Chapter 4
Virtual Reality in Medical Education

Ahmet B. Ustun
https://orcid.org/0000-0002-1640-4291
Bartin University, Turkey

Ramazan Yilmaz
Bartin University, Turkey

Fatma Gizem Karaoglan Yilmaz
Bartin University, Turkey

ABSTRACT

The aim of this research is to examine student acceptance and use of virtual reality technologies in medical education. Within the scope of the research, a questionnaire consisting of 4 sub-dimensions and 21 items was developed by the researchers. This questionnaire consists of sub-dimensions of performance expectancy, effort expectancy, facilitating conditions, and social influence. The study was conducted on 421 university students who participated in courses and activities related to the use of virtual reality applications in medical education. The findings of the research demonstrated that the students' acceptance and use of virtual reality applications were high in medical education. Various suggestions were made for researchers and educators in accordance with the findings.

INTRODUCTION

Although Virtual Reality (VR) has been used in a few fields such as some sectors in the military since the 1970s, technological advances have recently made the accessibility of VR affordable and the use of it prevalent now (Beheiry et al., 2019). While the affordability of it has increased its usage among prospective customers, it has evolved to become a sophisticated technology that immerses a user in a virtual environment that is getting similar to reality, which even draws non-consumer attention towards

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this technology. It can be seen as a technological revolution that leads to the triumph of 3-D environments. Therefore, it is widely used in fields such as healthcare, military and education.

The popularity of VR increases in the realm of medicine. Many researchers emphasize the use of VR in healthcare as a potentially effective tool that provides innovative techniques for clinical practice settings. Morel, Bideau, Lardy, and Kulpa (2015) state that standardization, reproducibility and stimuli control are the benefits of the VR system in clinical assessment and rehabilitation. The use of VR technology offers a standardized virtual environment in which stimuli can be controlled to accurately evaluate the balance recovery of patients and their progression, and this standardized environment can be reproducible to make comparisons among patients in the same condition or between the trials of patients (Morel et al., 2015). Also, the accessibility and affordability of VR technologies are easier with the commencing mass production of low-cost devices so rehabilitation can be continued anywhere, anytime in motivating and entertaining virtual environments (Morel et al., 2015; Riener, & Harders, 2012).

Rose, Nam and Chen (2018) indicate that VR technologies have been employed in treatments of physical impairments as an emerging rehabilitation technology for those who suffer from "stroke (Jack et al., 2001), cerebral palsy (Reid, 2002), severe burns (Haik et al., 2006), Parkinson's disease (Mirelman et al., 2010), Guillain-Barré syndrome (Albiol-Pérez et al., 2015), and multiple sclerosis (Fulk, 2005) among others" (p. 153). This aligns with the comprehensive systematic review study conducted by Ravi, Kumar and Singhi (2017) who state that the utilization of VR technologies in therapeutic interventions for children and adolescents suffering from cerebral palsy is a promising intervention in order to make improvement in balance and overall motor capabilities. VR technology can also be used in psychotherapy. The use of VR applications has been proved as an effective treatment for phobias through the processes of habituation and extinction (Riva, 2005). In the VR treatment of phobias, patients are exposed to controlled, fear-provoking stimuli to gradually alleviate the anxiety in the realistic environment.

While VR has been gained popularity in the use of interventions for balance assessment, rehabilitation and psychotherapy in the medical field, De Luca et al. (2019) point out that it is commonly cited as a valuable educational tool used in many fields of study such as medical and dental sciences. When VR is employed in medical education, it offers a safe environment where students gain fun, engaging, interactive and cost-effective experiences by eliminating the risk factors (de Ribaupierre et al., 2014). These situation-based experiences including specifically surgical experiences generated by VR technologies represented to students enable them to practice how to perform surgery for knowledge and skill acquisition without suffering possibly life-changing consequences. When the promise and potential of VR are considered in medical education, it can be seen that there are few numbers of research. It is important to increase current knowledge and diversity of research on this subject. Therefore, the aim of the study is to investigate the students' acceptance and use of VR technologies in healthcare education.

