing detailed procedural information. The researcher of this study hopes that electronic course instructors can understand more about their undergraduate students' perceptions towards the basic electronic concepts with animation-based learning materials by observing the results of this study, allowing them to prepare more animation-based multimedia materials.

1.3. Statement of the Problem

Animation based learning materials encourages self-motivation to create or problem solve. However, its effectiveness in fostering motivation for learning is inconclusive. There is an ongoing debate in literature over whether the use of animation is preferable as a teaching method. For example, Kesner and Linzey (2005), found no improvement on students' learning in using animations in their study. Similarly, in studies equating the knowledge in animated and non-animated graphics, no differences found in comprehension and memory have been found (Morrison & Tversky, 2001). Many other studies have failed to find benefits of animated over equivalent static graphics (Lloyd P. Rieber, 1989; Lloyd P. Rieber & Hannafin, 1988). On the other hand, researchers have found that integrating visual representations such as animations in instructional contexts may afford students with opportunities to promote their understanding of unobservable phenomena in science (Barak & Dori, 2011; Gilbert, 2005) and provide them with the opportunities to make abstract concepts visible (Yarden & Yarden, 2011). It appears that animation indeed has many advantages, provided it is properly integrated into the teaching process (Höffler & Leutner, 2007). This research was intended to expand the limited information in the literature using animation-based learning in electronics topics and the understanding of learning motives about the impact of animation-based teaching. While there are some

contradictions in the literature the information is needed to understand whether animation-based learning is effective in the topics of electronics.

1.4. Purpose of the Study

Using animation-based learning materials in the topics of basic electronics have not been comprehensively investigated. Therefore, the purpose of the study is to extend the accumulated knowledge on the effects of animation-based learning on electronic concepts. More specifically, the current study investigates, undergraduate students' perceptions towards the use of animation-based learning material in the basic electronic and electronic components course.

1.5. Significance of the Study

Firstly, the study can provide the needed information, the opinions about the animation-based learning materials for the course of basic electronic components. Secondly, the study will analyze the students' perceptions for the use of animation-based learning materials. Thirdly, this study will develop the huge literature of animation-based learning. Also, this study provides information literature of animation-based learning on the topics of electronic components. Practically, the study might shed a light on the information for content manager, educational material developers, course instructors, course plan designers. This research might help instructors and educators for future implementations of animation based-interactive learning materials in electronics courses. This study provides meaningful and practical information to the universities who wish to adopt interactive course materials into their learning management platforms.

1.6. Research Questions

The following research questions are investigated throughout this study.

Research question 1: What are the first-year undergraduate students' opinions and perceptions towards the use of animation-based multimedia materials in learning basic concepts of electronics?

Research question 2: What are the design components of animation-based multimedia materials from the perspective of students?

1.7. Assumptions

It is assumed that;

The participants are familiar with e-learning platform (Moodle)

1- The participants are from the same or similar backgrounds both culturally and socially
2- The data are to be accurately recorded and analyzed
3- Participants can easily use animation based-interactive course materials.

1.8. Limitations

There are a couple of limitations to our investigation. The results obtained should be cautiously treated and considered. First, the number of animation-based materials might have not be as large as it could be in order to ascertain or detect the true effects of animation-based learning materials for the course basic electronic and electronic concepts. Secondly, confinement is that the predetermined number of members may not be sufficient to make summed up derivations. Also, this investigation will expect that the members know about the present Learning Management System (LMS)

utilized by all offices at the university. Be that as it may, it might be conceivable that the degree of the information may contrast from individual to individual.

1.9. Delimitations

The study was conducted in Middle East Technical University in the Department of Computer Education and Instructional Technology. Participants are all from the first-year students of the department. Students were assumed that they were familiar with using online learning materials. Therefore, the study cannot be generalized to all students who are at the first year of their university.

CHAPTER 2

LITERATURE REVIEW

2.1. Overview

There have been extensive studies regarding the use and efficacy of multimedia learning in education. With the advent of ubiquitous technologies like smartphones and tablet pc, people start spending more time watching videos and engaging in other media contents. Meanwhile, the use of educational videos that are prepared using interactive e-learning techniques has been trending upwards in commercial and educational institutions. There are varied and extensive contributions of multimedia-based educational materials to learning and teaching processes. It is known that when the instructor's teaching style does not match the students' learning styles, the students could feel bored and become inattentive in the class, resulting in poor academic performance and possibly causing the instructor to lose interest in teaching (Ebner & Holzinger, 2003). This situation may cause a considerable loss for the field of education. Multimedia materials like videos and animations can help students involved in a course much better than the traditional approach (Lloyd P. Rieber, 1989).

Moreover, educational materials could be an excellent means of building a healthy relationship with the students. In addition to that, a multimedia material could afford to invite the learners to think, evaluate, and critique, and in turn, improve the overall teaching experience. They can also be a reliable medium for soft skill acquisition, where learning involves contextualization in private expertise and the capacity to see distinct views. However, to get as many benefits as possible from these multimedia materials, learners need to participate actively and engage in the content provided (Tversky, Morrison, & Betrancourt, 2002). This study investigates the perceptions of undergraduate students on animation-based multimedia materials, which were

developed as supplementary material the course basic electronic and electronic components for the Department of Computer Education and Instructional Technologies.

2.2. Multimedia Learning Theory

Multimedia learning is the presentation of learning materials through different media forms: words and pictures. These media forms, specifically images, could take several formats. For example, the pictures could be either in the form of static graphics such as photos, drawings, maps, charts, figures, and tables or in the form of dynamic graphics such as video or animation. As for the words, they can be presented in a computer environment as a form of printed text or spoken text. A piece of writing published in a window on a computer screen could be given as an example to the printed version. As an example of spoken text, on the other hand, a speech presented via computer speakers could be given (Mayer, 2002). Multimedia learning is described to happen when the learner forms a mental representation after being engaged in instructional or teaching materials, including both words and text (Mayer, 2002). The multimedia learning theory pays close attention to the learner-centered approach and considers education as a constructive process shaped and favored by meaningful learning connections and appropriate cognitive activities (Mayer, 2014). Related to the multimedia learning theory, a bunch of principles is proposed for the design and development of computer-based multimedia instructional materials from policies that decrease extraneous processing (coherence, signaling, redundancy, spatial contiguity and temporal contiguity) to the principles that control essential processing (segmenting, pre-training and modality) and promote generative processing (personalization, voice and embodiment) (Mayer, 2017). A well-designed computer-based multimedia instructional message could afford fruitful opportunities for leaners or the instructors. However, for the learners, building an active interaction with these materials is rather crucial. It is stated in previous studies that investing more cognitive

effort on multimedia learning materials brings about more benefits to the learners (Price, Wills, Dror, Cherrett, & Maynard, 2008). In their study, Price et al. (2008) reported that students who actively engaged in instructional videos learned information literacy concepts better than the students who passively watched the videos.

2.3. Animation Based Learning

The animation is a compelling means of delivering learning content in a multimedia learning environment. Because of its promising results, several researchers have been intrigued and tempted to focus on animation in their research studies (Gero, Zoabi, & Sabag, 2014, 2012). For example, Gero et al. (2014) conducted an experimental study in which they developed a learning unit using animations in an introductory course, introduction to electronics. The course aimed to provide information about advanced electronics, such as current sources and amplifiers, to the engineering students. In the study, the researchers compared the effect of the use of animations and static diagrams on students' achievement and examined students' attitudes towards animation-based learning. Two groups were randomly formed from 41 students: an experimental group (n=21) and a control group (n=20). While the experimental group took animation-based instruction, control group were taught through static diagrams. After analyzing the qualitative and quantitative data, it was reported that students studied the subject through animation achieved better performance and reported more positive attitude towards of electronics than their peers.

In a study carried out by Mackenzie and Ballard (2015), the effect of online interactive activities on participants learning outcomes was examined. In the study, 133 university students took a twelve-weeks longer asynchronous online course, Principles of Marketing, in which they were exposed to online interactive activities including video and traditional case discussions, multiple-choice questions, and matching exercises. Students' total exam scores and weekly scores on these interactive activities

were statistically investigated by the correlation analysis method. The results indicated that the whole student's exam scores and scores for the online activities were significantly correlated. Based on the result, the study concluded that students' interactions with online interactive activities resulted in better learning performance.

In their empirical study, (Zhang, Zhou, Briggs, & Nunamaker, 2006a) investigated whether interactive videos make students learn better and increase their satisfaction in e-learning environments. In the study, 138 undergraduate students from an introductory course were randomly divided into four groups. Students in each group were then exposed to a different learning environment. The researchers used a multimedia-based e-learning system to build each e-learning environment. Different instruction was given to the subjects in each e-learning environment. Groups' learning outcomes and satisfaction in the e-learning environment were measured by pre-test, post-test, and questionnaire. Analyzing the study data using the statistical method, analysis of variance (ANOVA), they found that the learning outcome of the students lectured by interactive video was better than that of the students in the other three groups.

Similarly, the study result showed that students in the group lectured by interactive video reported a higher level of satisfaction than students in the other three groups. The study results also indicate that the integration of interactive educational video into e-learning systems may be essential. Furthermore, the study suggested that educational software must incorporate a range of resources that support critical thinking. In addition, the software should look visually attractive, paying due attention to color, font size, graphics, buttons, quantity of text, and the incorporation of film, sound, animation, questions leading to further sources, and databases that hold information such as questionnaire returns and present opportunities for students to ask questions.

Bayram and Koçak (2013) investigated the contributions of the use of animation to undergraduate students learning outcomes and performance in the retention of

knowledge in a first-year chemistry course. The study sample consisted of 80 first-year students who took a chemistry course. The students were randomly assigned to two equal groups: experimental group (n=40) and control group (n=40). Classification of matter and separation of mixtures were the topics taught in the chemistry course. The students in the experimental group received the course content accompanied by animations, whereas the students in the control group received only the course content. Each group took a general chemistry academic achievement test before and after the treatment. After five weeks passed in the course, an achievement test was used to measure the extent to which animation help students retain the knowledge of given topics. The inspection of collected data indicated that pre-test achievement and retention scores of the students in experimental and control groups were not different from one another. On the other hand, students in the experimental group outperformed students in the control group in terms of performance on post-test achievement and retention scores. The study concluded that the use of animation in a chemistry course could help students increase their academic achievement and retain information about the concepts of chemistry.

The animation is often thought to assist learners in visualizing a dynamic process compared to static images mentally. Researchers state that animation-based visualization provides a realistic representation of the procedures to be explained, promotes a deeper understanding of dynamic systems, and inspires higher motivation for learning. (Höffler & Leutner, 2007; Richard E. Mayer, Hegarty, Mayer, & Campbell, 2005). Past studies have revealed that vivified designs can be utilized more adequately than static models to outline troublesome unique ideas and to picture dynamic forms (Bodemer, Ploetzner, Feuerlein, & Spada, 2004; Williamson & Abraham, 1995).

Also, it has been discovered that coordinating visual portrayals, for example, mechanized atomic models, recreations, and movements in instructional settings may manage the cost of understudies with chances to advance their comprehension of undetectable wonders in science (Barak & Dori, 2011; Gilbert, 2005; Zhang et al.,

2006b), and furnish them with the chances to make unique ideas noticeable (Yaden H. & A, 2010). Visual guides may assist understudies with relating the visible, microscopic, and symbolic portrayal levels of concoction elements to one another (Gilbert, 2005). Visual guides can improve students' theoretical understanding and spatial capacity (Barak & Dori, 2011; Williamson & Abraham, 1995), they can likewise encourage the handling of complex information, make the logical procedure progressively powerful, and give approaches to considering intriguing and complex marvels (Barak & Dori, 2011).

As of late, the increments in IT equipment and programming execution have altogether pushed the advancement of new instruments that are utilized to show data in different authentic arrangements, for example, discourse, content, realistic, animations, and video, and are being applied in numerous instructive settings (Bargeron et al., 2002; Hoogeveen, 1997; Reimann, 2003; Szabo & Poohkay, 1996). In such rich-media conditions, students could be presented to showing content in different portrayals, for example, verbal configurations as in representation, content organizations, for example, on-screen content, pictorial arrangement, for example, static charts, and dynamic setting, for instance, animations (Mayer & Moreno, 2002). Consider a basic showing situation where a business college teacher is disclosing ideas and techniques to comes back from business activities. The teacher may address (portrayal), show recipes on the board (content), represent with Excel charts (pictorial), and use animations to show the connection between expanded deals and benefits (dynamic). Along these lines, the teacher could utilize content or potentially animations as descriptions to help address. A few scientists have indicated the advantages of using IT-based activities, expressing that giving data in different arrangements can catch students' consideration and increment learning results (Mayer, 1997; Ragsdale, 2003; Rieber, 1990). Programming merchants and course reading distributors pack reading material with programming apparatuses that can assist personnel with creating activities to improve showing adequacy, in spite of the fact that investigation into animation utilization in the homeroom has displayed clashing discoveries in regards

to the potential learning benefits (Moore & Weatherford, 2001; Powell & Baker, 2004; Wolfgang Schnotz & Bannert, 2003). Students can acquire learning benefits with the utilization of IT antiques, for example, movements that can show the adjustments in parameters visually and dynamically (Powell & Baker, 2004). Contrasted and static outside portrayals with content/equations or charts/pictures, activities explicitly allude to a reproduced movement delineating the development of drawn (or mimicked) objects. Rotbain, Marbach, and Stavy (2008) suggested that animation can be used more effectively than static pictures to illustrate difficult abstract concepts and to visualize dynamic processes.

Information and communications technology (ICT) have opened up fresh opportunities to increase teaching and learning processes' efficiency (Salomon, 2002).The animation is a vibrant representation that can be used explicitly to the learner to create changes and complicated procedure (Schnotz & Lowe, 2003). Studies in series have shown that learning in computer-based animation settings has improved knowledge of complicated ideas and structures compared to traditional learning settings focused on verbal explanations (Park, 1994; Lloyd P. Rieber, 1991; Tversky et al., 2002). For instance, the motion of electrons in an electrical system, or chemical reactions between compounds, is hard to articulate in traditional teaching settings (Williamson & Abraham, 1995). Animation promotes the development of phenomena's mental representations, encouraging better comprehension. Computer animation is extremely efficient in demonstrating procedures that are not natural or hard to show in the classroom or even in the laboratory (Fleming et al., 2000).In the development of algorithmic thinking in computer science, animation-based technology-enhanced teaching environments were discovered to be extremely efficient (Levy, Ari, & Uronen, 2003; Esponda-Argüero, 2008), constructing knowledge in geometry and algebra (García, Quirós, Santos, González, & Fernanz, 2007), understanding an abstract concept in chemistry and biology (Kelly & Jones, 2007; Rotbain et al., 2008), and biotechnology learning (Good, 2004; Yarden & Yarden, 2011). Analyses that examined the efficacy of animation-based teaching

settings have generated mixed and even different outcomes compared to static images. On the one side, several trials showed that there is no important benefit over static images by and big animation-based learning (Betrancourt, 2005; Tversky et al., 2002). On the other side, a meta-analytic finding shows that in encouraging learning achievement, dynamic animations have important benefits (Höffler & Leutner, 2007). Other researches have shown that it can boost the impact of animation-based teaching settings by providing students control over animation and collaborative learning (Betrancourt, 2005; Richard E. Mayer & Chandler, 2001; Schwan & Riempp, 2004). Indeed, it was discovered that there is no benefit to user control over the animation in the scope of complex systems (Boucheix, 2007; Lowe, 2004), so that the effectiveness of the animation is not limited to cases where, in addition to watching the animation, the learner is required to perform specific actions. Interactive media learning is characterized as the obtaining and making of learning through the mix and simultaneous handling of data in both verbal and pictorial organizations, for example, content, portrayal, outlines, and animations (Mayer, 2009). The adequacy of learning with sight and sound relies upon a few elements, including how well its structure and presentational configuration holds fast to settled standards of media learning (R. E. Mayer, 2009; Ozdemir & Doolittle, 2015). Multimedia learning involves the utilization of media, such as text, illustrations, video, audio, and animation, to facilitate the acquisition of new information or construction of knowledge (i.e., understanding). Mayer (2002) who studied multimedia learning, presented seven general principles in designing a multimedia instructional presentation. First, the concepts need to be concentrated, for example, highlighting the key ideas both in the illustrations and in the text. Second, the presentation must be concise, minimizing extraneous descriptions in the text as well as visual features in the illustrations. Third, ideas must be correspondent to the visuals, such as presenting the corresponding illustrations and text segments near each other on the page. Besides, the presentation should be concrete, for instance, presenting the text and illustrations in ways that clearly show relationships. It must also be coherent and comprehensible, presenting the content in a coherent manner and with a clear structure. An example of this is to

present the text and illustrations in ways that allow the learner to apply relevant experience. Last, an effective presentation should be able to code, consistently use key terms in the text and key features of the illustrations in ways that make them more memorable. Mayer also proposed theories and principles applicable in the learning received from multimedia instructional presentation. His subjective hypothesis of media learning accepts that the personal data preparing framework incorporates dual channels for visual and sound-related handling, that each channel has constrained limit with regards to preparing, and that dynamic learning includes making an organized arrangement of intellectual forms. His interactive media standard expresses that understudies gained to be preferable from words and pictures over from words alone. The spatial contiguity principle reflects the fact that students learn better when corresponding words and pictures are presented near, rather than far, from each other on the page or screen. Then there is a temporal contiguity principle, which assumes that students learn better when corresponding words and pictures are presented simultaneously rather than successively. The coherence principle points out that students learn better when extraneous material is excluded rather than included. For example, student learning will be impaired when interesting but irrelevant words, pictures, sounds, or music are added to a multimedia presentation. Mayer's modality principle suggests that students learn better if the multimedia presentation is animation with narration rather than with printed text. His last principle is the one of redundancy, which states that students also learn better if the multimedia presentation is from animation with narration rather than from animation with narration plus printed text.

