UNDERSTANDING THE EFFECT OF SERIOUS GAMES ON SURGICAL EDUCATION WITH RESPECT TO SIMULATION ENVIRONMENTS

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Approval of the Graduate School of Natural and Applied Sciences, Atılım University.

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Prof. Dr. İbrahim Akman

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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ABSTRACT

UNDERSTANDING THE EFFECT OF SERIOUS GAMES ON SURGICAL EDUCATION WITH RESPECT TO SIMULATION ENVIRONMENTS

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Serious games and simulations today are providing several benefits for areas such as education, training, health, military as well as commercial systems. However, the borderline between these environments is not very clear in literature. This information is important for designing more appropriate instructional systems according to the variations on learners' behaviours and their expectations. Our main assumption is that, depending on their experience levels, knowledge levels and individual differences, learners may behave differently on simulation or game based educational systems. Then, as a part of neurosurgery Education Project (ECE), a simulation environment was developed in two versions by applying a gamification approach and simulation. Afterwards, an experimental study was conducted to better understand the effect of gamification on beginners of such an education program. The results of this study indicate that the success rates of the participants for performing assigned tasks in both versions of the application did not change significantly. On the other hand, the gamification group has spent significantly more time for performing the assigned tasks by rarely referring to the navigation feedback. This consequence is evidence showing that the participants' behaviours have differed in simulation and game-based environments. The results of this study is expected to provide innovative perspectives to the instructional system designers for improving possible benefits of simulations and games in different fields and user groups.

Keywords−game, simulation, serious game, gamification, surgical education.

ÖZ

CİDDİ OYUNLARIN VE SİMULASYON ORTAMLARININ CERRAHİ EĞİTİM SÜREÇLERİNE OLAN ETKİSİNİ ANLAMAK

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Ciddi oyunlar ve simülasyonlar günümüzde eğitim, öğretim, sağlık, askeri alanların yanı sıra ticari sistemler alanlarında da çeşitli yararlar sağlamaktadır. Ancak, bu ortamlar arasındaki sınır alanyazında çok da net değildir. Bu bilgi, öğrencilerin davranışları ve beklentilerindeki farklılıklara göre daha uygun eğitim sistemleri tasarlamak için önemlidir. Bu çalışmanın temel hipotezi öğrencilerin deneyim ve bilgi seviyelerine ve bireysel farklılıklarına bağlı olarak simülasyon ya da oyuna dayalı öğretim ortamlarında davranışlarında farklılıkların olacağıdır. Oyunlaştırma yaklaşımı uygulanarak bu simülasyon ortamının başka bir versiyonu geliştirilmiştir. Daha sonra, oyunlaştırmanın eğitim programının başlangıç seviyesindekiler üzerindeki oyunlaştırmanın etkilerini daha iyi anlamak için böylesi bir deneysel çalışma yapılmıştır. Araştırmaya göre, uygulamanın her iki versiyonda da verilen görevleri yapan katılımcıların başarı oranı önemli ölçüde farklılık göstermemiştir. Ancak, oyunlaştırma grubu verilen görevleri harita yardımına nadiren başvurarak, yapmak için istatistilsel olarak anlamlı ölçüde daha fazla zaman harcamıştır. Bu sonuç, katılımcılarının davranışlarının simülasyon ve oyun odaklı ortamlarda değiştiğini gösteren bir kanıttır. Bu araştırma sonuçlarının farklı alanlar ve kullanıcı gruplarında oyun ve simülasyonların olası faydalarını geliştirmek için eğitim sistem tasarımcılarına yenilikçi bakış açıları sağlaması beklenmektedir.

Anahtar Kelimeler −oyun, ciddi oyun, simülasyon, oyunlaştırma, cerrahi eğitim

To My Family

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LIST OF ABBREVIATIONS

ECE	-	Endoneurosurgery Education
Q & A	-	Question and Answer
3D	-	Three Dimensional
DLL	-	Dynamic-Link Library
GPS	-	Global Position System
ESST	-	Endoscopic Surgery Simulation Tool
RQ	-	Research Question
F	-	Female
M	-	Male
EG	-	Experimental group
CG	-	Control group

CHAPTER 1

INTRODUCTION

Simulations and games are powerful tools for creating interactive instructional environments in different domains such as military, heath, training, education programs and commercial applications. In the literature there are studies showing possible benefits of simulation and games on instructional systems [29]. Even though there are some studies showing that simulations [55], [56] and games [57] have positive effects on surgical education, applications of game technologies in surgical simulation area is very limited. Additionally, in the literature, there is no clear borderline between these simulated and game-based educational environments [1], and also their possible effects on the instructional systems are not clear.

By better understanding the borderline between games and simulations, design of instructional systems could be improved by considering variations on learners' behaviours in these environments. Our main assumption is that, depending on their experience levels, knowledge levels and individual differences, learners may behave differently on simulation or game-based educational systems. Accordingly, this study is organized to better understand the behaviours of individuals on game-based or simulation-based educational environment. Hence, in this study first a literature review has been conducted to better understand the borderline between games and simulations.