BACKGROUND

Brief History of VR

Although VR can be seen as a new phenomenon because of recent technological advancements that support the development of today's VR systems, the early roots for VR emerged in the 1920s. In 1920, Edwin Albert Link began working on a flight simulator for flight training and the first flight simulator was presented in 1929. Link later launched a company that produced flight simulators for flight training in the early 1930s (Page, 2000). The evolutionary origins of the VR system can be traced back to the 1960s when Cinematographer Morton Heilig created a multi-sensorial simulator "Sensorama" that stimulates the senses through wind and scent emitter, vibratory sensation, audio and a colorful 3D display (Pelargos et al., 2017). In the mid of 1960s, Ivan Sutherland, a head of computer graphics, developed the ''Sword of Damocles" that was the first VR systems equipped with head-mounted displays (HMDs), which enabled users to be able to view the virtual world and interact with objects (Drummond, Houston & Irvine, 2014). In 1975, Myron Krueger developed the first interactive VR platform, video place, that captures the users' image to allow them to see their computer-generated silhouettes imitating their own movements in 2D screens (Krueger & Wilson, 1985). Besides, VCASS developed by Thomas Furness in 1982 was for a better flight simulator than previous ones and VIVED – Virtual Visual Environment Display developed by NASA in 1984 was for their astronauts. Over the last decade, there were many other advancements in the developments of VR systems such as DataGlove (1985), HMD (1988), BOOM (1989), CAVE (1992) and Augmented Reality (1990s). In spite of the endeavours of these early researchers and companies, the technological improvements in computer efficiency were not sufficient to support VR systems that could be widely appealing until the year 2010 (Pelargos et al., 2017). VR systems including Augmented Reality (AR) have therefore been utilized in a variety of fields and worldwide sales of products and services of VR systems by the Oculus Rift from Oculus VR and Facebook, HTC Vive from HTC and Valve Corporation, PlayStation VR from Sony Corporation, Samsung Gear VR from Samsung Electronics, and HoloLens from Microsoft Corporation are expected to increase more than $162 billion in 2020 (Gaggioli, 2017).

Definition and Description of VR

Zhang et al. (2018) define VR as "a computer-generated simulation of a 3-D environment that users can interact with in a seemingly real or physical way using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors" (p. 138). Sacks, Perlman and Barak (2013) define (VR) as "a technology that uses computers, software and peripheral hardware to generate a simulated environment for its user" (p. 1007). As understood from the definitions, the VR system aims to provide a sense of being within a simulated environment. Users can experience a generated artificial environment that is exhibited to them by means of electronic equipment in such a way as to persuade their brain to perceive this artificial environment as a real environment. Due to this reason, those who viewed this artificial computer-generated environment for the first time depict their experience as a surprise or "wow effect" (Beheiry et al., 2019).

It is important to describe VR/AR and how both differ from each other. AR can be categorized as a subset of VR (Sharif, Ansari, Yasmin, & Fernandes, 2018). Although these technologies have similarities, there are major differences between them to individually provide a distinguished experience. Klopfer and Squire (2008) define AR as "a situation in which a real-world context is dynamically overlaid with coherent location or context sensitive virtual information" (p. 205). According to the definition, virtual objects are integrated into the real world (Durak, Karaoglan, & Yilmaz, 2019). Therefore, users can simultaneously experience the blending of the real world and virtual objects instead of being fully immersed in a virtual world (Pelargos et al., 2017). However, the idea behind VR is the creation of a simulated three-dimensional world that can be similar to or totally different from the real-world. The users are completely immersed in this simulated reality in which they can interact by holding, pushing, pulling and throwing virtual objects. In this sense, VR and AR systems have their own advantages and disadvantages to create a safe and simulated setting and therefore; there are concrete differences between the use of VR and AR systems in medical (Lee & Wong, 2019). On the one hand, the AR system allows a surgeon to see the surgical field as a real-life structure and at the same time artificial elements such as digital images of the surgical field and patient's other vital information (Murthi & Varshney, 2018). In this surgery, one of the distinguished benefits of AR is to enable the surgeon to see the patient's multiple interpreted information without breaking his concentration by looking away from the patient to obtain this information from multiple different displays (Murthi & Varshney, 2018). On the other hand, VR system can be used to fully immerse a mental illness patient in a crafted, virtual conditions where the patient encounters his fear to treat and cure phobia such as a fear of spiders, flying or being in a small space (Riener & Harders, 2012, p. 5). In this type of treatment, VR applications can be used to gradually expose the patient to the phobic condition and the treatment of the VR session can instantly be terminated if necessary.

Virtual Reality in Education

The use of VR technology in education and training has widely attracted attention because of its capability to create a virtual environment in which learners are steered toward achieving targeted tasks in order to acquire a variety of new skills. These tasks can be designed to captivate and engage learners in the learning process (Norris, Spicer & Byrd, 2019). This system mostly uses head-mounted displays with headphones and hand controllers as electronic devices to engage their multiple senses. Engaging multiple senses increases learners' attention and focus, and fosters meaningful learning experiences to develop new knowledge or skills in an immersive environment. Gadelha (2018) states that VR is a state-of-the-art technology product that enables learners to make connections with the instructional material in a way that has never been possible before by eliminating external distractions in the classroom.