Undoubtedly, the advancement of Java, Flash, and other unique online applications enables educators these days to introduce complex movements. The animation is conceptualized as the demonstration, procedure, or an after effect of conferring life. It identifies with the craftsmanship or method of getting sharp animated motion pictures that include the deception of development on a screen. Consistently, animations were displayed in film and TV. Today, numerous instructive movements can be found on the web. Concerning learning, activity is robust, particularly in envisioning forms that

cannot be seen or that are hard to clarify in class (Höffler & Leutner, 2007). The utilization of animation was found to affect understudies' learning inspiration and thinking aptitudes positively (Barak & Dori, 2011). Animation can add to a superior comprehension of the learning material in two different ways. To begin with, it empowers the formation of mental portrayals of ideas, marvels, and procedures. Second, it very well may be utilized to supplant psychological testing forms (for example, innovativeness, deliberation, creative mind), of which a few students are short. Specialists guarantee that the best strategy for training effective procedures is using computerized action (García et al., 2007; Höffler & Leutner, 2007). Studies show that the utilization of activities adds to understudies' theoretical comprehension and inspiration to learn science (Barak & Dori, 2011; Yaden H. & A, 2010). These positive outcomes can be disclosed because of the movements' traits as visual apparatuses in helping understudies' development of mental pictures that are increasingly harmonious with those of researchers. E-learning is a fresh way to set up education without limiting time and room for learners. Although this is also a new and innovative sector in education, there are still many issues that need to be solved. The main point with e-learning platforms is the lack of involvement and motivation. Using interactive video to facilitate learning through the experience of failure process has excellent potential to foster deeper learning, thereby allowing more efficient implementation of values learned in the workplace, accelerating the skill acquisition process (Price, Wills, Dror, Cherrett, & Maynard, 2008b). Several studies have reported that animated graphics can be used more effectively than static graphics to illustrate difficult abstract concepts and to visualize dynamic processes (Bodemer et al., 2004; Williamson & Abraham, 1995). Reigeluth (1999) Elaboration Theory proposes that instruction should organize material in increasing order of complexity for optimal learning. This theory suggests that learners need to develop a meaningful context into which subsequent ideas and skills can be assimilated. A related concept proposed by McCombs (2001), Learner-Centered Education, suggests that education should emphasize learners’ backgrounds, interests, capacities, and needs. To do this,

school policies should support active learning and increase student motivation and achievement by considering these factors.

It is regularly accepted that activity can help students rationally imagine a unique procedure contrasted with static pictures; in any case, this supposition that is as yet questionable. Scientists have accepted that liveliness perception offers a sensitive portrayal of the to be clarified forms, encourages further appreciation of dynamic frameworks, and rouses more prominent inspiration to learn (Höffler & Leutner, 2007; Richard E. Mayer et al., 2005). In contrast, it is also believed that some possible cognitive advantages are associated with learning from It is essential to include interactivity within videos to make students concentrate, evaluate, feel, act on interacting with the video. If videos are not interactive, students may be bored, and they may lose interest in the content of the course. Videos can be fantastic for learners if they are manufactured well and used strategically in eLearning classes. Interactive video is beginning to play a significant part at this stage in how an interactive course material based on animation can be designed to motivate and involve learners in IT training. The movement offers open doors for the perception of complex scientific ideas, is persuading regarding thoughts and impact of amounts or parameters, produces a theory, and supports an investigation. In research ponders that have analyzed students' immediate connection with content that incorporates movements, a few have detailed improved learning results, especially with more youthful students (Rieber, Boyce, & Assad, 1990; Rieber, 1990). Organizations of advanced education in the United States have all around grasped PC based internet, which is reflected by a 29% expansion in online enlistment in the course in the last three years. This acknowledgment is especially valid for junior colleges, where over 60% of understudies join up with online classes (Wladis, Conway, & Hachey, 2015). Notwithstanding the way that the expansion in web-based learning at junior colleges has altogether improved the entrance and progression of students in STEM disciplines, especially underrepresented gatherings, the 30 to 40% wearing down the pace of these understudies is a lot higher than those in customary up close and personal courses

(Wladis et al., 2015). Even though these insights are cause for incredible worry, there is next to no examination concerning the reason for such a high wearing down rate among understudies took a crack at online STEM courses versus those in conventional up close and personal classes (Wladis et al., 2015).

2.4. Electronics Concept Learning

Two different ways of learning are possible in a computer-based e-learning environment: learning with computers and learning from computers. Even if the two concepts seem to be the same thing, they refer to two different ways of learning. Learning with computers takes place when the main course learnings are mediated and aided by multimedia resources or IT artifacts whereas learning from computers happens when the main course itself is distantly presented in an e-learning platform (Gupta & Bostrom, 2005; Jonassen & Reeves., 2001). The inquiries emerge concerning what the reasons are which have made intelligent activities an indispensable piece of present-day educational programs and whether there is exact proof to help asserts that utilizing sight and sound and intelligence in the e-educational program has a positive effect to intellectual advancement and scholarly accomplishment at understudies (Pinter, Radosav, & Čisar, 2012). In a meta-analysis study, Van der Kleij, Feskens, and Eggen (2015) examined the impacts of feedback in the multimedia learning setting on the learning outcomes of learners. To reveal the effects of feedback techniques on the learning outcomes of learners, they focused on item-based feedback given in a computer-based setting. In the study, 70 impact sizes were calculated after analyzing 40 research articles. For data analysis, they used a mixed method. The study findings indicated that the effect sizes for the elaborate feedback were more significant than the feedback given on the right response. In other words, effect sizes were revealed to be in favor of detailed feedback. Also, as reported by the study, compared to social sciences, science, and languages, larger effect sizes were discovered for mathematics. While the findings revealed that instant feedback

was more efficient than delayed input and vice versa for reduced-order teaching, no significant interaction was found. Computer-based mixed media is another innovation with various learning prerequisites than other PC adapting, for example, PC programming or Computer Assisted Design (CAD). A case of an alternate learning prerequisite would be the significance of an individual's cerebrum response in learning interactive media. The brain of man shifts rapidly from sense to sense in the following approximate proportions: sight 70%, hearing 20%, smell 5%, touch 4%, and taste 1%. These unite into the dynamic stream of sensations (Packer & Jordan, 2001). Multimedia learning requires the students to appreciate the beauty of art (mostly visual art). It requires the students to have essential PC learning and PC controlling experience, for example, Internet perusing and looking to recover data, programming, and pictures. It additionally requires more collaboration and correspondence in the learning condition than conventional PC courses. Along these lines, students' PC experience and their character are significant for sight and sound learning. The integration of multimedia technologies to promote learners' cognitive development is considered one of the most critical objectives for science education (Mayer & Moreno, 2002). Several studies have shown that multimedia learning environments can help learners learn more efficiently than traditional approaches(Jereb & Šmitek, 2006; Najjar, 1996).

2.5. The Effect of Multimedia Content on Motivation, and Participation

Animation based learning materials, a popular type of multimedia learning content, has been attracted by many researchers in the educational area because of its considerable promise as an instructional and learning tool to increase engagement, motivation, and participation. Some previous studies have examined the affordances of interactive videos in different contexts of education. For instance, in their research study, Price, Wills, Dror, Cherrett, and Maynard (2008) investigated the effectiveness of combining the lecture with an interactive video in a civil engineering course of risk

assessment in construction management. The researchers developed the interactive video to engage students in identifying and exploring risks and hazards associated with the fieldwork or construction area. Seventy-five second-year undergraduate students participated in the study and reflected their views regarding the usefulness of mixing the lectures with multimedia content. The study reported that the majority of students found the combination of lectures and video as a practical learning tool. Also, most students said that the interactive video positively contributed to their learning experience. Many students in the study also suggested that this type of interactives videos should be used in other topics of the course.

A recent review study on cognitive load in multimedia learning environment revealed the characteristics of 94 research studies that have been conducted from 2015 to 2019 (Bayraktar, Cosgun, & Altan, 2019). According to the study findings, the previous studies that have primarily analyzed the STEM subjects found it associated with four featured dimensions: cognitive load, learning, prior knowledge, and motivation.

In an educational context, multimedia content could successfully accompany the university course content to help the learners flourish in many areas. Huang and Zhang (2017) developed and implemented a blended e-learning program in an undergraduate engineering course related to power electronics. In the platform, they integrated interactive multimedia material into the web-based contents of power electronics courses. The analysis of the data collected in the study revealed that the majority of the students produced better learning outcomes in terms of understanding and building knowledge of power electronics. In a similar recent study, the researchers assisted the introductory biochemistry courses with a web-based multimedia interactive learning tool to alleviate undergraduate students understanding and comprehension of enzyme kinetics (Gu, Andreopoulos, Jenkinson, & Ng, 2019). The study involved designing and developing interactive simulations, along with assessment quizzes, that provide the course content with multiple modalities: texts, visuals, animations, graphs, and mathematics. In the study, they concluded that compared to traditional learning approaches, which tend to be passive-oriented learning, interactive inquiry-based

learning is a better instructional means of engaging students actively in learning process. The study also noted that small classrooms could benefits from this approach better than crowded classrooms. Likewise, Junsawang, Jittivadhna, Luealamai, and Pookboonmee (2019) integrated multimedia content into the health science course to augment undergraduate nursing students' basic life support knowledge and understanding. In the study, the cooperating learning groups is provided as a supplement to the multimedia-aided instruction on basic life support knowledge. Using a single-group pretest-posttest design, the researchers collected data from sixty-five undergraduate nursing students via pretest and posttest open-ended questions. The study result showed that compared to the pretest, a significant number of students gave correct answers to the posttest questions, showing that multimedia-aided instruction, supplemented by a cooperating learning group, made a substantial contribution to the nursing students in gaining knowledge and understanding of necessary life support.

There have been some authors interested in analyzing the pedagogical benefits of multimedia animations along with the text, audio, visual clues, graphics, and so forth. A recent study investigated the effects of animated videos on undergraduate students' learning experience in an advanced accounting course (Liu and Elms, 2019). In the study, nine animated instructional cartoon videos were developed based on students' pedagogical needs, and then those videos were given to 254 undergraduate students over two semesters. A survey, including open-ended and closed-ended questions, was used to gather data from students about the perceived benefits of animated videos as a learning tool. They also conducted a regression analysis to reveal how animations affect student learning experiences. The analysis results showed that students derived several benefits from animated instructional videos, including an increase in engagement, interest, and understanding. Multimedia learning environments or digital multimedia platforms provide instructional and learning content with different content forms, including graphics, audio and video clips, animation, and text. The development of computer network technology has pushed the application of digital multimedia platforms into many educational fields including physical education. A

study conducted by Da-Wei, Chao, Shun, Xun-Ling, and Wen-fang (2018) examined the effect of the use of multimedia tools and applications on the learning and development of physical education. In the study, the researchers designed and developed a digital multimedia platform with various multimedia forms like videos, animations, and so on that were used to promote university student's development and understanding of the sports knowledge. The study data stemmed from students who were exposed to different multimedia content at the digital multimedia platform. The study reported that using precious multimedia materials in physical education promoted student's participation and initiative in sports and drove them to learn more sports skills.

Original e-learning conditions that give the more prominent ability to investigation and intelligence can prompt more noteworthy degrees of student fulfillment. To fulfill their learning necessities, they offer understudies more power over both learning substance and procedure. As internet learning turns out to be increasingly common and instructors understand the significance of making connecting with encounters in online classes, automatic apparatuses will probably turn out to be all the more broadly utilized. While a few recordings may require critical time and want to make, including video intelligence merits the exertion. Understudies will be increasingly occupied with the materials, and bookkeepers will be better ready to show ideas and dissect understudies' outcomes.

Institutions of higher learning have undergone rapid development in the use of computer-based learning activities and their related ICTs over the past three decades (Mnguni, 2014).

This one is especially obvious as training monitoring systems like Blackboard and E dmodo are widely being used in online learning for both higher education and primar y and secondary education environments. Roughly half of U.S. four-year post-secondary education programs and two-thirds of two-year colleges documented presenting hybrid courses in 2007, according to Parsad & Lewis (2008). As a

consequence, a growing number of higher education teachers have utilized computer-based instructional activities as a way of actively engaging students in learning material in and outside the classroom (Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012). Software-based educational technologies also enabled learning products to be accessed in a variety of presentation formats, including hypertext, animation, images, video, and audio (Moos & Marroquin, 2010). The excessive use of digital media in computer-based learning settings has resulted in a massive increase in research studies, its implementation, and effectiveness over the past three decades (Mnguni, 2014). Regardless of the multiplication of research in computer-based interactive media learning, there is still no by, and primarily acknowledged accord on the best usage and plan, or a brought together a hypothetical system that tends to all perspectives and components included (Höffler & Leutner, 2007; Schmidt-Weigand & Scheiter, 2011; Um, Plass, Hayward, & Homer, 2012).

2.6. Conclusion and Summary

While this research promotes animation instruction superiority, the findings should not be interpreted to mean that animations are relatively more effective in all situations. Since the instructions were designed to visualize processes that are not visible by the naked eye in the real world in this study, it is not appropriate to generalize the findings to instructions that are designed to visualize visible phenomena. Future studies are needed to examine the relative effectiveness of animations that are designed to imagine other types of events compared to static picture instructions. The results showed that as a consequence of teaching and learning with embedded animations, learners altered their perception of basic concepts of electronics and technology learning.

CHAPTER 3

METHODOLOGY

3.1. Overview

The current study designed to investigate the effects of animation-based learning on undergraduate students' perceptions towards basic electronics concepts. In this chapter, the research design of the study was first described. Then, elaborative information was given about the sampling method chosen in the study. After that, the data collection forms that were used to collect a mix of qualitative and quantitative data were reported. Finally, the procedures and methods used in the data collection and analysis process were presented.

3.2. Research Design

This study employed a case study as a research method to examine students' reactions, opinions, and responses to the effectiveness and design of educational materials. The case study design is a collection of research procedures allowing the researcher to answer the research questions of the study and draw meaningful conclusions by making use of multiple data forms (Yin, 2003). A case study is identified as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not evident" (Yin, 2003).

There are basic types of design for case studies: a single case study and multiple case studies. In this study, a single case study was chosen. The rationale for using a single case design is that the animation-based educational materials were implemented in a course that was given for the first time at the department, and students of the

department were entirely new to the course and its content. Besides, the course is about basic concepts of electronic components, but the students who took the course were from computer education and instructional technology programs, which makes the course unique case to evaluate the design of the developed educational materials from the perspective of ICT students. The reason for using a single case study corresponds to Yin's (2003) conception of what makes a research study a single case study. Accordingly, a single case study is a suitable method to be used in an investigation when the case in the study has extreme or unique characteristics.

3.3. Participants

The participants of this study consisted of all twelve undergraduate students out of 21 who took the course, basic electronic and electronic components, in the 2018-2019 academic year. All of the participants were in their first year, and their ages ranged from 19 to 24. Participants' native language was Turkish, but the medium of communication in the university was English. Therefore, the course materials were given and presented in the English language, and the instructor speaks English during the course. As for gender, the participants composed of six females and six male students (see Table 3.1). All of the students who participated in the study were studying Computer Education and Instructional Technology program (CEIT), at a public university in Ankara, Turkey.

For the interviews, a convenience sampling method was used to gather participants (Fraenkel, Wallen, & Hyun, 2012). All of the students were voluntarily invited to be an interviewee in the study. The average of the ages for female and male students was 21.10 and 20.32 accordingly.