Additionally, a simulation environment has been developed for surgical education purposes according to their domain specific requirements and educational objectives. Afterwards, a gamification approach, which refers to experimental group, has been implemented to this simulation environment to create a game-based version of it, together with a control group, called simulation group. These two versions of the educational materials have been then studied experimentally to more decently

understand the effect of gamification on the progress of the beginners. Since the beginners of these educational programs can be classified as any university level students, the participants of this study are selected from various faculties of Atılım University.

In this environment learners were asked to travel in a 3D vessel like model and reach ten different targeted places in different locations in the model. Additionally, when they needed help by pressing a button, the learners were able to get a navigation help, showing their current position and the target position. The learners' time duration spent while performing each task, distance travelled, number of mistaken path (number of wrong ways), number of hits to the walls, their success rate (if they have successfully reached the target position and cleared the target), and navigation usage (number of references to the navigation map) were all recorded. Students were randomly assigned for one of the gamification (experimental group) version of the educational material or the simulation version (control group). Results of this experimental study were then analysed statistically to understand the gamification effect.

The results show that in general the amount of the reference to the navigation map is significantly low for the experimental group (gamification version) compared to the control group (simulation version). Additionally, the time duration spent for each task to be completed is significantly low for the control group in comparison with the experimental group. On the other hand, their success rate, number of hits to the walls, number of wrong ways and distance travelled to perform each value did not change considerably in both groups.

The study has been conducted on surgical education domain. Hence, the results of this study need to be validated in other domains as well. The same study can be conducted with surgeons having different expertise levels to better understand the gamification effect on their performance. Additionally, the gamification parameters may also be experimentally analysed and re-designed to improve the positive effect of gamification on learners.

The rest of this thesis is organized as follows: Chapter 2 covers the background of the study, Chapter 3 gives information about ECE project and system characteristics

of the ECE. Furthermore, this chapter includes the scenario of the Navigation application, with subcategories of control and experimental version. Chapter 4 describes the research methodology used in this study. Chapter 5 details the results of the study and Chapter 6 contains discussions and conclusion part.

CHAPTER 2

BACKGROUND OF THE STUDY

The background of this study is organized in three main sections. In the first section, the literature review has been done to more adequately understand the features of simulations and games for instructional systems and the second attempts to draw a borderline between them. The third section of the literature study has been prepared to more deeply understand the usage of these technologies for educational purposes, especially for medical education.

2.1. Simulations and Games

According to Webster (2011), simulation is defined as "*the representation of the behaviour or characteristics of one system through the use of another system, especially using a computer", which refers to the representation of an aspect of reality based on an abstracted and simplified model"* [2]. Simulation means the technique of imitating process of areas such as economic, military or mechanical by means of situation, especially for the purpose of study or personnel training, which can be readily applied to a learning environment [3]. In the literature, the educational benefits of simulation have been appreciated for some time environments [61]. For instance, simulation has been implemented in real-time application areas, including researching, training, analysis, testing and also development of new products [4]. Studies reviewed in previously done experiments show that surgical skills can be taught more effectively using simulations [5]. By utilizing simulation, designing a skill acquisition module requires steps as described below [5]:

- Defining the skill to be taught,
- Standardizing values for these skills, using appropriate metrics,
- Defining desired levels of performance through definition of criteria,

- Significantly assessing the validity of the simulator,
- Integrating this process into a defined curriculum

Through simulations, learners are able to acquire the skills any time by repeatedly creating unusual situations [6]. Thus, nowadays the simulations have started to become a part of medical apprenticeship at offices in the simulator centre. Visual realism has significant aspects for medical simulation which includes the acoustic environment of medical procedure and the physical objects in games, besides, and advanced graphics makes the simulation more realistic [7]. Moreover, the network technologies introduce multiplayer of surgical simulators for training cooperative tasks. Surgical simulators are brought in the networks for training cooperative tasks [7].

Even though simulation environment has successful applications and beneficial potentials, there are nevertheless some drawbacks which have been reported by the researchers. For instance, the simulators are limited with the number of defined scenarios and adding new scenarios is a difficult and time-consuming task [8]. Main disadvantages of simulation are that the trainees usually get familiar with the training dataset quickly and, thus, cannot develop adequate skills to handle complex clinical cases with such a limited dataset [8]. Another shortcoming of these systems is the level of realism which is usually not enough to provide users with a realistic environment for the development of required skills [8]. Accordingly, some studies found in the literature points out that through such simulated environments performance and learning do not vary [9].

2.1.1. Games

Gaming is a method of teaching that provides active learning and encourages participation. This shows that games also lighten the mood, increasing trainee's morale and facilitating greater creativity [10]. In the literature, several definitions of games are existent. For instance, Kapp (2012) defines a game as, "*A system in which players engage in an abstract challenge defined by rules, interactivity, and feedback, that results in a quantifiable outcome often eliciting an emotional reaction.*" [11]. In addition to this, the definition of games includes decision making and outcome-oriented activities according to a set of rules [1].