According to Gadelha (2018), VR technology has changed how teachers teach and how learners learn. It has the potential to help shift from the traditional teacher-centered approach to a student-centered approach. The Multimedia Cone of Abstraction (MCoA) based on Dale's Cone of Experience (CoE) explicating learners retain more information when they learn by doing demonstrates that learners become active learners by interacting with a purposeful virtual environment in which they learn by doing targeted tasks (Baukal, Ausburn, & Ausburn, 2013). Basically, the researchers put the VR technology in place of the base of the CoE that is "Direct Purposeful Experiences" the least abstract level, which means that VR provides very realistic simulations of things that learners can interact with and learn best by doing.

Under appropriate conditions such as providing immediate feedback and enough time to allow learners to progress at their own pace, individual students achieve mastery of the task or materials (Bloom, 1974). The use of VR technology gives the opportunity for learners to practice what they have learned regardless of the number of repetitions until they carry out the targeted tasks. Its use also intrinsically motivates them to keep striving to successfully practice (Sánchez-Cabrero et al., 2019). In other words, its use encourages them to perform to their own capacities until mastering a skill or task instead of giving up repeating instructional sessions. Besides, they can receive immediate feedback on their current level of mastery in a virtual learning environment. The instant feedback helps them realize what they need to do better to achieve a skill or task and initiates the visual programming to recreate a virtual learning environment to be tailored (Norris, Spicer, & Byrd, 2019).

VR technology provides safe learning environments that learners can experience damaging, risky, dangerous or harmful situations while never putting their safety in jeopardy. Not only safe virtual situations that are hazardous in reality such as operating medical devices in healthcare training and combat training in the military can be created by VR for learners, but also can possibly be personalized according to each learner's need by simulating countless scenarios (Norris, Spicer, & Byrd, 2019). While infinite virtual instructional scenarios that are only limited by imagination and knowledge can be generated, Zhang et al. (2018) point out that the creation of these scenarios consumes very few natural and social resources in comparison with a real one.

Virtual Reality in Healthcare Education

Particularly, several studies have shown simulation training as an effective approach to improve knowledge acquisition and skills in healthcare education (Bracq, Michinov, & Jannin, 2019). VR training enables healthcare professionals to educate medical students by eliminating potential risks resulting in an adverse outcome in a patient. VR technology is not only considered as interactive and effective experiential learning for medical students to develop skill and confidence needed when they encounter in a real-life situation, but it is also seen as a cost-effective learning approach to repeatedly practice number of simulated clinical scenarios in healthcare (King et al., 2018). Therefore, the utilization of VR gives opportunities for medical learners to rehearse without being anxious about making mistakes and facing any grave results and to be prepared for recognizing the symptoms of a disease and even conducting complicated operations.

The utilization of VR simulations eliminates the need for the use of cadavers or animals to acquire professional knowledge and develop essential practical skills by providing a realistic method of training in the field of medicine. VR system also provides surgery training and rehearsal for inexperienced trainees to gain surgical skills in a variety of surgery operations such as endoscopic surgery, laparoscopic surgery, neurosurgery and epidural injections. Vaughan, Dubey, Wainwright and Middleton (2016) highlight the importance of attaining practice skills before operating theatre scenarios in real life and indicate that surgeons have great chance to develop and enhance their operative and decision-making skills in a controlled, risk-free realistic operating room through the utilization of orthopedic VR training simulations. Thus, the use of these VR simulations can be seen as suitable training opportunities for surgeons who have a lack of surgical experience to practice key skills in orthopedic and other types of surgeries.

Traditional forms of education like a verbal presentation of information and conveying written material may not be appropriate to teach complicated medical information for patients and their primary caregivers (Hoffmann & McKenna, 2006). Specifically, language proficiency, cultural and socioeconomic backgrounds, levels of education and understanding and language or cognitive impairment should be taken into consideration in stroke cases where risk factors and causes vary greatly from person to person in stroke survivors (Thompson-Butel et al., 2019). In this sense, it is a demand to tailor education according to the stroke survivor's needs for providing relevance and comprehensible information (Eames, Hoffmann, Worrall, & Read, 2010). A study was conducted by Thompson-Butel et al. (2019) who developed guided and personalized VR education sessions to prevent recurrent stroke and maximize rehabilitation for stroke survivors and their primary caregivers and explored the use of these VR sessions in delivering post stroke education to find out its effectiveness. They revealed that the use of VR provides safe and individualized educational experiences for participants who were highly satisfied with the education sessions and "demonstrated varied improvements in knowledge areas including brain anatomy and physiology, brain damage and repair, and stroke-specific information such as individual stroke risk factors and acute treatment benefits" (p.450).