Table 3.1 The interviewees in terms of number and age

Gender	*Number*	*Mean (Age)*
Female	6	21.10
Male	6	20.32
Total	12	20.71

3.4. Instruments

This study collected different forms of data using various data collection instruments, including semi-structured interview protocol and survey. The interview form was composed of two parts: introduction and interview questions (Appendix C). The first part of the interview form included a piece of information about the purpose of the study and informed participants about the rights they owned during the interviewing. The second part consisted of interview questions. There were seven main interview questions, each accompanied by several sub-questions.

The researcher of this study collaborated with an experienced graduate student who graduated from Computer Education and Instructional Technology Department and experienced to make qualitative data collection instruments to write down the interview questions and benefitted from the basic electronic and electronic components course instructor's feedback on the subjects. Specifically, the process of writing and validating the interview questions started with consulting a graduate student about how to write the questions that could provide answers to the research questions. The graduate student had a broad experience in formulating similar questions in his doctoral dissertation. The researcher, together with the graduate student, wrote the first draft of the interview questions and then sent it to a course instructor who has a grasp of knowledge about forming open-ended questions for the interview. The researcher revised the interview questions that needed editing based on the feedback given by the instructor. After that, the altered items were mailed to the instructor again for the second review. After the instructor approved the final version

of the questions, the researcher attempted to contact the students and initiate the interview process.

The survey was the second data collection tool used in the study (Appendix D). There were two parts to the survey. The first part was used to collect demographic information about the participants, such as gender, age, department, etc. The second part of the survey included twenty-three Likert type questions, asking for getting participants opinions, perceptions, and experiences regarding the educational materials they were engaged as part of the basic electronic and electronic component course.

Another form of the data stemmed from students' logs, the frequency of use of educational materials by each one of the students. Students' records were used to examine the degree to which students involved in using animation-based learning materials.

Like the interview questions, the researcher asked for help from his colleagues to generate potential survey questions. While writing the survey items, they reviewed the relevant studies and the survey items used in relevant studies in order to come up with a pool of the items that best answered the research questions of the study. The survey questions were accumulated as the researcher wrote a new one. As a result, the first draft of the survey consisted of twenty-seven Likert-type questions. Once the process of forming survey questions was finalized, the questions were sent to the course instructor who is expert about the survey methods. The instructor provided comprehensive feedback about the wording, language, and meaning of the items. Four of the items were excluded from the survey, and some were rewritten and revised following the instructor's advice and suggestions. The final form of the survey comprised twenty-three items, along with a couple of questions for demographic information.

3.5. Data Collection Process and Procedure

The semi-structured interviews were conducted with twelve students who volunteered and agreed to participate in the study. All of the interviews were tape-recorded and carried out after students completed using the educational materials. The researcher conducted all the interviews in a meeting room. At the beginning of each interview session, the researcher gave the interviewee a consent form and asked to read it carefully before putting his/her signature. It took approximately 15 minutes to complete each interview session. Once the interview sessions were over, the recorded data were transcribed for further analysis and inspection.

The quantitative data of this study stemmed from the survey. The survey was given to the students at the end of the last course in the semester. The researcher printed out a hard copy of the survey for each of the students. Then, he attended the semester's last lecture hours and handed out hard copies to the students. The researcher intentionally collected the survey data by himself so that he could answer the students' questions and clear up any misunderstandings regarding the survey items. Students successfully filled out the survey and handed the hard copies over to the researcher.

Another form of the data used in the study was the records of students' logs, which were taken from the course web site. The course was taught face-to-face in the classroom, but its materials and documents were shared with students on a learning management system. The system was capable of holding a complete track and record of what students had done on the course section.

3.6. Interviewing

Semi-structured interviews were conducted with 12 participants who became a volunteer and agreed to participate in an interview. The interview process was mediated by the interview guideline suggested in the literature (Creswell, 2012). The researcher carried out all of the meetings based on the steps described in the instruction.

In advance of each interview, the researcher arranged a comfortable and quiet place so that the interviewee could feel safe, and nobody could disturb the interview process. The researcher informed participants about the study and gave them a consent form to sign. Once the participants read the consent form and sign it, the researcher asked them if they have any questions before starting the interview. Besides, the researcher asked participants that the interview process would be audio recorded if it was okay for them.

The researcher first asked the main questions and then sub-questions in order to get as much information from participants as possible. Those main and sub-main questions were accompanied by some probing questions to encourage participants to provide further information. Probing questions were used to gain more insight into the interviewee's experiences of animation-based materials. During the interviews, the interviewees could freely express their experiences and opinions related to the design and development of the materials. Besides, the researcher tried to develop empathy with the interviewees during the interviews so that they could give honest and trustworthy responses to the interview questions.

3.7. Animation Based Materials

Animation-Based learning materials were designed and developed by the researcher. Since the researcher did not have comprehensive knowledge about the basic electronics, and electronic components, he received help and guidance from the course instructor while determining and preparing the content of the animation-based

materials. Furthermore, the content of the materials was developed in parallel with the objectives specified in the basic electronic and electronic components course.

The educational materials composed of four parts. While the first three parts were used for introducing the basic electronic concepts and electronic components such as current, resistance, and Ohm's law, the last part was used for assessing students' performance and understanding about these concepts covered in the materials. Figure 3.1 below shows the layout of the animated learning content. As indicated in the figure, there was a navigation bar at the bottom of the video enabling learners to manage and control the video at their own learning pace. Preview and next buttons, situated at the right of the navigation bar, allowed learners to navigate between the contents. Also, an outline button at the left of the navigation bar enabled learners to jump directly from one substance to any one of the materials very quickly. Besides, the learners could pause and start the video at their own pace, and replay the video whenever they wanted. Moreover, there is a sound button that could be used to mute the video sound, depending on the preferences.

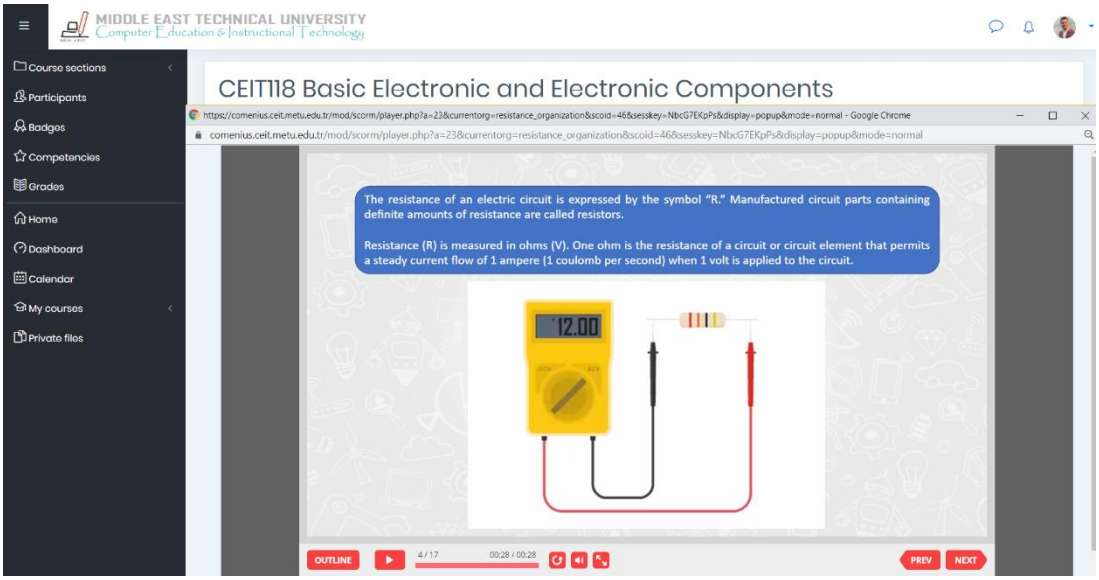

Figure 3.1. The layout of the animation-based learning content

The audio-visual materials used in the study included video, text, sound, animations, and visuals. There are 4 main animation-based multimedia materials, 3 of them surrounded by content and 1 of them if for test. The Test materials include 30 test questions about the content provided in 3 learning materials. 30 minutes was given for the students while taking the exam material. When participants open the course page on Moodle, they reach can reach the materials from the list they see on the dashboard. Figure 3.2 below was a screenshot taken from the educational materials. The figure illustrates how informative content was delivered to the learners. As shown in the figure, there was a piece of text introducing an electronical concept, and audio, relevant animations, and visuals accompanied the book.

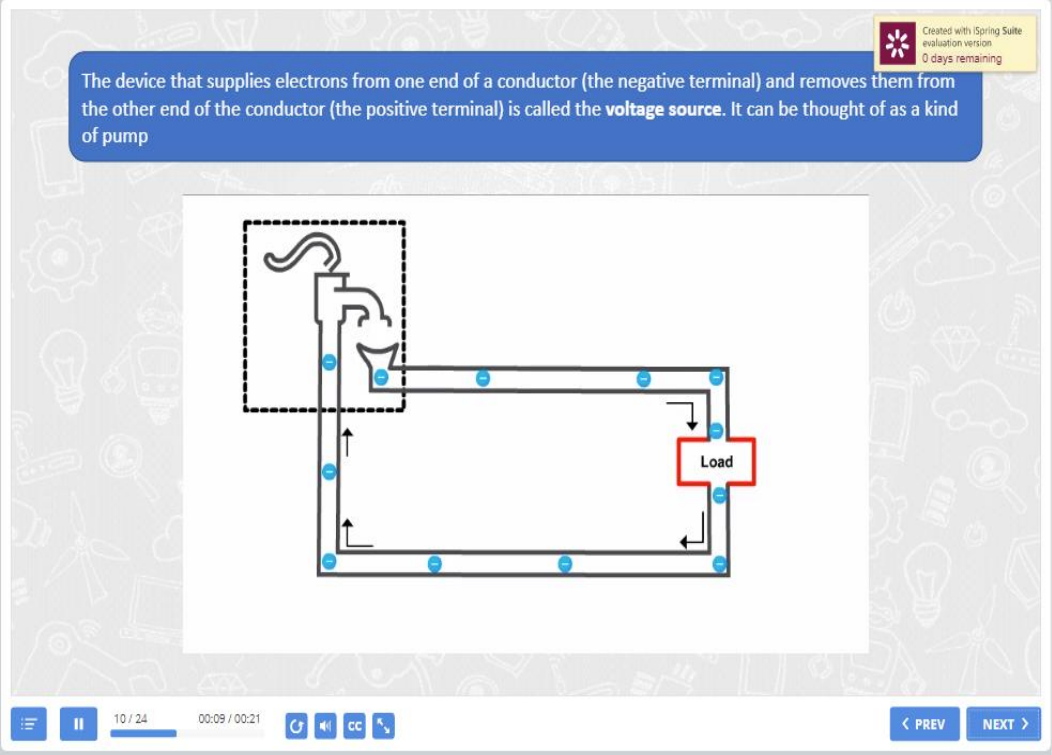

Figure 3.2. Delivering content of the materials through video, audio, text, and animation modes

3.8. Learning Management System - Moodle

The animation-based materials were delivered to the students on a learning management system named "Moodle." The instructor used Moodle to share course materials and documents with students, but the course was taught in the classroom by face-to-face format. The instructor opened an account on Moodle for each student who took the course. Students used the given account name and the password to sign in Moodle and access to the course materials and documents. The instructor opened an administrative account for the researcher on Moodle as well and equipped him with necessary permissions to manage the course content and materials shared on the course site.

Since the basic electronic concepts covered in the animation-based materials were in parallel with the topics taught in the course, the researcher shared educational

materials with students on Moodle during the week when the instructor covered the relevant concepts in the class. The prepared educational materials were divided into four packets, current, resistance, Ohm's law, and assessment test. Each week, one package was shared with students. The first part of the materials, current, was uploaded to the course web site between 1-7 March 2019. The second packet, resistance, was delivered to the students between 22-28 March 2019. The third packet, Ohm's law, and fourth packet, assessment test, were shared with students between March 29 and April 4, 2019.

Each week when the materials were shared, the researcher and the course instructor encouraged and informed students to engage in the animation-based materials. In order to increase students' participation in the materials, the instructor gave an extra point to the students who had been involved in all the materials and completed the assessment test. On Moodle, the researcher could see how many times and when each of the students logged in the course and participated in the developed materials. The students' logs provided by Moodle enabled us to detect those who barely benefitted from the animation-based learning materials.

3.9. Data Analysis Techniques and Procedures

The current study used qualitative and quantitative data to examine the effectiveness of the design of animation-based educational materials from the perspective of first-year undergraduate students. Two data collection methods, an interview, and a survey were utilized to gather qualitative and quantitative data accordingly. The study benefitted from different data analysis techniques and procedures while inspecting the qualitative and quantitative datasets.

For the data coming from the interviews, once the audio-recorded interviews were completed, the researcher started to transcribe the recorded speech into a written form. After undertaking the transcription of all interviews, the researcher made use of data analysis software (MAXQDA 2018) to analyze the interview data. The in-depth

analysis of qualitative data was conducted based on the coding strategies provided by Creswell (2012). Adhering to the suggested coding guide, the researcher examined the transcript of the first participant's interview, which ended up with the identification of a couple of themes or patterns, concepts, dimensions, and properties (Corbin & Strauss, 2008).

The second and third interview transcripts were analyzed in the same way as the first interview transcript. After combining, merging, and condensing the codes drawn from the primary three interview transcripts, a flexible and tentative coding template was formed. The coding model was used in the analysis followed. During the investigation of other transcripts, as new themes or concepts emerged, they are immediately added to the existing coding template. Throughout the data analysis process, the coding model was continuously revised, extended, and developed until the final version of the template was attained. To ensure the validity and reliability of qualitative data, the final codes were cross-checked and reviewed by an intercoder who is a graduate student from the Department of Computer Education and Instructional Technology, and have an experience to examine interview transcripts, independently examined each student's interview transcript and the codes given by the researcher. The coding process was terminated after the researcher and intercoder had reached an agreement on the final codes.

For the analysis of the data coming from the survey, the researcher used statistical data analysis software (SPSS 2019). Students responses to the survey items were entered into the SPSS program. After that, the data were checked and inspected for missing data, outliers, and normality (Pallant, 2010). No missing data and outliers were detected after examining histogram and boxplot of the scores. In the literature, the data were regarded to be distributed normally when the value of skewness and kurtosis is between +3.00 and -3.00 (Hair, Anderson, Tatham, & Black, 1998). The result showed that the survey data had a value of 2.43 and -1.61 for skewness and kurtosis, respectively.

3.10. Reliability and Validity

Ensuring the validity and reliability of the study data is crucial because it could affect all the inferences and conclusions that are drawn from the study. According to a well-known author, validity refers to "the appropriateness, correctness, meaningfulness, and usefulness of the specific inferences researchers make based on the data they collect" (Fraenkel, Wallen, & Hyun, 2012, p. 148). As for the reliability, Fraenkel et al. (2012) state that reliability addresses "the consistency of the scores obtained how consistent they are for each individual from one administration of an instrument to another and from one set of items to another" (p. 154). In qualitative studies, however, the authors used the term 'trustworthiness' which encompasses the concepts of validity and reliability (Lincoln & Guba, 1985). In order to ensure the validity and reliability of the collected data, the author of this study adheres to the following strategies. First of all, multiple sources of data, qualitative and quantitative, are gathered and triangulated to answer the research questions of this study. Second, the one experienced and the one novice researcher in the field of computer education and instructional technology, who have extensive experience in qualitative research, reviewed all the data collection instruments several times, including interview form and survey items, and guided the data collection processes from beginning to the end. Third, apart from the researcher himself, a doctoral student, who has previously engaged in several qualitative data analysis projects, served as an intercoder and independently inspected and coded the qualitative data of the study. As part of the qualitative data analysis, the final codes extracted by the researcher and the intercoder were then cross-checked and reviewed. The coding process was terminated after the researcher and intercoder had reached an agreement on the final codes. Forth, the researcher gives a detailed description of the study setting, the participants, and data collection and analysis process. In addition to that, the quotations are taken from the interviews and attached to corresponding parts of the findings.

CHAPTER 4

RESULTS

4.1. Overview

The study findings stemming from the mix of qualitative and quantitative data. The analysis of qualitative data culminated with six themes (see Table 4.1): (I) design components of the animation-based multimedia materials, (II) implementation of the multimedia materials to the teaching of basic electronic topics in other subjects, (III) appropriateness of the animation-based multimedia materials, (IV) challenges, (V) benefits of using animation-based multimedia materials, and (VI) suggestions. Each of these themes, along with the corresponding sub-themes, as described below, was supported by quantitative results as well as excerpts from interview transcripts.