Roy, Bakr and George (2017) explored the current situation of VR simulations and evaluated the value of VR simulations in dental education. According to them, VR devices that are employed in dental education offer great possibilities for flexible learning and self-learning. Learners can play an active role in their learning. For instance, the features of VR devices enable them to practice simulations in the form of VR when and where they want and assess their work after completing practices by storing and replaying. Besides, the use of VR technology also alleviates anxiety and boredom of a classroom setting and makes the learning process engaging and effective. The rapid technological advances in VR provide more effective and efficient realistic pre-clinical dental experiences for students in all disciplines of dentistry (Roy et al., 2017).

Purpose of the Study

The use of VR to train medical learners for the acquisition of clinical skills has several advantages including but not limited to offering safe and reliable clinical learning environments, facilitating self-directed learning and providing personalized learning (Ruthenbeck & Reynolds, 2015). Riener and Harders (2012) articulate the aim of the VR system in healthcare as enhanced quality of the education and long and efficient training sessions through motivating and exciting realistic simulations. Seymour (2008) indicates that training in a VR environment improves learning outcomes in clinical settings when taking advantage of the advancing capabilities of VR simulation. A study conducted by Gunn et al. (2018) who assessed the effect of using VR simulation on the first-year medical imaging students' technical skills by comparing their technical skill acquisition via the traditional laboratory-based simulation and the medical imaging VR simulation revealed that the use of VR simulation improved their technical skill acquisition better than the use of the traditional laboratory-based simulation. However, VR system has limitations including the latency, "the delay between the actions of the immersed patient with input devices and the reaction of the virtual environment" and "the underestimation of perceived distance in virtual environments compared to real situations" (Morel et al., 2015, p.324). These limitations may hinder the delivery of effective learning content or make the learning process difficult. Also, educators' self-perception of inadequate technological skills might hinder the use of VR technology. For example, VR technology is considered in some instances as a technology that requires a high level of technological knowledge and skills in order that learners are able to use (Warburton, 2009). Also, Sanchez-Cabrero et al. (2019) point out that VR as a learning tool "is a relatively unexplored area in its beginnings that urgently needs to deepen its application in the classroom" (p. 2). In addition, Gunn et al. (2018) indicate that there are limited scholarly documentations in the realm of undergraduate medical education in spite of the growing popularity of using VR technologies in healthcare. Taking full advantage of using the VR system as an educational tool depends ultimately on medical students' acceptance of VR (Huang, Liaw, & Lai, 2016). In this sense, it is vital to widen existing knowledge and a variety of research on the use of VR technologies in medical education. Thus, the purpose of the study is to explore the students' acceptance and use of VR technologies in medical education.

METHOD

This section includes information about the research design, participants, data collection tool and data analysis.

Research Design and Participants

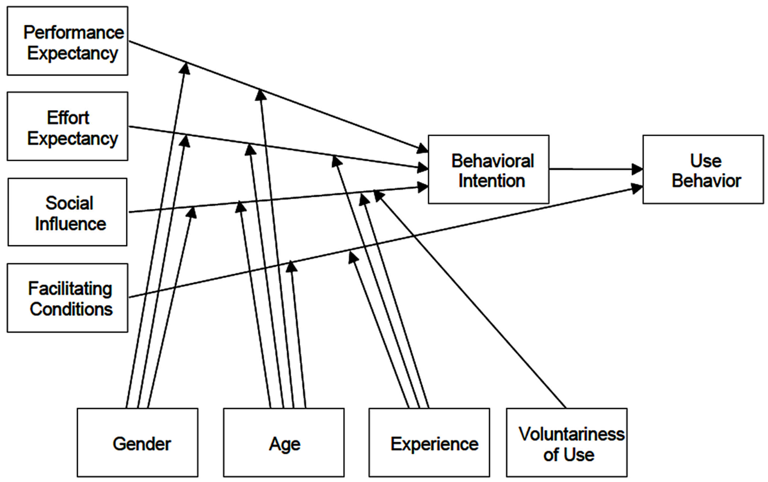
Within the scope of the research, a survey model was used to examine the university students' opinions about the use of VR technology in medical education. The participants were university students studying at a public university and taking the anatomy course that is taught by using VR technologies. Accordingly, this study was carried out on 421 university students. This study was conducted on undergraduate students studying at a public university in Turkey. When the distribution of students was examined according to their gender; it was determined that 46.8% (n = 197) are female and 53.2% (n = 224) are male. The students who participated in the research studied in diverse departments including health sciences (f = 111, 26.4%), physical education and sports (f = 91, 21.6%), coaching (f = 63, 15%), recreation (f = 81, 19.2%) and sports management (f = 75, 17.8%). The reason why the research was carried out on students studying at different departments was that an anatomy course was taught in these departments. It was attempted to contribute to the generalizability of the results by including students studying at different departments in this research. The students were in the 18-25 age range. More than half (61%) of the students were freshmen and the rest of them (39%) were sophomores. They were enabled to experience VR technologies within the scope of their anatomy course At the end of the research process, a questionnaire was completed by students to determine their acceptance and use of VR technologies in healthcare education.

Data Collection Tools

The data were obtained by a questionnaire developed by the researchers in this study. In the first phase of the development process of the questionnaire, the problem situation was determined and then the appropriate themes were composed in accordance with this problem situation by carefully examining the related literature (Sezer & Yilmaz, 2019; Yilmaz, Karaoglan Yilmaz, & Ezin, 2018). These sub-themes were 'Performance Expectancy', 'Effort Expectancy', 'Facilitating Conditions', 'Social Influence'. The sub-themes were developed by taking into account the Unified Theory of Acceptance and Use of Technology (UTAUT) model, which is one of the technology Acceptance models. Technology acceptance is a structure consisting of cognitive and psychological variables underlying the use of technology (Venkatesh, Morris, Davis, & Davis, 2003). The aim of this structure is to explain the acceptance of individuals to use a particular technology and the factors that affect this acceptance. Many models (TAM, TAM 2, UTAUT, UTAUT2, etc.) have been proposed in technology acceptance studies (Schepers & Wetzels, 2007). The aim of all these models elucidates the factors that affect the effective use of technology. Venkatesh et al. (2003) believe that it would be inadequate to explain a complicated structure consisting of cognitive and psychological variables like technology acceptance with a single model. Because of this reason, they expressed that this complicated structure should be examined in a multidimensional way and formulated the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). UTAUT model is consisted of four essential elements including "performance expectancy", "effort expectancy", "facilitating conditions" and "social influence" (Venkatesh et al., 2003). The graphic representation of the model is given in Figure 1.

As shown in Figure 1; Performance expectancy pertains to the belief that performance increases with the use of technology. Effort expectancy pertains to the belief that the related technology is easy to use. Social influence pertains to the belief and attitudes of influential individuals (teachers, successful students, etc.) towards the use of the related technology. The positive belief and attitudes of these indi-

Figure 1. Unified theory of acceptance and use of technology
(Source: Venkatesh et al., 2003, p.447)



viduals create a positive social impact on other individuals to use that technology. Facilitating conditions are related to whether or not various facilitating elements exist to support the use of technology for the individual (Venkatesh et al., 2003). Within the scope of this research, UTAUT model was taken into consideration in order to investigate the acceptance and use of VR technologies in healthcare education and a measurement instrument consisting of sub-dimensions of ‘Performance Expectancy’, ‘Effort Expectancy’, ‘Facilitating Conditions’, ‘Social Influence’ was developed.

After the determination of the sub-themes, a pool of 55 items based on the information extracted from the literature review was created. 35 items that were picked to suit the draft of the opinion form were selected from the item pool and a pre-application form was created with a Likert-type rating. In order to discuss the appropriateness of the pre-application form, three experts working in the field of Turkish language and literature, instructional technologies and health sciences were consulted on. The linguist evaluated the items in terms of intelligibility, expression and grammar. The experts in the field of instructional technology and health sciences assessed the items in terms of scope, criteria, structure and appearance validity. Modifications were carried out to the questionnaire in accordance with the feedback from the experts. Subsequently, the pilot test of the questionnaire was conducted on 95 university students who were excluded in the main study and the questionnaire items were revised and finalized by evaluating the questionnaire in terms of criteria such as language validity, clarity and appropriateness. Thus, the final version of the student evaluation form prepared for the investigation into the use of VR technologies in medical education was structured as a five-point Likert type scale consisting of four sections and 21 items.