Table 4.1 Themes and Sub-themes of qualitative data

Main themes	Sub-themes
Design Component of the Animation-Based Multimedia Materials	Content of the Animation-Based Materials Interface Overall continuity in design Design examples Circuit diagram Overall satisfaction with the existing design format
Implementation to Other Electronics Subjects	
Appropriateness of the Animation-Based Multimedia Materials.	Students The subject of electronics Content
Challenges	
Benefits of Using Animation-Based Multimedia Materials	
Suggestions	Design Content of the materials

4.2. Findings

The qualitative and quantitative findings, reported below, were merged to provide a better understanding of the phenomena being investigated. Despite using two types of data, the main emphasis was given to the qualitative findings when reporting the results. Quantitative data were used to strengthen and validate the conclusions drawn from qualitative data.

4.2.1. Design Component of the Animation-Based Multimedia Materials

After exposing to the multimedia materials, students were asked to evaluate the design of the educational materials in terms of their experiences of materials. The analysis of interview data resulted in a theme named "design of the materials." This theme divides into six sub-categories, and each describes a different dimension of the theme, namely the content of the materials, interface, overall continuity in design, design examples, circuit diagram, and satisfaction with the design format.

Content of the Animation-Based Materials

The first category, the content of the materials, deals with how well the instructional content provided in the multimedia materials was arranged and organized. Regarding the complexity and understandability of the content of the materials, six of the students interviewed stated that the content of the materials was clear, straightforward, and easy to understand. Besides, they added that they did not grapple with following the content and navigate the videos. The similar results were founded after the survey data were examined (see table 4.2). About %72 of the students slightly agreed and agreed that they did not get into difficulty while engaging in the multimedia materials. Likewise, 50% of the students disagreed and 43% of the students strongly disagreed that the content of the materials was so complicated that it was difficult to understand. Furthermore, 86% of the students disagreed and strongly disagreed that having access to animation-based multimedia materials was challenging.

EN_INT_3: I think the way this has been designed is good. I think a plain design is better, and I like how it is simple.

TR_INT_ 3: Bence bu şekilde iyi tasarımı. Ne kadar sade olursa bence o kadar daha iyi. Bence sade bir tasarımı var.

EN_INT_12: No, it was not complicated. I did not struggle to understand it. I think everything was very obvious.

TR_INT_12: Hayır karmaşık değildi, ben anlamakta sıkıntı çekmedim. Kafamı karıştıran bir durum olmadı. O yüzden bence gayet açıktı.

EN_INT_6: It was obvious and easy to understand. I like providing the opportunity to work again later, switching to the desired screen in the content and the fact you can control the sound was a good thought

TR_INT_6: Gayet açık ve anlaşılırdı. Daha sonra tekrar çalışmak imkânı sunması, içerikler alanında istenilen ekrana geçiş yapabilme özelliği güzeldi. Ses kontrolleri iyi düşünülmüş.

In addition, the result of the interview data analysis showed that the majority of the students were happy and satisfied with the design and content of the multimedia materials. Nine of the students indicated in the interviews that they were quickly adopted with the combination of video, sound, text, animation, graphics, and images. They explained that the design and organization of these media formats were formed satisfactorily, and the content was presented shortly and nicely without losing essential information about the topic.

EN_INT_6: The topics were explained in a short but detailed way. The visuals helped a lot. I liked the content in general.

TR_INT_ 6: Konuları güzelce açıklamış, özetlemiş kısa bir biçimde ama önemli detayları kaybetmemiş. Görseller eklemiş, görseller çok yararlı olmuş. İçerikleri genel olarak beğendim.

EN_INT_8: Apart from that, the design was good; the animations and the content worked very well together.

TR_INT_8: Onun dışında tasarımı iyiydi, animasyonlar ve konular çok iyi birleştirilmişti ve anlatılmıştı.

Another part of the materials the students liked was the use of plenty of visuals and graphics to make the learning content understandable and meaningful. Ten of the students expressed that the materials provided rich visual information about the concepts being covered in the course.

EN_INT_9: The photos were easier to understand in comparison to the book. I ended up using these materials more.

TR_INT_9: Kullanılan görseller de kitaba göre daha net ve anlaşılırdı. O yüzden de daha çok bu materyalleri kullandım.

EN_INT_12: The design was excellent; the colors of the boxes behind the texts made the text a lot easier to read. I liked the photos. However, the quality of some of the pictures was terrible. Apart from that, it was excellent.

TR_INT_12: Tasarımı iyiydi, metinlerin renkleri ve arkasında yer alan kutuların renkleri okumayı çok kolaylaştırmıştı. Görseller güzeldi. Bazı görsellerin görüntü kalitesi diğerlerine kıyasla daha kötü idi. Bunların dışında güzeldi.

All of the students found the multimedia materials practical and useful to teach basic concepts of the electronics and circuit. All twelve of the students interviewed stated that incorporating rich visual information such as animation, sound, visuals, and text turned the material into a useful multimedia learning tool.

EN_INT_6: As there were photos and sounds, it made learning more effective. When the content is put together like this, it makes learning easier and more permanent.

TR_INT_6: Hem ses hem de görseller kullanması nedeniyle daha etkin bir öğrenme materyalidir. Bu şekilde bilgileri birleştirdiğimizde daha kalıcı olmasını sağlıyor daha iyi öğrenmemizi sağlıyor.

EN_INT_7: The use of sounds and visuals made it a successful learning material.

TR_INT_7: Hem ses hem de görseller kullanması nedeniyle daha etkin bir öğrenme materyalidir.

Besides, the students were convinced that the learning concepts delivered through the multimedia materials matched to the objectives of the course given in the face-to-face form. Six of the students mentioned that what they were taught in the course by the lecturer was just the extended version of the content delivered in the multimedia materials.

EN_INT_4: It has definitely had an impact on the exam. The content follows the exam. The topics studied matches the content.

TR_INT_4: İçeriğin kesinlikle sınava yönelik katkısı olduğunu söyleyebilirim. Tüm konular ve içerik birebir örtüşüyor.

EN_INT_7: It was a summary of all the topics we studied.

TR_INT_7: Hani derste işlediğimiz içeriklerin özeti gibiydi.

Interface

Students in interviews reflected their opinions regarding the arrangement, organization, and placement of the different parts of the content. All of the students interviewed stated that the interface of the materials was straightforward, and it was easy to use materials when working on the topics. They explained that the interface of the materials was so natural that they did not have any difficulty to find what they were looking for.

EN_INT_12: I used the materials with no problems. Interface usability was straightforward to use.

TR_INT_ 12: Materyalleri sorunsuz kullandım, ara yüz kullanımı çok rahattı.

EN_INT_11: The design was good; it was simple and easy to understand.

TR_INT_ 11: Tasarımı iyiydi, basit anlaşılır ve açıktı.

EN_INT_1: I do not remember having any technical issues within the application.

TR_INT_1: Uygulama içerisinde yer alan yönlendirmeler, butonlar, butonların kullanımları ve fonksiyonları ile ilgili bir sorun yaşadığımı hatırlamıyorum.

Overall continuity in design

This section is about how well students think that the delivery of the content is connected and related throughout the presentation. There could be some parts of the design undermining the organization of the materials. All twelve of the students expressed in interviews that they did not experience a discontinuity in the delivery of the materials. Students thought that the transition between screens was smooth, and there were not even subtle design changes while migrating from one screen to another.

EN_INT_13: Well, yes, the app definitely flowed well. The colours worked well together. It was not an eyesore.

TR_INT_13: Yani evet akış olarak bence akıcı. Göze batmıyor. Renk kullanımları vs. arka plan rengi gibi bu renkler falan bence güzel yani. Göze akıcı geliyor.

EN_INT_6: It was apparent and easy to understand. The fact you could go back and work on it again and go to other screens was good. Being able to control the sound was a good thought.

TR_INT_6: Gayet açık ve anlaşılırdı. Daha sonra tekrar çalışmak imkânı sunması, içerikler alanında istenilen ekrana geçiş yapabilme özelliği güzeldi. Ses kontrolleri iyi düşünülmüş.

Design examples

The animation-based materials consisted of additional design examples so that students could observe and find the differences between different circuit designs. The analysis of the students' responses to interview questions indicated that students found the design examples beneficial. Four of the students expressed that the use of multimedia tools such as visuals and text made the design examples more useful.

> EN_INT_11: Well yes, the visuals and text going together made it a lot easier to understand
>
> *TR_INT_11: Aslında evet gösterimi iyiydi, yazı ve görselin birlikte kullanılması anlamayı kolaylaştırıyor.*

> EN_INT_5: It was a good and helpful example.
>
> *TR_INT_5: Güzel, faydalı devre örnekleriydi.*

Circuit diagrams

Circuit diagrams with varying levels of complexity were embedded in the materials. It was aimed to help students understand how the circuit components are connected or wired. Ten of the students stated in interviews that the way circuit diagrams were provided was excellent and quite beneficial. One of the students said that in addition to show and animate the different circuit diagrams, the differences and similarities could have been asked between them.

> EN_INT_5: The circuit diagrams were simple and not confusing at all.
>
> *TR_INT_5: Devre şemaları açık anlaşılır kafa karıştıran herhangi bir şey yoktu.*

> EN_INT_7: There could have been a few different examples given.
>
> *TR_INT_7: Örneklemeler ve gösterimlerde farklılık aranabilirdi.*

EN_INT_4: It still has a reasonable basis for learning, like in middle school, you learn the content in an easy way. You cannot show this in a different form.

TR_INT_4: Yine çok temel öğretiyor, orta okuldaki gibi, eğer amaç basit anlamda konuyu anlatmak ise çok güzel bir şekilde bunu başarıyor. Başka türlü gösterilemez.

Overall satisfaction with the existing design format

The analysis of the interview data showed that the majority of the students thought that the current design of the materials was satisfactory. Nine of the students expressed that they were content with the way materials were designed and the methods used for the design type. Some of the characteristics of the animation-based multimedia materials, such as the selection of the visual, colors, animations, and the arrangement of the navigation panels and buttons, were considered to be appropriate and in harmony with the design.

EN_INT_12: The design was good, and the colors of the boxes behind the texts and the texts themselves made it the content easy to read. The pictures were nice. The quality of some of the visuals was better than the others. Other than that, it was good.

TR_INT_12: Tasarımı iyiydi, metinlerin renkleri ve arkasında yer alan kutuların renkleri okumayı çok kolaylaştırmıştı. Görseller güzeldi. Bazı görsellerin görüntü kalitesi diğerlerine kıyasla daha kötü idi. Bunların dışında güzeldi.

EN_INT_6: The topics were explained nicely, there was a summary of each topic, but none of the essential points were missed out. The photos were beneficial. Generally, I liked the content.

TR_INT_6: Konuları güzelce açıklamış, özetlemiş kısa bir biçimde ama önemli detayları kaybetmemiş. Görseller eklemiş, görseller çok yararlı olmuş. İçerikleri genel olarak beğendim.

Contrary to the qualitative results, the analysis of survey data showed that 50% of the students disagreed or strongly disagreed with the idea of using the supplementary resources similar to the animation-based multimedia materials. Similarly, 43% and 21% of students disagreed and strongly disagreed that they would not recommend their colleagues to use the same multimedia materials.

4.2.2. Implementation to Other Electronics Subjects

Students were asked to indicate whether these materials could be used to teach other electronic concepts related to circuitry. Nine of the students expressed in interviews that it was quite possible to utilize similar multimedia materials to present information about the related circuitry topics. Few of the participants also added that it might be better to modify and enhance these materials so that they could match the targeted objectives.

> EN_INT_4: Of course, it can still be used and also be improved. More rich additions can be made.
>
> *TR_INT_4: Tabii kullanabiliriz, tabii geliştirmeye açıktır. Zengin öğeler eklenebilir.*

> EN_INT_3: I think all lessons should be like this, not just electronic concepts. Like I said, with more animation and richer content. Could add examples from day to day life. Could add questions. Right, wrong, different animations, videos, photos, and even more examples that I cannot think of at the moment. Examples that can be replicated small games, maybe.
>
> *TR_INT_3: Bence sadece elektrik ve elektronik için değil bütün derslerde bu şekilde olmalı bence. Daha faydalı oluyor. Yani dediğim gibi işte animasyon şeklinde ve içeriği zenginleştirilmiş bir biçimde. Gerçek hayattan örnekler konulabilir. Sorular konulabilir. Doğru, yanlışlar, farklı*

animasyonlar, videolar, fotoğraflar daha aklıma gelmeyen örnekler. Çoğaltılabilir örnekler. Küçük oyunlar

EN_INT_7: Chemistry was helpful when I was in high school. I preferred lessons that included animation, in biology, especially animations, should be preferred. In biology, it is easier to watch and learn the way molecules move and bump into each other, etc. through the use of visuals.

TR_INT_7: Kimya da çok faydalı, lise de ben animasyon içeren eğitimler tercih etmiştim, biyoloji de de özellikle animasyonlar tercih edilmelidir, kimya da moleküllerin oluşması örneğin çok uygun konular, çarpışmalar vs. konular dolaysı ile bu konuları görerek izleyerek öğrenmek çok daha kolay oluyor.

The analysis of participants' responses to survey items showed that more than half of the participants, 57%, agreed or strongly agreed that similar kinds of activities that included animation-based media could be frequently used in other subjects (see table 4.2).

The analysis of quantitative data also revealed that students perceived competence in conveying the learned concepts of electronics. 36% and 21% of the students slightly agreed and agreed that they found themselves competent to transfer their learning gains and experiences in the course to somebody else.

4.2.3. Appropriateness of the Animation-Based Multimedia Materials.

The sub-themes below are about how appropriate the content of the animation-based materials for the freshman students and whether these materials are suitable for the coverage of the subject of electronics. There is another sub-theme describing the correspondence between the content of the materials and the main course.

Students

In addition to the design of the materials, it is also essential that the prepared materials are suitable for the target group. First-year students were asked in interviews to provide their opinions about the appropriateness of the content to the level of the students. All twelve of the students stated in interviews that the difficulty level of the materials matched the level of first-year students. Several students taught that the content of the materials was straightforward, even more suiting to the high school level.

> EN_INT_2: Because we saw the basis of electronics, we saw these before, and it usually is easier. The topics are easier for university students only because we saw these topics in high school.
>
> *TR_INT_2: Şimdi biz temel elektrik elektronik aldığımız için zaten bu tür şeyleri görüyoruz ama normalde kolaydı. Üniversite öğrencisine göre kolaydı konular. Çünkü lisede gördüğümüz konuların aynısıydı.*

> EN_INT_11: Definitely suitable. In fact, it could have been more detailed for students at our level.
>
> *TR_INT_11: Kesinlikle uygundu. Hatta bizim seviyemize göre biraz daha detaylandırılabilirdi.*

> EN_INT_12: Yes, it was suitable, because we already gained the foundation. We moved forward by adding what we knew.
>
> *TR_INT_12: Evet, uygundu, daha önce edindiğimiz alt yapı vardı. Onun üzerine koyarak ilerliyoruz.*

The subject of electronics

Students were probed to evaluate how appropriate to use animation-based materials to introduce the subject of the electronics. All twelve of the students expressed that the combination of different media devices was a suitable and helpful means of teaching the concepts of electronics. As it could be seen in table 4.2, the analysis of quantitative data revealed a similar result. 64% of the participants slightly agreed or agreed that

they thought that they could use animation-based materials to teach the concepts about electronics.

> EN_INT_9: I liked how the materials explained the notions of electronics.
>
> *TR_INT_9: Materyalin elektrik kavramlarını öğretmede çok yararlı olduğunu düşünüyorum.*

> EN_INT_6: Definitely think it can be used; learning this topic was very useful for me.
>
> *TR_INT_6: Kullanılabilir elbette, benim için de konuyu öğrenmemde çok yardımcı oldu.*

The analysis of survey data showed that 44% of the students slightly agreed or agreed that they thought that similar animation-based multimedia materials could be used in schools as in-school activities (see table 4.2).

Content

Students' performance or grades on the course exam could be undermined if the educational materials have the type of information that is not in parallel with the information given in the main course. Because the content of the materials was supposed to be matching that of the main course. The analysis of the interview data showed that students thought that the type and amount of the information delivered through multimedia materials were firmly relevant to the course content. Five of the students expressed that they found the amount of information provided by multimedia materials sufficient and appropriate.

> EN_INT_4: I can say the content was helpful towards the exam. The concept and topics worked well together.
>
> *TR_INT_4: İçeriğin kesinlikle sınava yönelik katkısı olduğunu söyleyebilirim. Tüm konular ve içerik birebir örtüşüyor.*

EN_INT_6: It summarized the lessons very well. Furthermore, additionally, they had visuals. I think it was excellent.

TR_INT_6: Dersin öğrenimi açısından birebir özetlemişti. Ek olarak görselleştirmişti. Bence güzeldi.

The result of survey data, as shown in Table 4.2, indicated that 36% and 21% of the students agreed and strongly agreed that the animation-based multimedia materials should be incorporated into the electronic curriculum.