Data Analysis

The value of factor loading for the developed data collection tool, KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) coefficient value to determine the suitability of the sample for measurements, Bartlett test to determine the consistency of inter-items, and Cronbach α reliability coefficient to estimate the reliability were used. The values of factor loading for 21 items ranged from .91 to .95. KMO value was .89. As the KMO value comes close to 1, factor analysis becomes more significant. KMO value between .50 and .70 is considered to be a medium level, between .71 and .80 is considered to be a good level and between .81 and .90 is considered to be a very good level and .91 and above is considered to be a great level (Field, 2005). Therefore, the sample was sufficient that data analysis could be conducted. It was found that the result of Bartlett's test was significant (Chi-square = 2329.147, $p < 0.01$). When the reliability of the questionnaire was examined, it was found that Cronbach's alpha reliability coefficient was .91. These findings confirmed that the data collection tool was reliable. Frequency and percentage values were used in the analysis of the collected data.

FINDINGS

Particular themes were found out in the process of preparing the data collection tool. These themes were Performance Expectancy', 'Effort Expectancy', 'Facilitating Conditions', 'Social Influence'. The findings related to the analysis of the first theme, "Performance Expectation" are given in Table 1.

Table 1 discusses the statistics in regard to the questions of "Performance Expectancy". The vast majority of students stated that the use of VR technologies in medical education enables the work to be done faster, enhances their performance, boosts their productivity and motivation, makes doing the assignments and practices easier, enhances the quality of the work done by them, and makes their learning process more effective and efficient. Based on these results, the students' performance expectancies

Table 1. Performance expectancy

Items		Strongly Disagree --- Strongly Agree					Total
		1	2	3	4	5	
1. Using Virtual Reality applications help me do my work more quickly in my courses.	f	18	26	78	197	102	421
	%	4.3	6.2	18.5	46.8	24.2	100.0
2. Using Virtual Reality applications improves my performance in my courses.	f	12	31	70	203	105	421
	%	2.9	7.4	16.6	48.2	24.9	100.0
3. Using Virtual Reality applications increases my productivity in my courses.	f	16	18	74	193	120	421
	%	3.8	4.3	17.6	45.8	28.5	100.0
4. Using Virtual Reality applications increases my motivation in my courses.	f	14	19	72	200	116	421
	%	3.3	4.5	17.1	47.5	27.6	100.0
5. Using Virtual Reality applications makes it easier for me to do my assignments in my courses.	f	10	30	76	192	113	421
	%	2.4	7.1	18.1	45.6	26.8	100.0
6. Using Virtual Reality applications improves the quality of my work in my courses.	f	10	30	74	191	116	421
	%	2.4	7.1	17.6	45.4	27.6	100.0
7. I find the use of Virtual Reality applications beneficial in my courses.	f	10	25	77	187	122	421
	%	2.4	5.9	18.3	44.4	29.0	100.0
8. Using Virtual Reality applications enables the learning process to be effective in my courses.	f	14	21	82	184	120	421
	%	3.3	5.0	19.5	43.7	28.5	100.0

regarding the use of VR technologies in medical education were high. This finding can be interpreted as facilitating students' acceptance and use of VR technologies in medical education.

The findings related to the analysis of the second theme, "Effort Expectancy" are given in Table 2.

Table 2 discusses the statistics in regard to the questions of "Effort Expectancy". The vast majority of students pointed out that learning the use of VR technologies in medical education is easy, they are effortlessly able to VR applications, the use of VR applications is not challenging and time-consuming, they feel comfortable while using VR applications, and they can easily do everything with VR applications. Based on these results, the students' effort expectancy regarding the use of VR technologies in medical education was low. In other words, students thought that they can easily utilize VR technologies by making a little effort. This finding can be interpreted as facilitating students' acceptance and use of VR technologies in medical education.

The findings related to the analysis of the third theme, "Facilitating Conditions" are given in Table 3.

Table 3 discusses the statistics in regard to the questions of "Facilitating Conditions". The vast majority of students indicated that they have the required knowledge to use VR technologies in medical education, there are persons whom they can get help when they have difficulty in using VR technologies in medical education, the use of VR applications is similar to the use other computer systems, they know persons whom they can get help in solving the problems that they encounter while using VR applications, and the help that they get will be sufficient to solve the problems they face. Based on these results, students have facilitating conditions related to the use of VR technologies in medical education. This finding can be interpreted as facilitating students' acceptance and use of VR technologies in medical education.

The findings related to the analysis of the fourth theme, "Social Influence" are given in Table 4.