4.2.4. Challenges

The challenges theme deals with the problems and issues students experienced while using the educational materials. The challenges students encountered when engaging in materials were grouped as browser compatibility issues, the amount of text, time, content quantity, and sound quality problems. Thus, one of the students pointed out that the type of browser used by the user might not correctly support the media contents embedded into the materials. That is why the learners should be informed about the kind of browser that best works with the materials.

EN_INT_12: There may be a problem for the user on the browser side of the application.

TR_INT_12: Kullanılan tarayıcı kaynaklı kullanıcı tarafında bir sorun yaşanılabilir.

The other reported challenge concerned with the amount of the text. One of the students in interviews complained that his interest in the educational materials faded out after finding out that the materials involved plenty of texts. Using more text could distract the learners and damage their desire to learn with multimedia materials.

EN_INT_7: The text was too long, and it made me not want to read it.

TR_INT_7: Yazıların çok fazla uzun olması durumunda eğitimi okumak içimden gelmiyordu,

Students also complained that they could not be able to complete answering all test questions within the specified time period. Three of the students stated in interviews that they had difficulties in finishing the test in time. Therefore, it would be better to allocate more time than it was assigned in the first place. On the other hand, the analysis of survey data showed that 43% and 36% of the students slightly agreed that they thought that a sufficient amount of time was given for the topics covered in multimedia materials. Similarly, 70% of the students disagreed or strongly disagreed with the statement, "it took me a long time to complete animation-based learning materials" (see table 4.2).

EN_INT_7: There could have been more time given on the test side, or make the timing more flexible.

TR_INT_7: Süre daha çok verilebilirdi test materyalinde, daha esnek zamanlar verilebilirdi.

EN_INT_10: The time limit on the interactive exam material bit was a problem, other than that, I did not face any issues.

TR_INT_10: Etkileşimli testte zaman sınırı sorun oldu, onun dışında bir sorunla karşılaşılmadı.

One of the students emphasized the luxury of adding more content to the materials. He thought that the animation-based multimedia materials were filled with more amount of the content then it should typically be. Therefore, it was demanded that the content could have been accompanied with plenty of questions.

EN_INT_12: There was a lot of content explanation. There could have been more examples given. The content explanations were enough, but there could have been more questions to answer.

TR_INT_12: Çok fazla konu anlatımı olmuş. Çok fazla örnekle desteklenebilirdi. Konu anlatımın yeterli idi ama daha çok soru çözümü olabilirdi.

The analysis of students' answers to interview questions showed that one of the media formats, sound, distracted some of the students' attention. Seven of the students reported that the noise coming from the background was uncomfortable and irritating. It could be better to use a real person/speaker instead of a machine speaker for sound recording.

EN_INT_4: I did not like the sounds. Machine sound was used. Noise tends to distract me. Also, the explanations added on the interface pages distracted me.

TR_INT_4: Ses beni rahatsız etti. Makine sesi kullanılmıştı. Ses genel olarak da dikkatimi dağıtıyor. Ayrıca ara yüzde bulunan bilgilendirme ekranları da dikkatimi dağıttı.

EN_INT_9: The background vocals could have been said a little slower; they spoke very fast in some parts.

TR_INT_9: Arkadan gelen ses farklı yavaş seslendirilebilirdi, bazı kelimler çok hızlı geçmişti.

EN_INT_7: I was bored at this bit; the background noise distracted me a little.

TR_INT_7: Bir kısmında ise sıkıldım, arka planda eklenen ses biraz dikkat dağıtıcı olmuştu.

4.2.5. Benefits of Using Animation-Based Multimedia Materials

This theme describes the positive characteristics attributed to animation-based multimedia materials. According to students interviewed, these materials could provide a number of benefits from better and meaningful learning to the growth of intrinsic motivation and interests in learning, and enjoyment. For instance, four of the

students expressed in the interviews that the existing animation-based multimedia materials were utterly superior to traditional text-based instruction. For the students, the combination of multimedia tools, including text, sound, animation, visual, and video, could facilitate the introduction to the concepts of electronics and circuit.

> EN_INT_3: Instead of reading a book, this worked better and easier for me.
>
> *TR_INT_3: Direk kitabı alıp okumaktansa böyle daha akıcı ve kolay geldi.*

> EN_INT_4: Yes, and in a book, there tons of pages with writing in. It makes it seem like a long process. Instead of reading twenty twenty-five pages, it is more comfortable to do it this way.
>
> *TR_INT_4: Evet birde kitapta bir sayfa dolusu yazı var. İnsanın gözünde büyüyor. On beş yirmi sayfa tek tek okumaktansa böyle daha iyi.*

Besides, these materials could be more beneficial if the content of the materials is designed in parallel with the course objectives. Ten of the students stated that animation-based multimedia materials helped them to fulfill the course objectives.

> EN_INT_9: Yes, it meets the standards of what we learned in the lessons. This way, we managed to recap everything.
>
> *TR_INT_9: Evet karşılıyor derste öğrendiklerimizi burada tekrar etmiş olduk.*

> EN_INT_2: I think it met the standards. It matched the objectives that we learned perfectly.
>
> *TR_INT_2: Bence karşıladı. Öğrenme hedefleriyle örtüşen birebir içerikler vardı.*

The analysis of data showed that students enjoyed studying when the content of the course was delivered through animation-based multimedia materials. Five of the students expressed in interviews that they got great satisfaction and enjoyment from

the materials. Besides, the materials helped students use time effectively by providing only essential and summary of the information given in the coursebook.

> EN_INT_9: It increased, if I were to study from the book or bits of paper, I would have left it, but the way it flowed and finished the lesson program helped me finish it.
>
> *TR_INT_9: Artırdı, kitaptan yapmış olsam ya da kağıtlardan yapmış olsam sıkılır bırakırdım, ama geçişlerin olması ve eğitim tamamlama bilgisi bitirmemi sağladı.*

> EN_INT_1: It makes the lessons much more fun. The animations and the visuals make it less annoying. This helps students to concentrate more. It has these kinds of positive aspects.
>
> *TR_INT_1: Hem bu şekilde dersi de biraz daha eğlenceli hale getiriyor. Animasyonlu ve görsellerin olduğu içerik olması sıkıcı olmasını engelliyor. Bu da öğrencinin dikkatini daha çok toplayabiliyor. Bu tarz avantajları var.*

In addition to enjoyment, the analysis result revealed that the students' intrinsic motivation was increased when using animation-based multimedia materials. All twelve of the students reported in interviews that multimedia materials helped them grasp the subjects, and this, in turn, creates an upward movement in their intrinsic motivation. Similarly, the analysis of quantitative data revealed that more than half of the students, 57%, slightly agreed and agreed that the animation-focused materials drove their interest and motivation in the concepts of electronics (see table 4.2).

> EN_INT_1: It is made me believe that I have learned more, which has helped with my motivation.
>
> *TR_INT_1: Daha fazla öğrendiğimi düşünmeme neden oldu, bu da motivasyonuma pozitif etki etti.*

> TR_INT_12: Depending on the motivation of the student, it was an application that increased the retention.
>
> *TR_INT_12: Öğrencinin de motivasyonuna bağlı olarak akılda kalıcılığı artıran bir uygulamaydı.*

EN_INT_6: It makes the lessons much more fun. The animations and the visuals make it less annoying. This helps students to concentrate more. It has these kinds of positive aspects.

TR_INT_6: Hem bu şekilde dersi de biraz daha eğlenceli hale getiriyor. Animasyonlu ve görsellerin olduğu içerik olması sıkıcı olmasını engelliyor. Bu da öğrencinin dikkatini daha çok toplayabiliyor. Bu tarz avantajları var.

The other benefit acquired through these multimedia materials was reported to be the growth of students' interests in learning. Students responses to the interview questions showed that nine of the students thought that the involvement with animation-based multimedia materials intrigued them and even pushed them to learn more about the subject. A similar result was reflected in the analysis of quantitative data, where 72% of students slightly agreed or agreed that they interested in studying multimedia materials (see table 4.2). Likewise, 57% and 21% of students somewhat agreed and decided that they did not get bored while working with the supplementary materials.

EN_INT_8: Yes, it increased my interest; I did not have an approach like this towards other lessons. It was the first time we had an interactive experience in lessons. In this sense, the app has definitely interested me.

TR_INT_8: Evet ilgimi artırıldı, diğer derslerde bu tarz bir yaklaşım olmamıştı. İlk defa bir derste interaktif bir uygulama deneyimledik. Bu anlamla ilgimi çeken bir uygulama oldu.

EN_INT_5: Yes, my interest has increased; instead of drowning under pages of the book, these types of materials have motivated me to learn more.

TR_INT_5: Evet ilgimi artırdı, kitaptan sayfaların arasında boğulmaktansa burada materyal ile öğrenmek ilgimi artırdı.

Multimedia materials allowed students to make meaningful connections between learning parts, thereby strengthening their learning of the course subject. Seven of the students expressed in interviews that the multimedia materials visualized and

animated the abstract concepts that were very difficult to understand from text-based books or resources. With the help of the animation-based materials, as described by the students, the concepts that were difficult to grasp could become more understandable and comprehensible. This is, of course, due to the affordances of multimedia technology and the better combination of a variety of multimedia devices. Quantitative data supported this result. The analysis of survey data showed that 64% of the students agreed or strongly agreed that it would be easy to learn abstract basic concepts using animation-based multimedia materials.

> EN_INT_2: I think this type of learning has more of a positive effect. It is a concrete concept, and you learn it substantially. When we show the current in an abstract period of time, we can see why the current moves in such a way.
>
> *TR_INT_2: Bence asıl bu tarz kavramları öğrenmede etkili oluyor. Yani somut bir şeyi zaten somut olarak görebiliyorsun. Soyut olarak devrede akımın geçiş yönünü falan gösterdiğimizde akımın ne olduğunu falan anlayabiliyoruz devrelerle.*

> EN_INT_8: When we put the information together, it allows the information to become more permanent and help us learn better.
>
> *TR_INT_8: Bu şekilde bilgileri birleştirdiğimizde daha kalıcı olmasını sağlıyor daha iyi öğrenmemizi sağlıyor.*

Exposing learners to the animation-based multimedia materials could bring about a positive impact on the acquisition of learning and students' understanding of the concepts. All twelve of the students expressed in interviews that the multimedia materials made fruitful contributions to the learning and understanding of the concepts of the electronics and circuit. The animation-based multimedia materials are characterized as mixing and blending of different media tools such as animation, video, audio, text, and visual. Students thought that these various media tools collectively helped them learn the course content better and effectively.

EN_INT_6: The fact there are visuals, and sounds make it a much more productive learning material. This way, when we put the information together, it creates a more permanent form of learning.

TR_INT_6: Hem ses hem de görseller kullanması nedeniyle daha etkin bir öğrenme materyalidir. Bu şekilde bilgileri birleştirdiğimizde daha kalıcı olmasını sağlıyor daha iyi öğrenmemizi sağlıyor.

EN_INT_8: It becomes more permanent when we put the information together in this way.

TR_INT_8: Bu şekilde bilgileri birleştirdiğimizde daha kalıcı olmasını sağlıyor daha iyi öğrenmemizi sağlıyor.

EN_INT_2: I think it is a beneficial way of learning.

TR_INT_2: Faydalı olduğunu öğrenmeye katkısı olduğunu düşünüyorum.

Besides, analysis of quantitative data showed that the majority of the students, about 84%, slightly agreed or agreed that they thought that the animation-based materials were useful in learning the concepts of electronics. Similarly, half of the students, 50%, slightly agreed or agreed that they thought that they had developed their knowledge and skills about the basic electronics and electronic components.

4.2.6. Suggestions

Students reported a number of suggestions regarding the design and content of the animation-based multimedia materials. The recommendations are grouped into two parts: design and content. Each of these parts, as described below, along with the relevant quotes, was drawn from interview transcripts.

Design

Feedback could work as an essential catalyst for the construction of the learning in the delivery of multimedia content. Three of the students underlined the importance of giving immediate feedback to the questions.

According to students, there should be a feedback mechanism or system working as a response to the questions that were asked at the end of each package of the multimedia materials.

> EN_INT_4: In order to reinforce learning, the question should immediately follow the content and then get feedback on the question answered.
>
> *TR_INT_4: Öğrenmeyi pekiştirmek amacı ile konunun arkasından hemen bir soru ve ilgili soru ile ilgili feedback geri dönüşü almalı.*

> EN_INT_3: The application should give feedback straight away so the student can realize their mistakes and learn from them. I think it will be better if the feedback happens immediately after.
>
> *TR_INT_3: Uygulama hemen feedback verilmeli ki öğrenci hemen hatasını görsün ve öğrensin. Direk olunca daha iyi olur bence.*

The test questions that measured students' learning and understanding of the subject concepts were placed at the last multimedia package. Seven of the students suggested that the test questions should be embedded into the related content so that they could immediately find out and monitor their learning progress. Instead of giving test questions after the introduction of the whole three packages, it could be an efficient method to scatter test questions over the instructional content or put them at the end of each part of the material.

> EN_INT_8: At the end of every slide, there could be a question asked, the questions could be asked with some form of animation, could also use a video with animations.
>
> *TR_INT_8: Her slaydın bitiminde soru sorulabilir, animasyonlarla gösterip onun sorusu sorulabilir, soru kökünde de video ve animasyonları kullanabilir.*

> EN_INT_5: At the end of every topic, there could be a little quiz added for it to show how much we have learned or not learned.

> Moreover, according to the results of the quiz, I could go back to improve on the topics I did not answer correctly on.
>
> *TR_INT_5: Her bir materyal sonunda küçük quizler eklenebilir, ne kadar öğrenip öğrenmediğimi ölçen. Quiz sonuçlarına göre eksiğim olan konulara beni geri yönlendirebilirdi.*

One of the students recommended that there should be an auto-pacing mode along with the self-pacing way in the multimedia content. When in operation, the automation mode would allow users to sit on their desk without acting to change the content screen by mouse or touchpad and concentrate on the content.

> EN_INT_8: Instead of pressing the next button to go on to the next page, it should automatically do it after a couple of seconds.
>
> *TR_INT_8: Devamlı next tuşuna basmak yerine belirli bir saniye sonra otomatik değişebilirdi.*

Presenting information about the subject concepts might not be enough for learners to explore the similarities and differences between distinct concepts. One of the students stated in the interview that the introduction of a subject concept should be elaborated by presenting how that concept was similar to and different from other corresponding concepts. Another student expressed that there should be more complex circuits and circuit diagrams to see how various circuit components were wired in different forms.

> EN_INT_4: Of course, it can be improved; things like similarities and differences can be added. It could make it better. Could create more comparisons and similarities.
>
> *TR_INT_4: Geliştirilebilir tabili, testler, similarities and differences benzeri şeyler eklenebilir. Daha iyi olabilir. İçerisinde daha fazla kıyaslama, benzerlik kurarak*

> EN_INT_2: There could be more complicated examples. This is so that students can see difficult examples.
>
> *TR_INT_2: Daha karışık devreler kullanılabilir. Öğrencilerin daha karmaşık örnekleri görebilmesi açısından.*

One of the students emphasized that there could have been more entertaining activities. Furthermore, a different student recommended that some parts of the multimedia content could also be delivered in 3D format, along with the 2D form. Leveraging the technological opportunities and incorporating 3D animations or 3D-animated graphics into the multimedia content would indeed create a significant impact on students learning, interests, and motivation.

> EN_INT_4: Could involve more fun activities.
>
> *TR_INT_4: Daha ilgi çekici etkinlikler eklenebilirdi.*

> EN_INT_1: For it to be more efficient, instead of two, there should be three-dimensional explanations.
>
> *TR_INT_1: Daha da etkili olması için sadece 2 boyutlu değil devreler için 3 boyutlu anlatımlar daha çekici olurdu.*

It was suggested by one of the students that the subject content that was delivered by multimedia devices should be sequenced in terms of difficulty level. Beginning to provide simple and understandable content, and then proceed with providing more and more difficult content, can be an effective way to organize multimedia content. In addition, two of the students expressed that more interactive media formats should increase students' interactions with the materials.

> EN_INT_4: If it were me, I would make the content go up from easy to difficult, add more examples, add more similarities, by adding more visuals I could make it a lot more interesting.
>
> *TR_INT_4: Ben olsam bu içeriği basitten karmaşığa doğru, içerisinde daha fazla kıyaslama, benzerlik kurarak, görsellerini daha fazla artırarak, daha ilgi çekici etkinlikler koyabilirim*.

> EN_INT_3: Yes, I think it is enough. However, I do not find it any different from opening up a book and reading it. Because under the texts are pictures. I think it should be more interactive.

TR_INT_3: Evet. Bence yeterli ama bir ders kitabından açıp okumakla çokta bir farkı yok bence. Çünkü yazılar var altında da fotoğraf var. Daha etkileşimli hale getirilmesi daha faydalı olur bence.

Content of the materials

Participants made suggestions about the number of questions and the quality of the content in multimedia materials. Three of the students stated in interviews that there should be various types of questions embedded into the multimedia content.

EN_INT_12: There are many content explanations. These could have been supported with more examples. The content explanation was enough, but there could have been more questions to answer.

TR_INT_12: Çok fazla konu anlatımı olmuş. Çok fazla örnekle desteklenebilirdi. Konu anlatımın yeterli idi ama daha çok soru çözümü olabilirdi.

EN_INT_9: There should be more questions; it should have contained more visuals as it said in the explanation.

TR_INT_9: Soruları çoğaltmalıyız, anlatımda olduğu gibi görsel açıdan zengin bir sınav olmalı.

In addition to the increase in the number of questions, students also demanded improvement in the quality of the content forms. Six of the students stated in interviews that the quality of some media tools, especially audio and visuals, should be enhanced.

EN_INT_8: It is useful in general, but there could be more improvements in the sound aspect.

TR_INT_8: Genel olarak iyi ama Seslendirme ile ilgili iyileştirme yapılabilir.

EN_INT_4: There could have been more delightful visuals with more attention paid to it. Electrons could flow, and the quality of images and graphics could be improved.

TR_INT_4: Daha güzel ve özenle çalışılmış, görseller olabilir. Elektronlar akabilir, görüntülerin ve grafiklerin kalitesi daha iyileştirilebilirdi.

Students also pointed out the inadequacy in the quantity of the content forms. Nine of the students expressed that it would be more useful to upgrade multimedia content with the addition of more media items, particularly animation. It seemed that participants were no longer interested in reading lots of textual content and instead preferred to be exposed to more interactive multimedia forms.

EN_INT_10: I would have added more animations. I would have explained the topics with a lot more animations.

TR_INT_10: Ben aslında biraz daha animasyon eklerdim. Konuları çok daha fazla animasyonla gösterirdim.

EN_INT_7: Because the text was too long, I did not feel like reading the whole thing, I'd rather the texts be shorter, and there be more visuals and videos.

TR_INT_7: Yazıların çok fazla uzun olması durumunda eğitimi okumak içimden gelmiyordu, yazının mümkün olduğunca az olması görüntü ve videoların çok daha fazla olmasını isterim.

It is likely to enrich the multimedia materials by including the questions from a real world. One of the students put forward a suggestion that some of the examples in multimedia content could stem from real-life situations.

EN_INT_3: There could be more real-life scenarios and examples. Questions could be added. Right, wrong, different animations, videos, and photos. More examples that I cannot think of could also be added. More examples that could be replicated.

TR_INT_3: İçeriklere gerçek hayattan örnekler konulabilir. Sorular konulabilir. Doğru, yanlışlar, farklı animasyonlar, videolar, fotoğraflar daha aklıma gelmeyen örnekler. Çoğaltılabilir örnekler.

Table 4.2. Means, standard deviations, and frequencies for students' opinions on use of animation-based multimedia materials

	M	*SD*	**1 Strongly Disagree**	**2 Disagree**	**3 Slightly Disagree**	**4 Neutral**	**5 Slightly Agree**	**6 Agree**	**7 Strongly Agree**
item1	5.21	0.89	-	-	1 (%7.1)	-	9 (%64.3)	3 (%21.4)	1 (%7.1)
item2	5.21	1.05	-	-	1 (%7.1)	2 (%14.3)	5 (%35.7)	5 (%35.7)	1 (%7.1)
item3	5.21	0.80	-	-	-	2 (%14.3)	8 (%57.1)	3 (%21.4)	1 (%7.1)
item4	5.14	1.66	1 (%7.1)	-	1 (%7.1)	2 (%14.3)	2 (%14.3)	6 (%42.9)	2 (%14.3)
item5	3.43	1.91	1 (%7.1)	6 (%42.9)	1 (%7.1)	2 (%14.3)	1 (%7.1)	2 (%14.3)	1 (%7.1)
item6	5.00	1.52	-	2 (%14.3)	-	2 (%14.3)	3 (%21.4)	6 (%42.9)	1 (%7.1)
item7	5.21	1.42	1 (%7.1)	-	-	-	8 (%57.1)	3 (%21.4)	2 (%14.3)
item8	2.86	1.99	3 (%21.4)	6 (42.9)	2 (%14.3)	-	-	2 (%14.3)	1 (%7.1)
item9	3.64	2.02	4 (%28.6)	1 (%7.1)	-	3 (%21.4)	3 (%21.4)	3 (%21.4)	-
item10	4.43	1.55	1 (%7.1)	1 (%7.1)	1 (%7.1)	2 (%14.3)	7 (%50)	1 (%7.1)	1 (%7.1)

Table 4.2 (cont'd)

item11	5.14	1.29	-	1 (%7.1)	1 (%7.1)	-	6 (%42.9)	5 (%35.7)	1 (%7.1)
item12	2.29	1.07	3 (%21.4)	7 (%50)	1 (%7.1)	3 (%21.4)	-	-	-
item13	4.07	1.44	1 (%7.1)	1 (%7.1)	2 (%14.3)	4 (%28.6)	4 (%28.6)	2 (%14.3)	-
item14	4.21	1.63	1 (%7.1)	2 (%14.3)	1 (%7.1)	2 (%14.3)	5 (%35.7)	3 (%21.4)	-
item15	5.07	1.49	1 (%7.1)	-	-	3 (%21.4)	3 (%21.4)	6 (%42.9)	1 (%7.1)
item16	5.29	1.64	1 (%7.1)	-	-	3 (%21.4)	2 (%14.3)	5 (%35.7)	3 (%21.4)
item17	1.79	1.25	8 (%57.1)	4 (%28.6)	-	1 (%7.1)	1 (%7.1)	-	-
item18	4.50	0.94	-	-	2 (%14.3)	5 (%35.7)	5 (%35.7)	2 (%14.3)	-
item19	5.21	1.53	-	2 (%14.3)	-	-	5 (%35.7)	5 (%35.7)	2 (%14.3)
item20	1.71	1.07	7 (%50)	6 (%42.9)	-	-	1 (%7.1)	-	-
item21	5.64	1.01	-	-	1 (%7.1)	-	4 (%28.6)	7 (%50)	2 (%14.3)
item22	5.14	1.17	-	1 (%7.1)	-	2 (%14.3)	4 (%28.6)	7 (%50)	-
item23	2.00	1.41	6 (%42.9)	6 (%42.9)	-	1 (%7.1)	-	1 (%7.1)	-

CHAPTER 5

DISCUSSION AND CONCLUSION

In this section, the findings of the current research study are discussed within the perspective of previous views and research findings reported in the literature. This discussion and conclusion chapter is composed of three parts. The first part covers a summary of the study and its salient components. The second part deals with the discussion and conclusion of the findings concerning the research questions. Specifically, the study findings are discussed in the perspective of literature under the corresponding research question. The final part addresses the implications of the findings and recommendations for further research.

Research question 1: What are the first-year undergraduate students' opinions and perceptions towards the use of animation-based multimedia materials in learning basic concepts of electronics?

Research question 2: What are the design components of animation-based multimedia materials from the perspective of students?

5.1. What are the First-Year Undergraduate Students' Opinions and Perceptions Towards the Use of Animation-Based Multimedia Materials in Learning Basic Concepts of Electronics?

The analysis of the study data highlights some elements associated with the animation-based multimedia materials. Those elements are classified as content, interface, overall continuity in design, design examples, circuit diagram, and overall satisfaction with the current design format. Some of these elements like content and interface has been explored in previous studies (Liu, Cheng, Lin, Chang, & Chen, 2008). The study

shows that most of the students are pleased with the content of the materials in terms of organization, arrangement, difficulty level, complexity, and the media tools used. Besides, students thought that the content of animation-based multimedia materials is straightforward and easy to understand. Also, all the participants are convinced that the prepared multimedia materials are practical and useful resources for giving students information and resources about the Basic Electronic and Electronic Components.

5.2. What are the design components of animation-based multimedia materials from the perspective of students?

The study findings showed that students faced various challenges in relation to the use of multimedia learning materials. One of the challenges was found to be about the type of web browser utilized to bring the content of the learning materials to the learners so that they can access and navigate through pages of information. Some of the existing web browsers such as Internet Explorer, Google Chrome, Mozilla Firefox, Safari, and Opera may not be compatible with the technologies and media tools used to prepare multimedia learning materials. On such occasions, a part of multimedia materials like animation, sound, and others could not appear or work as intended and, in turn, this could deprive learners of exposing to the crucial learning content. In order to avoid browser compatibility issues, the best decision can be to test in advance which web browser can run the multimedia materials smoothly. The amount of text included in the multimedia material appears to be another problem. Students reported to struggle with reading and seeing lots of text parts. It seems that incorporating more texts into multimedia content is less enjoyable and could discourage learners from studying subjects through multimedia materials.

Multimedia technologies give multimedia content developers and designers a great opportunity to measure the learners' knowledge and understanding of the relevant subjects while the learners' experiences with the multimedia content are still fresh.

However, the time allocated for the measurement of learning tests must comply with the learners' ability to answer all the test questions within the allocated time. In this study, some students reported that they were unable to give answers to all the test questions in the specified time. Therefore, the response time for the test questions could be extended or determined based on the difficulty of the subject or learners' characteristics.

The study findings also show that some of the media formats, specifically sound, could be detrimental to the learners. Many students complained about the distracting and irritating effect of the background sound used in multimedia materials. It might be better to use real-person sound instead of machine-generated sound because the human-voiced sound could be better at invoking encouragement and emotions. Besides, as part of the sound, it might be better to keep the volume of the background sound as normal level as possible or give learners a choice to fully control the volume of the background sound.

The current study concludes that it can be beneficial to make use of animation-based multimedia materials to support learners in the learning of topics in basic electronic and electronic components. The results of this study indicate that incorporating multimedia learning materials into a university course could enhance students' learning performance and engagement, spark their motivation, enjoyment, and interest in learning, and promote meaningful learning connections. These findings are in line with those of previous studies who reported the positive effect of the use of multiple representations, such as animation, text, sound, and visual elements, on learners' motivation (Lai, Chen, & Lee, 2019), enjoyment (Yilmaz, Kucuk, & Goktas, 2017), interest (Liu & Elms, 2019), engagement (Gu, Andreopoulos, Jenkinson, & Ng, 2019), and learning performance (Bayram & Kocak, 2013; Da-Wei, Chao, Shun, Xun-Ling, & Wen-fang, 2018; Huang & Zhang, 2017; Junsawang, Jittivadhna, Luealamai, & Pookboonmee, 2019).

In addition to the contributions of multimedia learning materials, students also reported some suggestions that could be applied to the prepared multimedia learning materials and increase their potential benefits. According to the participants, a feedback mechanism that is capable of providing personalized responses to the learners' actions in a multimedia learning environment should be integrated into the multimedia learning materials. This kind of feedback method could engage learners in learning materials and help them correct their mistakes and misunderstanding immediately. Also, according to the participants, the presentation of multimedia materials should be available in auto-pacing mode along with the self-pacing mode. Previous evidence shows that multimedia materials with self-pacing feature led to improvement in understanding (Kühl, Eitel, Damnik, & Körndle, 2014). Besides, many students pointed out the low quality of media representations, more specifically audio and visual elements, and called for improvement in the quality of those media formats. It is important that the multiple representations that are embedded in an online learning environment are produced in high quality because low-quality media content is doomed to draw learners' attention to the essential aspects of educational content.

Furthermore, it appears that the developed multimedia materials have plenty of texts but not enough of animation because the majority of the participants suggest that more simulations should be used while preparing and designing the content of the subject. Prior studies have confirmed the superiority of the animation over the static picture or text (Höffler & Leutner, 2007; Kühl & Münzer, 2019). Therefore, using more animations in the delivery of the learning content can ease the burden on learners' cognitive load (Mayer & Moreno, 2003) and, in turn, be more helpful for the learners to grasp the subject.

5.3. The Implications of the Findings and Recommendations for Further Research

The findings of the current study have important implications for the integration of animation-based multimedia materials into a university course and the use of multimedia materials to teach students basic concepts, specifically Basic Electronic and Electronic Components. Different groups of people, including multimedia content developers, teachers, and the researchers could benefit from these findings. The study findings could inform them of challenges to the delivery of the content through multiple representations and give insight into the understanding of the design and development of multimedia learning materials for the Basic Electronic and Electronic Components course.

The sample of this study is limited to first-year undergraduate students. In further studies, a different type of sample, including high school and secondary school students are advised. Besides, the study data derive mainly from limited data sources, namely participants' self-reported subjective responses, which may be sensitive to biases. It is recommended that follow-up studies be conducted to use different data sources like achievement tests and questionnaires. Also, in future research, instead of qualitative design, an experimental or quasi-experimental research design could be conducted to examine the effect of animation-based multimedia learning materials on learners' learning outcome, motivation, engagement, and cognitive load.

REFERENCES

Allen, I. E., & Seaman, J. (2013). *Changing course: Ten years of tracking online education in the United States: Babson Survey Research Group Repor*. Retrieved from https://www.onlinelearningsurvey.com/reports/changingcourse.pdf

Allen, I. E., & Seaman, J. (2014). *Grade change: Tracking online education in the United States: Babson survey research group*. Retrieved from Babson survey research group website: https://www.onlinelearningsurvey.com/reports/gradechange.pdf

Barak, M., & Dori, Y. J. (2011). Science Education in Primary Schools: Is an Animation Worth a Thousand Pictures? *Journal of Science Education and Technology*, *20*(5), 608–620. https://doi.org/10.1007/s10956-011-9315-2

Bargeron, D., Grudin, J., Gupta, A., Sanocki, E., Li, F., & Leetiernan, S. (2002). Asynchronous Collaboration Around Multimedia Applied to On-Demand Education. *Journal of Management Information Systems*, *18*(4), 117–145. https://doi.org/10.1080/07421222.2002.11045706

Bayram, K., & Koçak, N. (2013). Öğretmen adaylarının genel kimya dersindeki erişilerine ve kalıcılık düzeylerine animasyon uygulamalarının etkisi. *Electronic Turkish Studies*, *8*(12), 167–177.

Ben-Bassat Levy, R., Ben-Ari, M., & Uronen, P. A. (2003). The Jeliot 2000 program animation system. *Computers & Education*, *40*(1), 1–15. https://doi.org/10.1016/S0360-1315(02)00076-3

Bennett, S., Bishop, A., Dalgarno, B., Waycott, J., & Kennedy, G. (2012). Implementing Web 2.0 technologies in higher education: A collective case study. *Computers & Education*, *59*(2), 524–534. https://doi.org/10.1016/j.compedu.2011.12.022

Betrancourt, M. (2005). The Animation and Interactivity Principle of Multimedia Learning. In R. E. Mayer (Ed.), *Cambridge Handbook of Multimedia Learning*. Cambridge University Press.

Bodemer, D., Ploetzner, R., Feuerlein, I., & Spada, H. (2004). The active integration of information during learning with dynamic and interactive visualisations. *Learning and Instruction*, *14*(3), 325–341. https://doi.org/10.1016/j.learninstruc.2004.06.006

Boucheix, J. M. (2007). Young learners' control of technical animations. In R. Lowe & W. Schnotz (Eds.), *Learning with animation: Research and design implications* (pp. 208–234). New York, NY: Cambridge University Press.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory (3rd ed.).* SAGE Publications, Inc.

Creswell, J. W. (2012). *Educational research : planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson Education.

Da-Wei, C., Chao, L., Shun, W., Xun-Ling, W., & Wen-fang, W. (2018). Research and application of multimedia digital platform in the teaching of college physical education course. *Journal of Intelligent & Fuzzy Systems*, *34*(2), 893–901. https://doi.org/10.3233/JIFS-169383

Ebner, M., & Holzinger, A. (2003). Instructional Use of Engineering Visualization: Interaction Design in e-Learning for Civil Engineering. *Human–Computer Interaction, Theory and Practice*, *1*, 926–930.

Esponda-Argüero, M. (2008). Algorithmic Animation in Education—Review of Academic Experience. *Journal of Educational Computing Research*, *39*(1), 1–15. https://doi.org/10.2190/EC.39.1.a

Fleming, S. A., Hart, G. R., & Savage, P. B. (2000). Molecular Orbital Animations for Organic Chemistry. *Journal of Chemical Education*, *77*(6), 790. https://doi.org/10.1021/ed077p790

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). New York, NY: McGraw-Hill.