Table 3 discusses the statistics in regard to the questions of "Facilitating Conditions". The vast majority of students indicated that people around them think it is important to effectively use VR technologies in medical education, the effective use of VR technologies increases their eminence among their schoolmates in medical education, and the effective use of VR technologies increases their respectability among their friends in medical education. Based on these results, it is concluded that students have social influence

Table 2. Effort expectancy

Items		Strongly Disagree --- Strongly Agree					Total
		1	2	3	4	5	
9. It is easy for me to learn to use Virtual Reality applications.	f	10	25	102	183	101	421
	%	2.4	5.9	24.2	43.5	24.0	100.0
10. I can easily use Virtual Reality applications.	f	12	24	97	189	99	421
	%	2.9	5.7	23.0	44.9	23.5	100.0
11. It takes less time to complete a task when I use Virtual Reality applications	f	12	28	107	170	104	421
	%	2.9	6.7	25.4	40.4	24.7	100.0
12. I feel comfortable while using Virtual Reality applications.	f	11	21	88	186	115	421
	%	2.6	5.0	20.9	44.2	27.3	100.0
13. I can do anything I want to do with Virtual Reality applications.	f	16	40	111	167	87	421
	%	3.8	9.5	26.4	39.7	20.7	100.0

Table 3. Facilitating conditions

Items		Strongly Disagree --- Strongly Agree					Total
		1	2	3	4	5	
14. I have the essential knowledge to use Virtual Reality applications effectively.	f	15	32	134	154	86	421
	%	3.6	7.6	31.8	36.6	20.4	100.0
15. There are persons whom I can get help when I have difficulty in using Virtual Reality applications.	f	11	23	87	183	117	421
	%	2.6	5.5	20.7	43.5	27.8	100.0
16. Using Virtual Reality applications is similar to using other computer applications.	f	13	29	122	171	86	421
	%	3.1	6.9	29.0	40.6	20.4	100.0
17. I know persons whom I can get help in solving the problems that I encounter while using Virtual Reality applications.	f	14	21	98	179	109	421
	%	3.3	5.0	23.3	42.5	25.9	100.0
18. The help service of Virtual Reality applications is enough to solve the problems I face.	f	15	30	105	181	90	421
	%	3.6	7.1	24.9	43.0	21.4	100.0

conditions related to the use of VR technologies in medical education. This finding can be interpreted as facilitating students' acceptance and use of VR technologies in medical education.

CONCLUSION

This study explored university student acceptance and use of VR technologies in medical education. The study was conducted with a sample of 421 university students who participated in courses and activities related to the use of VR applications in medical education. A questionnaire consisting of 4 sub-dimensions and 21 items developed by the researchers was administered to the students. This questionnaire consisted of sub-dimensions of 'Performance Expectancy', 'Effort Expectancy', 'Facilitating Conditions' and 'Social Influence'. The results demonstrated in general that the students' acceptance and use of VR technologies are high in medical education.

Table 4. Social influence

Items		Strongly Disagree --- Strongly Agree					Total
		1	2	3	4	5	
19. People around me think it's important that I use Virtual Reality applications effectively.	f	15	25	116	176	89	421
	%	3.6	5.9	27.6	41.8	21.1	100.0
20. The fact that I use Virtual Reality applications effectively increases my prestige among my schoolmates.	f	18	41	123	152	87	421
	%	4.3	9.7	29.2	36.1	20.7	100.0
21. My friends who effectively use Virtual Reality applications have more respectability.	f	25	38	130	137	91	421
	%	5.9	9.0	30.9	32.5	21.6	100.0

When the results related to the performance expectancy sub-dimension were examined, the majority of the students indicated that the use of VR applications helps make tasks faster, increase their performance, productivity and motivation in the courses, do assignments easily, improve the quality of assignments and lectures, and make the learning process more effective. Beheiry et al. (2019) state that tasks can easily be divided into virtual manageable tasks through the adoption of VR technologies, which boosts knowledge acquisition and makes knowledge transfer faster and they also state that the use of VR applications helps close knowledge gaps between experts and novices, which enables an inexpert to maintain and promote interest and motivation in healthcare.

When the results related to the effort expectancy sub-dimension were probed, the majority of the students remarked that the use of VR applications is easy to learn, that they can easily use these technologies and applications, and that they feel comfortable while using these applications. For these reasons, it can be claimed that the use of VR technologies is simple to operate for students. In other words, they can use VR technologies without making much effort. This result supported the claim that VR applications are easy to use (Huang et al., 2016).