García, R. R., Quirós, J. S., Santos, R. G., González, S. M., & Fernanz, S. M. (2007). Interactive multimedia animation with Macromedia Flash in Descriptive Geometry teaching. *Computers & Education*, *49*(3), 615–639. https://doi.org/10.1016/j.compedu.2005.11.005

Gero, A. (2014). *Advances in Engineering Education Animation Based Learning of Electronic Devices*. *4*(1), 1–21.

Gero, A., Zoabi, W., & Sabag, N. (2014). Animation based learning of electronic devices. *Advances in Engineering Education*, *4*(1), 1–21.

Gero, A., Zoabi, W. W., & Sabag, N. (2012). How does animation-based learning affect students' achievements and attitudes towards electronics? *ASEE Annual Conference and Exposition, Conference Proceedings*, (2011).

Gilbert, J. (2005). *Catching the Knowledge Wave? The Knowledge Society and the Future of Education*. Wellington: NZCER Press.

Good, D. J. (. (2004). The use of flash animations within a WebCT environment: Enhancing comprehension of experimental procedures in a biotechnology laboratory. *Nternational Journal of Instructional Media*, *31*(4), 355–370.

Gu, J., Andreopoulos, S., Jenkinson, J., & Ng, D. P. (2019). Rethinking enzyme kinetics: Designing and developing a biomolecular interactive tutorial

(BIOMINT) learning tool for undergraduate students. *Biochemistry and Molecular Biology Education*, bmb.21302. https://doi.org/10.1002/bmb.21302

Gupta, S., & Bostrom, R. P. (2005). Theoretical model for investigating the impact of knowledge portals on different levels of knowledge processing. *International Journal of Knowledge and Learning*, *1*(4), 287. https://doi.org/10.1504/IJKL.2005.008352

Hair, J., Anderson, R., Tatham, R., & Black, W. (1998). *Multivariate data analysis* (5th ed.). New Jersey: Prentice Hall.

Höffler, T. N., & Leutner, D. (2007). Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction*, *17*(6), 722–738. https://doi.org/10.1016/j.learninstruc.2007.09.013

Hoogeveen, M. (1997). Toward a Theory of the Effectiveness of Multimedia Systems. *International Journal of Human-Computer Interaction*, *9*(2), 151–168. https://doi.org/10.1207/s15327590ijhc0902_4

Huang, L., & Zhang, C. (2017). Research of E-Learning Platform of Blend Learning for Power Electronics Courses. *Proceedings of the 2017 3rd Conference on Education and Teaching in Colleges and Universities (CETCU 2017)*. https://doi.org/10.2991/cetcu-17.2017.11

Jamet, E. (2014). An eye-tracking study of cueing effects in multimedia learning. *Computers in Human Behavior*, *32*, 47–53. https://doi.org/10.1016/j.chb.2013.11.013

Jereb, E., & Šmitek, B. (2006). Applying multimedia instruction in e-learning. *Innovations in Education and Teaching International*, *43*(1), 15–27. https://doi.org/10.1080/14703290500467335

Jonassen, D. H., & Reeves., T. C. (2001). Learning with technology: Using computers as cognitive tools. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology*. (pp. 693–719). New York: Macmillan.

Junsawang, C., Jittivadhna, K., Luealamai, S., & Pookboonmee, R. (2019). Multimedia-aided instruction in teaching basic life support to undergraduate nursing students. *Advances in Physiology Education*, *43*(3), 300–305. https://doi.org/10.1152/advan.00106.2018

Kelly, R. M., & Jones, L. L. (2007). Exploring How Different Features of Animations of Sodium Chloride Dissolution Affect Students' Explanations. *Journal of Science Education and Technology*, *16*(5), 413–429. https://doi.org/10.1007/s10956-007-9065-3

Kesner, M. H., & Linzey, A. V. (2005). Can Computer-Based Visual-Spatial Aids Lead to Increased Student Performance in Anatomy & Physiology? *The*

American Biology Teacher, *67*(4), 206–212. https://doi.org/10.2307/4451824

Kühl, T., Eitel, A., Damnik, G., & Körndle, H. (2014). The impact of disfluency, pacing, and students' need for cognition on learning with multimedia. *Computers in Human Behavior*, *35*, 189–198. https://doi.org/10.1016/j.chb.2014.03.004

Kühl, T., & Münzer, S. (2019). The moderating role of additional information when learning with animations compared to static pictures. *Instructional Science*, 1–19. https://doi.org/10.1007/s11251-019-09498-x

Lai, A.-F., Chen, C.-H., & Lee, G.-Y. (2019). An augmented reality-based learning approach to enhancing students' science reading performances from the perspective of the cognitive load theory. *British Journal of Educational Technology*, *50*(1), 232–247. https://doi.org/10.1111/bjet.12716

Large, A., Beheshti, J., Breuleux, A., & Renaud, A. (1996). *Effect of Animation in Enhancing Descriptive and Procedural Texts in a Multimedia Learning Environment*. *47*(6), 437–448.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Beverly Hills, CA: SAGE Publications.

Liu, C., & Elms, P. (2019). Animating student engagement: The impacts of cartoon instructional videos on learning experience. *Research in Learning Technology*, *27*. https://doi.org/10.25304/rlt.v27.2124

Liu, E. Z. F., Cheng, S. S., Lin, C. H., Chang, Y. F., & Chen, W. T. (2008). The development of evaluation indicators for LEGO multimedia instructional material. *WSEAS Transactions on Computers*, *7*(10), 1782–1791.

Lowe, R. (2004). Interrogation of a dynamic visualization during learning. *Learning and Instruction*, *14*(3), 257–274. https://doi.org/10.1016/j.learninstruc.2004.06.003

Mackenzie, L., & Kim Ballard. (2015). Can Using Individual Online Interactive Activities Enhance Exam Results ? *MERLOT Journal of Online Learning and Teaching*, *11*(2), 2011–2015.

Mayer, R. E. (2009). *Multimedia Learning* (2nd ed.). New York, NY: Cambridge University Press.

Mayer, R.E. (2017). Using multimedia for e-learning. *Journal of Computer Assisted Learning*, *33*(5), 403–423. https://doi.org/10.1111/jcal.12197

Mayer, Richard E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist*, *32*(1), 1–19. https://doi.org/10.1207/s15326985ep3201_1

Mayer, Richard E. (2014). Introduction to Multimedia Learning. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp. 1–24).

https://doi.org/10.1017/CBO9781139547369.002

Mayer, Richard E., & Chandler, P. (2001). When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology*, *93*(2), 390–397.

Mayer, Richard E., Hegarty, M., Mayer, S., & Campbell, J. (2005). When Static Media Promote Active Learning: Annotated Illustrations Versus Narrated Animations in Multimedia Instruction. *Journal of Experimental Psychology: Applied*, *11*(4), 256–265. https://doi.org/10.1037/1076-898X.11.4.256

Mayer, Richard E., & Moreno, R. (2002). Animation as an Aid to Multimedia Learning. *Educational Psychology Review*, *14*(1), 87–99. https://doi.org/10.1023/A:1013184611077

Mayer, Richard E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, *38*(1), 43–52. https://doi.org/10.1207/S15326985EP3801_6

Mayer, Richard E. (2002). Multimedia learning. In *Psychology of Learning and Motivation* (Vol. 41, pp. 85–139). https://doi.org/10.1016/S0079-7421(02)80005-6

McCombs, B. L. (2001). What do we know about learners and learning? The learner centered framework: Bringing the educational system into balance. *Educational Horizons*, *79*(4), 182–193.

Mnguni, L. E. (2014). The theoretical cognitive process of visualization for science education. *SpringerPlus*, *3*(1), 184. https://doi.org/10.1186/2193-1801-3-184

Moore, J. H., & Weatherford, L. R. (2001). *Decision modeling with MicrosoftR? Excel* (6th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Moos, D. C., & Marroquin, E. (2010). Multimedia, hypermedia, and hypertext: Motivation considered and reconsidered. *Computers in Human Behavior*, *26*(3), 265–276. https://doi.org/10.1016/j.chb.2009.11.004

Morrison, J. B., Tversky, B., & Betrancourt, M. (2000). Animation: Does it facilitate learning. *AAAI Spring Symposium on Smart Graphics*. Retrieved from https://www.aaai.org/Papers/Symposia/Spring/2000/SS-00-04/SS00-04-009.pdf

Morrison, Julie B., & Tversky, B. (2001). The (in)effectiveness of animation in instruction. *CHI '01 Extended Abstracts on Human Factors in Computing Systems - CHI '01*, 377. https://doi.org/10.1145/634067.634290

Mutlu-Bayraktar, D., Cosgun, V., & Altan, T. (2019). Cognitive load in multimedia learning environments: A systematic review. *Computers & Education*, *141*, 103618. https://doi.org/10.1016/j.compedu.2019.103618

Najjar, L. J. (1996). Multimedia information and learning. *Journal of Educational*

Multimedia and Hypermedia, *5*(2), 129--150. https://doi.org/10.1.1.118.1654

Ozdemir, D., & Doolittle, P. (2015). Revisiting the Seductive Details Effect in Multimedia Learning: Context-dependency of Seductive Details. *Journal of Educational Multimedia and Hypermedia*, *24*(2), 101–119.

Packer, R., & Jordan, K. (2001). *Multimedia: From Wagner to Virtual Reality, Expanded Edition*. New York: WW Norton & Cia.

Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS* (4th ed.). New York, NY: McGraw-Hill.

Park, O. (1994). Dynamic visual displays in media-based instruction. *Educational Technology*, *34*(4), 21–25.

Park, O., & Gittelman, S. S. (1992). Selective use of animation and feedback in computer-based instruction. *Educational Technology Research and Development*, *40*(4), 27–38. https://doi.org/10.1007/BF02296897

Parsad, B., & Lewis, L. (2008). *Distance education at degree-granting postsecondary institutions: 2006-07*. Retrieved from National Center for Education Statistics (NCES) website: https://nces.ed.gov/pubs2009/2009044.pdf

Pinter, R., Radosav, D., & Čisar, S. M. (2012). Analyzing the Impact of Using Interactive Animations in Teaching. *Int. J. of Computers, Communications & Control*, *7*, 147–162.

Powell, S. G., & Baker, K. R. (2004). *The art of modeling with spreadsheets: Management science, spreadsheet engineering, and modeling craft.* Hoboken, NJ: Wiley.

Price, J., Wills, G., Dror, I. E., Cherrett, T., & Maynard, S. (2008a). Risk assessment education: Utilizing interactive video for teaching health and safety. *Proceedings - The 8th IEEE International Conference on Advanced Learning Technologies, ICALT 2008*, 727–729. https://doi.org/10.1109/ICALT.2008.245

Price, J., Wills, G., Dror, I. E., Cherrett, T., & Maynard, S. (2008b). Risk Assessment Education: Utilizing Interactive Video for Teaching Health and Safety. *Proceedings - The 8th IEEE International Conference on Advanced Learning Technologies, ICALT 2008*, 727–729. https://doi.org/10.1109/ICALT.2008.245

Ragsdale, C. (2003). *Spreadsheet modeling and decision analysis* (4th ed.). Oklahoma City: South-Western College Publishing.

Reigeluth, C. M. (1999). *Instructional-design theories and models: A new paradigm of instructional theory* (Vol. 2). Mahwah, NJ: Erlbaum.

Reimann, P. (2003). Multimedia learning: beyond modality. *Learning and Instruction*, *13*(2), 245–252.

Rieber, L. P., Boyce, M. J., & Assad, C. (1990). The effects of computer animation on adult learning and retrieval tasks. *Journal of Computer-Based Instruction*, *17*(2), 46–52.

Rieber, Lloyd P. (1989). The Effects of Computer Animated Elaboration Strategies and Practice on Factual and Application Learning in an Elementary Science Lesson. *Journal of Educational Computing Research*, *5*(4), 431–444. https://doi.org/10.2190/961X-QQEQ-7PVK-UK9E

Rieber, Lloyd P. (1990). Using computer animated graphics with science instruction with children. *Journal of Educational Psychology*, *82*(1), 135–140. https://doi.org/10.1037/0022-0663.82.1.135

Rieber, Lloyd P. (1991). Animation, incidental learning, and continuing motivation. *Journal of Educational Psychology*, *83*(3), 318–328. https://doi.org/10.1037/0022-0663.83.3.318

Rieber, Lloyd P., & Hannafin, M. J. (1988). Effects of Textual and Animated Orienting Activities and Practice on Learning from Computer-Based Instruction. *Computers in the Schools*, *5*(1–2), 77–90. https://doi.org/10.1300/J025v05n01_07

Rotbain, Y., Marbach-Ad, G., & Stavy, R. (2008). Using a Computer Animation to Teach High School Molecular Biology. *Journal of Science Education and Technology*, *17*(1), 49–58. https://doi.org/10.1007/s10956-007-9080-4

Salomon, G. (2002). Technology and pedagogy: Why don't we see the promised revolution? *Educational Technology*, *42*(2), 71–75.

Schmidt-Weigand, F., & Scheiter, K. (2011). The role of spatial descriptions in learning from multimedia. *Computers in Human Behavior*, *27*(1), 22–28. https://doi.org/10.1016/j.chb.2010.05.007

Schnotz, W., & Lowe, R. (2003). External and Internal Representations in Multimedia Learning. Introduction. *Learning and Instruction*, *13*(12), 117–123.

Schnotz, Wolfgang, & Bannert, M. (2003). Construction and interference in learning from multiple representation. *Learning and Instruction*, *13*(2), 141–156. https://doi.org/10.1016/S0959-4752(02)00017-8

Schwan, S., & Riempp, R. (2004). The cognitive benefits of interactive videos: learning to tie nautical knots. *Learning and Instruction*, *14*(3), 293–305. https://doi.org/10.1016/j.learninstruc.2004.06.005

Szabo, M., & Poohkay, B. (1996). An Experimental Study of Animation, Mathematics Achievement, and Attitude Toward Computer-Assisted Instruction. *Journal of Research on Computing in Education*, *28*(3), 390–402. https://doi.org/10.1080/08886504.1996.10782173

Tversky, B., Morrison, J. B., & Betrancourt, M. (2002). Animation: can it facilitate? *International Journal of Human-Computer Studies*, *57*(4), 247–262. https://doi.org/10.1006/ijhc.2002.1017

Um, E. "Rachel," Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of Educational Psychology*, *104*(2), 485–498. https://doi.org/10.1037/a0026609

Van der Kleij, F. M., Feskens, R. C. W. W., & Eggen, T. J. H. M. H. M. (2015). Effects of Feedback in a Computer-Based Learning Environment on Students' Learning Outcomes: A Meta-Analysis. *Review of Educational Research*, *85*(4), 475–511. https://doi.org/10.3102/0034654314564881

Williamson, V. M., & Abraham, M. R. (1995). The effects of computer animation on the particulate mental models of college chemistry students. *Journal of Research in Science Teaching*, *32*(5), 521–534. https://doi.org/10.1002/tea.3660320508

Wladis, C., Conway, K. M., & Hachey, A. C. (2015). The Online STEM Classroom—Who Succeeds? An Exploration of the Impact of Ethnicity, Gender, and Non-traditional Student Characteristics in the Community College Context. *Community College Review*, *43*(2), 142–164. https://doi.org/10.1177/0091552115571729

Yaden H., & A, Y. (2010). Studying biotechnological methods using animations: The teacher's role. *Journal of Science Education and Technology*.

Yarden, H., & Yarden, A. (2011). Studying Biotechnological Methods Using Animations: The Teacher's Role. *Journal of Science Education and Technology*, *20*(6), 689–702. https://doi.org/10.1007/s10956-010-9262-3

Yilmaz, R. M., Kucuk, S., & Goktas, Y. (2017). Are augmented reality picture books magic or real for preschool children aged five to six? *British Journal of Educational Technology*, *48*(3), 824–841. https://doi.org/10.1111/bjet.12452

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Zhang, D., Zhou, L., Briggs, R. O., & Nunamaker, J. F. (2006a). *Instructional video in e-learning : Assessing the impact of interactive video on learning effectiveness Instructional video in e-learning : Assessing the impact of interactive video on learning effectiveness*. (January), 14–27. https://doi.org/10.1016/j.im.2005.01.004

Zhang, D., Zhou, L., Briggs, R. O., & Nunamaker, J. F. (2006b). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information and Management*, *43*(1), 15–27. https://doi.org/10.1016/j.im.2005.01.004

APPENDICES

A. PERMISSION FROM METU-ETHICAL COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

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20 Şubat 2019

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Dr. Öğretim Üyesi Cengiz Savaş AŞKUN

Danışmanlığını yaptığınız **Necdet TÜRKÖZ'ün** **"The effects of animation-based learning on undergraduate students' attitudes towards the basic cenceptes of electtricity and electronics"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **066-ODTÜ-2019** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof. Dr. Tülin GENÇÖZ
Başkan

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Prof. Dr. Yaşar KONDAKÇI (4.)
Üye

Doç. Dr. Emre SELÇUK
Üye

Doç. Dr. Pınar KAYGAN
Üye

Dr. Öğr. Üyesi Ali Emre TURGUT
Üye

B. STUDENT CONSENT FORM

Gönüllü Katılım Formu

Bu çalışma Dr. Cengiz S. Aşkun danışmanlığında, yüksek lisans öğrencisi Necdet Türköz tarafından yürütülmekte olan araştırma çalışmasıdır. Çalışmanın amacı, animasyon teknolojileri kullanılarak tasarlanan Akım, Direnç ve Ohm Yasası odaklı temel elektrik elektronik konularını üniversite 1. sınıf düzeyi için doğru ve etkin bir şekilde kullanılabilmesi için öğretmenlerin bunu nasıl tasarlaması gerektiğini, bu etkinliklerin tasarlanmasında izlenilmesi gereken tasarım stratejilerinin neler olduğunu ve bu etkinlikleri tasarlarken hangi karakteristik özelliklerin göz önünde bulundurulması gerektiğini ortaya çıkarmaktır. Çalışmaya katılım tamamıyla gönüllülük esasına dayanmaktadır. Görüşme süresince, sizden kimlik belirleyici hiçbir bilgi istenmeyecektir. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir. Elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır.

Görüşme, genel olarak kişisel rahatsızlık verecek sorular içermemektedir. Ancak, katılım sırasında sorulardan ya da başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkabilirsiniz. Böyle bir durumda araştırmacıya, görüşmeyi bitirmek istediğinizi söylemeniz yeterli olacaktır. Görüşme sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Orta Doğu Teknik Üniversitesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğretim üyelerinden Dr. Cengiz S. Aşkun (Oda: EF-C 117; Tel: 210 3672; E-posta: askun@metu.edu.tr) ya da yüksek lisans öğrencisi Necdet Türköz (E-posta: necdetturkoz@gmail.com) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

Ad Soyad	Tarih	İmza	Alınan Ders
	----/----/-----		

C. INTERVIEW PROTOCOL

Grup Görüşme Formu

Araştırma Soruları:

- Animasyon teknolojiler kullanılarak hazırlanan elektrik-elektronik konularından Akım, Direnç ve Ohm Kanunu uzaktan eğitim programının tasarım ilkeleri nelerdir?
- Universite 1. Sınıf öğrencilerine yönelik Akım, Direnç ve Ohm Kanunu konularını animasyon destekli sunan uzaktan eğitim teknolojilerin tasarım, geliştirme ve kullanılabilirlik sorunları nelerdir?

Tarih ve Saat	: _____	Yer :	_____
Görüşmeci	: _____	Görüşülen Kişiler :(1)	_____
		:(2)	_____
		:(3)	_____
		:(4)	_____

GİRİŞ

Merhaba, ben Necdet Türköz. Orta Doğu Teknik Üniversitesi, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü'nde yüksek lisans öğrencisiyim. Yürütmekte olduğum tez çalışması kapsamında, temel elektrik ve elektronik konularından Akım, Direnç ve Ohm Kanunu konuları odaklı animasyon video teknolojisi kullanılarak hazırlanan uzaktan eğitim etkinlikleri ve bu etkinliklerde yaşamış olduğunuz deneyimler hakkında konuşmak istiyorum.

Bu görüşmede amacım, animasyon teknolojileri kullanılarak tasarlanan Akım, Direnç ve Ohm Kanunu konuları odaklı etkinliklerin üniversite 1. Sınıf düzeyince doğru ve etkin bir şekilde kullanılabilmesi için öğretmenlerin bunu nasıl tasarlaması gerektiğini, bu etkinliklerin tasarlanmasında izlenilmesi gereken tasarım stratejilerinin neler olduğunu ve bu etkinlikleri tasarlarken hangi karakteristik özelliklerin göz önünde bulundurulması gerektiğini ortaya çıkarmaktır. Bu çalışmanın diğer bir amacı ise basit elektrik devreleri ve kavramlarını öğretmek için tasarlanan etkinliklerin olumlu yönlerini, olumsuz yönlerini ve karşılaşılan problemleri öğretmenlerin deneyimleriyle ortaya çıkarmaktır. Bir diğer amaç ise animasyon teknolojileri

temel alınarak hazırlanan bir Akım, Direnç ve Ohm Kanunu eğitim programının sahip olması gereken tasarım ilkelerinin neler olduğunu bütün boyutları ile belirlemektir. Öğretmenlerin elektrik elektronik etkinliklerini tasarlama sürecinde önemli bir rol oynadıklarını ve bu etkinlikleri tüm boyutları ile değerlendirebildiğini düşündüğüm için onlarla görüşme yapıyorum.

Bu araştırmada ortaya çıkacak sonuçların, animasyon teknolojiler kullanarak hazırlanan temel elektrik-elektronik konuları odaklı etkinlikler tasarlayacak öğretmenlere tasarım sürecinde büyük katkılar sunacaktır. Bu nedenle sizin, temel elektrik-elektronik konularından oluşan etkinlikler ile ilgili deneyimlerinizi ve düşüncelerinizi öğrenmek istiyorum. Bu çalışmaya katılmayı kabul ettiğiniz için teşekkür ediyorum.

Görüşme sürecinde söyleyeceklerinizin tamamı gizli tutulacak ve yalnızca bu araştırma amacı ile kullanılacaktır. Ayrıca, araştırma sonuçlarını yazarken, görüşülen bireylerin isimlerini kesinlikle rapora yansıtılmayacak, bunun yerine takma isimler kullanılacaktır. İzin verirseniz görüşme boyunca gerçekleşen konuşmaların yazıya dökülmesini kolaylaştırmak amacı ile ses kaydı yapmak istiyorum. Bu ses kaydı, yazıya döküldükten hemen sonra silinecektir.

Görüşmeye başlamadan önce, gönüllü katılım formunu okuyarak imzalamanız gerekmektedir. Bu form, yürütülmekte olan çalışma hakkında genel bilgiler vermekle birlikte, çalışmaya gönüllü olarak katıldığınızı gösteren resmi bir belge niteliğindedir.

Görüşme, yaklaşık olarak 1 saat sürecektir ve genel olarak kişisel rahatsızlık verecek soruları içermemektedir. Ancak, katılım sırasında sorulardan ya da başka bir nedenden ötürü kendinizi rahatsız hissederseniz görüşmeyi yarıda bırakıp çıkabilirsiniz. Böyle bir durumda araştırmacıya, görüşmeyi bitirmek istediğinizi söylemeniz yeterli olacaktır. Görüşmeye başlamadan önce söylediklerimle ilgili belirtmek istediğiniz bir düşünce ya da sormak istediğiniz bir soru var mı?

İzin verirseniz ses kayıt cihazını açıp, sorulara başlamak istiyorum.

GÖRÜŞME SORULARI

(*Görüşme sorusu; AS: Alternatif Soru; S: Sonda Soru)*

İÇERİK

GS-1. Burada sizlerle elektrik konularının öğretimi üzerine SCORM temelli etkinlikler gerçekleştirdik. Gerçekleştirilen etkinliklerin içeriği hakkında ne düşünüyorsunuz

AS-1. Bu içeriklerin elektrik kavramlarını öğretmek için uygun olduğunu düşünüyor musunuz?

S-1.1. Uygun ise hangi açılardan uygun? Açıklar mısınız?
S-1.2. Uygun değil ise hangi açılardan uygun değil? Nasıl uygun hale getirilebilir?

AS-2. Eğitim süresince kullanılan Akım, Direnç ve Ohm Kanunu etkinliklerinin içeriğinin üniversite 1.sınıf düzeyi için uygun olduğunu düşünüyor musunuz?

S-2.1. Uygun ise hangi açılardan uygun? Açıklar mısınız?
S-2.2. Uygun değil ise hangi açılardan uygun değil? Nasıl uygun hale getirilebilir?

AS-3. Sizce etkinliklerin içeriği ve veriliş yöntemi tasarlanan etkinlikler de olduğu gibi mi verilmeli yoksa değiştirilmeli mi? Nedenini açıklar mısınız?

S-3.1. Siz olsaydınız bu içeriği nasıl verirdiniz?

AS-4. Etkinliklerde kullanılan senaryolar ile ilgili düşünceleriniz nelerdir?

S-4.1. Sizce problem durumunu belirten senaryo kullanılmalı mı yoksa kullanılmasına gerek yok mu? Sebebini açıklar mısınız?
S-4.2. Eğer bu etkinlikleri siz tasarlayacak olsaydınız nasıl bir senaryo yazardınız? Örnek bir senaryo söyler misiniz?

AS-5. Etkinliklerde verilen devre şemasının gösterimi ve örnek bir tasarım ile ilgili düşünceleriniz nelerdir?

AS-6. Etkinliğin nasıl yapılacağı ile ilgili verilen bilgilerin öğrenciler için yeterli olacağını düşünüyor musunuz?

S-6.1. Yeterli değilse neler yapılması gerekir?

S-6.2. Siz olsanız bu bilgileri nasıl verirdiniz?

TASARIM

GS-2. Akım, Direnç ve Ohm Kanunu konularını içeren uzaktan eğitim etkinliklerinin tasarımı hakkında neler düşünüyorsunuz?

AS-2.1. Sizce öğrenciler için gerçekleştirilen etkinliklerde uygulanan tasarım eğitimi takip etmek uygun mu? Nedenini açıklar mısınız?

GS-3. Akım, Direnç ve Ohm Kanunu etkinliklerinin tasarımı hakkındaki düşüncelerinizi anlatır mısınız? Örneğin;

AS-3.1. Tasarlanan bu etkinlikler elektrik devreleri ile ilgili kavramları öğretmek için kullanılabilir mi?

S-3.1.1. Sizce bu etkinlikler bu kavramları öğretmek için ne kadar kullanışlı?

S-3.1.2. Bu etkinliklerin daha iyi kullanılması için hangi türde düzenlemeler veya iyileştirmeler yapılması gerekiyor?

AS-3.2 Tasarlanan bu etkinlikler elektrik devreleri ile ilgili kavramları öğretmek için uygulanabilir mi?

S-3.2.1. Bu etkinlikleri kolay ve etkili bir şekilde uygulanabileceğini düşünüyor musunuz? Detaylı açıklar mısınız?

S-3.2.2. Uygulama sırasında ne gibi problemler ile karşılaşılabilir?

AS-3.3 Tasarlanan bu etkinliklerin elektrik devreleri ile ilgili kavramları öğretmek için etkinli olduğunu düşünüyor musunuz?

S-3.3.1. Etkinlikler çok fazla karmaşık mıydı?

YARATICILIK

GS-4. Akım, Direnç ve Ohm Kanunu etkinliklerinin yaratıcılık üzerindeki etkileri hakkındaki düşüncelerinizi anlatır mısınız?

AS-4.1. Bu etkinliklerin yaratıcılığı ve yaratıcı düşünmeyi geliştirdiğini düşünüyor musunuz? Nedenini açıklar mısınız?

AS-4.2. Bu etkinliklerde sizi yaratıcı düşünmeye ve yaratıcı fikirler üretmeye teşvik eden kısımlar nelerdi? Örnek verebilir misiniz?

ETKİLEŞİM

GS-5. Akım, Direnç ve Ohm Kanunu etkinliklerini uygularken ne tür etkileşimlerde bulundunuz? Örneğin;

AS-5.1. Grup arkadaşınız ya da diğer kişiler ile yapmış olduğunuz etkileşimlerden bahseder misiniz?

AS-5.2. Bu etkileşimleri istenilen seviyeye getirmek için sizce bu etkinlikler nasıl tasarlanmalı? Örneğin;

S-5.2.1. Etkinliklerin bu şekilde tasarlanması ve uygulanması yeterli olur mu? Neden?

S-5.2.2. Yetersiz ise etkinliklerde nasıl bir düzenlemeye ya da tasarıma gidilmeli?

S-5.2.3. Bireysel mi yapılmalı yoksa grup şeklinde mi yapılmalı? Grup şeklinde yapılacaksa grupta kaç kişi olmalı?

GS-6. Akım, Direnç ve Ohm Kanunu etkinlikleri öğrencilere ne gibi faydalar sağlayabilir?

AS-6.1. Geleneksel eğitimden farklı olarak Akım, Direnç ve Ohm Kanunu etkinlikleri neler sağlıyor? Örnek vererek açıklar mısınız?

AS-6.2. Etkinliklerde birden fazla alandaki bilgi ve becerilerin kullanılması elektrik kavramlarını öğrenmede yararlı olacağını düşünüyor musunuz?

ÖLÇME VE DEĞERLEDİRME

GS-7. Akım, Direnç ve Ohm Kanunu etkinliklerinin öğrencilerin başarıları ve performansları nasıl ölçülmesi ya da değerlendirilmesi gerekir?

AS-7.1. Etkinlikler için hangi ölçütler veya özellikler değerlendirme için kullanılabilir?

ENTEGRASYON

GS-8. Deneyimlerinizi göz önünde bulundurduğunuzda, sizce animasyon teknolojileri temel alınarak hazırlanan bir elektrik-elektronik konulu uzaktan eğitim programı hangi özelliklere sahip olmalıdır?

AS-8.1 Sizce Akım, Direnç ve Ohm Kanunu konularını işleyen uzaktan eğitim programı nasıl tasarlanmalıdır?

S-8.1.1. İçerik nasıl olmalı?

S-8.1.2. Tasarım nasıl olmalı?

AS-8.2. Bunların dışındaki özellikler nelerdir? Bahseder misiniz?

D. SURVEY

DEMOGRAFİK BİLGİLER

KİŞİSEL BİLGİLER		
Adı:	Soyadı:	
Doğum Tarihi	Cinsiyeti:	○ Erkek ○ Kadın

İLETİŞİM BİLGİLERİ		
Telefon (Cep):	E-Posta Adresi:	
EĞİTİM BİLGİLERİ		
Üniversite (Lisans):	Bölüm/Program:	

Aşağıdaki cümleleri dikkatlice okuyarak bu ifadelere katılma ve katılmama durumunuzu 1- 7 (1: Hiç- 7: Çok Fazla) arasında değişen skala üzerinde belirtiniz?

	Hiç						**Çok**
	1	**2**	**3**	**4**	**5**	**6**	**7**
Animasyon temelli uzaktan eğitim materyallerinin soyut elektrik elektronik konularını öğretmede yararlı olduğunu düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerinin fen bilimleri alanlarındaki bilgi ve becerilerimi artırdığını düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerinin elektrik kavramlarını öğrenmemde bana fayda sağladığını düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerini ilgi ile tamamladım.							
Animasyon temelli uzaktan eğitim materyalleri benim için sıkıcı geçti.							
Benzer animasyon temelli uzaktan eğitim materyallerinin sıklıkla uygulanması gerektiğini düşünüyorum.							

Bu veya buna benzer animasyon temelli uzaktan eğitim materyallerini tekrar kullanmak isterim.							
Bu animasyon temelli uzaktan eğitim materyallerini kullanmayı arkadaşlarıma tavsiye etmem.							
Benzer animasyon temelli uzaktan eğitim materyallerinin *okul içi* etkinlik olarak yapılması gerektiğini düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri elektrik kavramları konularına karşı ilgi ve motivasyonumu arttırdı.							
Konulara ayrılan sürelerin yeterli olduğunu düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerini tamamlamam çok fazla zamanımı aldı.							
Animasyon temelli uzaktan eğitim materyallerini kullanırken zamanın hızlı geçtiğini düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri ile öğrendiğim bilgileri diğer öğrencilere aktarabilecek kadar kendimi yeterli görüyorum.							
Elektrik kavramlarını öğretmek için animasyon temelli uzaktan eğitim materyallerinin kullanılabileceğini düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri etkinliklerinin müfredatta daha çok yer alması gerektiğini düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerini kullandığım sırada, kullanımı ile ilgili yardıma ihtiyaç duydum.							
Animasyon temelli uzaktan eğitim materyalleri sayesinde elektrik konularında bilgi ve becerilerimi geliştirdiğimi düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri ile çalışırken zorlanmadığımı düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri içeriklerinin anlaşılmayacak derecede karmaşık olduğunu düşünüyorum.							
Animasyon temelli uzaktan eğitim materyalleri ile soyut konulara ve kavramları öğrenmenin kolay olduğunu düşünüyorum.							

Öğrencilerin animasyon temelli uzaktan eğitim materyallerini kullanarak Fen, Teknoloji, Mühendislik, Sanat ve Matematik bilimleri gibi alanlarında bilgileri öğrenmenin daha etkili olacağını düşünüyorum.							
Animasyon temelli uzaktan eğitim materyallerine öğretim yönetimi üzerinden erişim zordu.							