When the results related to the facilitating conditions sub-dimension were looked into, the majority of the students pointed out that they have the required knowledge to use the VR applications effectively, that they know individuals whom they can get help around them when they have difficulty in using these applications and technologies, and that the use of VR applications is similar to the use of other computer systems. Therefore, these findings showed that students have facilitating conditions for using VR technologies, which increases their acceptance and use of VR technologies in medical education. This aligns with the study conducted by Sanchez-Cabrero et al. (2019) who explored users' interest in the use of VR technologies as a learning tool. They revealed that the desire to utilize VR as a learning tool is higher than the current use of VR although they didn't just focus on the interest in the use of VR in healthcare settings.

When the results related to the social influence sub-dimension were investigated, the majority of the students stated that the people around them think it is important to effectively use VR technologies in medical education and that the effective use of these technologies increases the prestige and respect among their friends. Based on these results, students have social influence for the use of VR technologies, which increases their acceptance and use of VR technologies in medical education. After Lee, Kim and Choi (2019) administered a survey with 350 people from South Korea, they reached a similar result that social interactions have a great effect on the intention to use VR technologies.

Based on these results, it can be asserted that university students are highly prone to accept and use VR technologies in medical education. Similar studies have shown that medical students have high acceptance and use of technology in medical education (Sezer & Yilmaz, 2019). These results of studies have a significant implication in terms of integrating VR technologies into courses and laboratory applications in medical education. A variety of instructional design models can be used in the VR integration process. Specifically, one of the instructional design models is ASSURE Model that can be used by instructors to design and develop an appropriate learning environment in medical education (Sezer, Yilmaz, & Karaoglan Yilmaz, 2013). Also, when the integration of VR technologies into a medical class is properly done, it potentially provides interactive and effective virtual learning experiences in which medical students can learn the subjects that are difficult to understand and practice the burdensome tasks that result likely in adverse outcomes. Thus, it will be possible to improve student performance, learning process and outcomes.

FUTURE RESEARCH DIRECTIONS

This study has some limitations. First, the students' acceptance and use of VR technologies in medical education is limited to data collected from the students through a questionnaire developed by researchers within the framework of UTAUT Model. Data from the questionnaire were described as item-based frequency and percentage values and the survey results were interpreted in the study. In future studies, students' acceptance and use of VR technologies in medical education would be examined according to other technology acceptance model in the literature. Besides, instead of item-based analysis of questionnaire items, students' acceptance and use of VR technologies in medical education would be investigated by using a questionnaire tested through exploratory factor analysis and confirmatory factor analysis in future studies. In this research, the students' acceptance and use of VR technologies in medical education were explored within the scope of an anatomy course. In order to increase the generalizability of the results of the study, students' acceptance and use of VR technologies would be compared by conducting similar studies within the scope of different courses in other specialties such as physiology, public health, emergency medicine, psychiatry. The acceptance and use of VR technologies in medical education were discussed in the view of the students in this study. The acceptance and use of VR technologies in medical education would be examined from the faculty perspective in future research. Therefore, it would be possible to gain insight into their opinions of utilizing VR technologies. Lastly, this study is limited to explore the acceptance and use of VR technologies in medical education. In future studies, the acceptance and use of VR technologies in different fields of higher education would be investigated.

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KEY TERMS AND DEFINITIONS

Acceptance of Augmented Reality: Students' behavioral status of acceptance and adaptation with regard to usage of augmented reality technologies with the educational purpose.

Acceptance of Virtual Reality: Students' behavioral status of acceptance and adaptation with regard to usage of virtual reality technologies with the educational purpose.

Augmented Reality: Augmented reality is a set of technologies that superimpose a computer-generated image(s) on the physical world, therefore providing a simultaneously mixed experience of virtual objects and the real world.

Effort Expectancy: The degree of ease associated with the use of the system (Venkatesh et al., 2003, p. 450).

Facilitating Conditions: The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh et al., 2003, p. 453).

Performance Expectancy: The degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al., 2003, p. 447).

Simulation: A simulation is an imitation of a real-world process in a controlled environment.

Social Influence: The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003, p. 451).

UTAUT Model: UTAUT Model is the Unified Theory of Acceptance and Use of Technology that is used for explanation of user perception and acceptance behavior. (Venkatesh et al., 2003).

Virtual Reality: Virtual reality is computer-generated simulations of three or more dimensions created by modelling of real objects or environments. Users can interact with these computer-generated simulations through their senses such as vision, hearing and touch and experience realistic objects by controlling them (Karaoğlan Yılmaz & Yılmaz, 2019).

Virtual Reality Immersion: Virtual reality immersion is the perception of being physically present in a non-physical world (Mukkamala & Madhusudhanan, 2016)

Virtual World: A virtual world is a computer-based simulated environment.