There are several features of games which are very important for getting improved benefits from these technologies. For instance, a set of agreed rules, constraints, and clear goals are some of the vital features of games for creating challenge in the game. Additionally, games involve competitive activity and provide feedback to players for reaching their goal, either as score or as changes in the game environment. These characteristics operate together within the system to provoke an emotional reaction, and then, quantifiable outcomes are located within an abstract version of a larger system [11]. Games create a training resource and skill acquisition. In the literature, several benefits of games are located and researchers report that playing video games improves performance on hand-eye coordination, faster reaction times, spatial visualization and mental rotation; besides, they are reliable, portable and inexpensive [8]. Today, computer games are not only designed for entertainment, but also for the purposes of training, investigation or advertising, and these games are called serious games [12].

2.1.2. Serious Games

There is cognitive motivation inherent in games which are regarded as a way to support learning activities by new technologies [13]. Those games used for a purpose other than entertainment are called serious games. Serious games are defined as computer games which are designed for learning and research purposes. Serious games include main principles such as realistic modelling, content integration, evaluation, learning skills and feedback by means of playing game [14]. They can be played on different platforms that may be either video game consoles, personal computers or smart phones. Thus, they can apply interactive content in any virtual environment. The most important characteristic of serious games is giving feedback because it helps the players to understand their performance in the game, and gives information about their success or failure [15]. According to Corti (2006), serious games increase the power of computer games to captivate and engage players or learners in a specific purpose such as developing new knowledge or skills [16].

Several advantages of serious games have been addressed in the literature. To illustrate, they include a goal, fun for the players, incorporate scoring mechanism, and supplying the players with skills that are also useful in reality by creating a balance between learning and challenge [17]. In this concern, educational games are

considered as serious games. Fitzgerald 1997 defines an educational game as "an instructional method requiring the learner to participate in a competitive activity with preset rules" [53]. Some studies show that educational game is a type of experiential learning and is a different intervention with its competitive nature, rules and procedures compared to other educational areas [53]. The use of educational games contains a variety of activities such as training, practicing skills, research, entertainment, teaching and operational analysis [53]. Additionally, it implements game thinking and game-based mechanics [11]. However, design features of those games and the ways of creating such an environment, which is called as gamification, is an important design approach for creating more efficient and effective games in different domains. In the next section gamification approaches are summarized.

2.1.3. Gamification

The rise of gamification idea is the use of elements of game design elements in non-game contexts [18]. Gamification includes trends, game mechanisms and non-implementation activities for changing people's behaviour. It is the use of game mechanic techniques to create more fun and to improve learning through the instruction systems. Besides, gamification is a kind of reward-based design that provides motivating and enjoyable product for people [18]. At the same time, the players are the most important elements of the gamification, and also their motivation becomes the outcome. Gamification may provide a combination of competition and cooperation [11]. Application of gamification encourages learning to use the appropriate game elements, and offers game thinking for solving problems [11]. The result of process of gamification includes behaviour changes and positive outcomes [19]. Thus, gamification ensures continuity by improving the time that people spend on the system [19].

The tools used in Gamification

Nowadays games are becoming popular in different areas such as health, education and training, providing practice activities rather than entertainment [20]. For improving the benefits of games, one needs to figure out the design characteristics, and control these attributes in accordance with the training, health or education

purposes. Several game characteristics such as challenge, chance, goals, competition, cooperation, enjoyment, concentration, learning, rules, skills, social interaction have been studied by several researchers [21] [22] [23]. These game design features must be carefully analysed in order to get more useful gains for the domain specific purposes. Hence, understanding each of the factors mentioned above and their effects improves the benefits of games in educational environments. These design characteristics of games are summarized below from the literature.

Chance – Uncertainty

The chance factor and uncertainty in games have not been discovered yet. Depending on the studies found in the literature, uncertainty raises the level of engagement [24]. Apart from learning environments, chance-based uncertainty is an important factor among educators. External uncertainty takes place whenever uncertainty is due to random chance events in a medium which cannot be taken under control [25]. Apart from this, related external uncertainty, internal uncertainty is aroused by varying the degrees of knowledge about the winning rules [25]. Studies report that a balance is required between external and internal uncertainty in the games as people usually represent frustration when the outcomes of their decisions are decided randomly [25].

Rules

Rules in games are important game design factors that increase or decrease the level of excitement through games. Without set of rules in a game, it is unthinkable that the game would involve enjoyment, fun, excitement and engagement. Also, people would not demand the game product. Game rules explain how to act in order to win the game in the game environment [1]. If the player behaves otherwise, the game is lost. Therefore, for a player rules are fundamental tools in order for him to learn, enjoy and experience failure and success.

Competition

In most of the definitions about competition, the key points of the competition are defined as individuals or groups, who compete with each other, and the existence of well-defined goals and improved motivation. One feasible form that differentiates

between individual and group play can be interpersonal competition and intergroup competition [26]. In most of the resources, classification of the competition can be done as relative distance between different game-players, and between user and computer [26]. Competition is a positive outcome because it is related to challenge. The development of the game theory is done to analyse competitions in which one player's experience is beaten by another player [27].

Researchers report that learning is engaged with the result of competition [28]. In literature, there are some studies displaying that competition is thought as an efficient technique to encourage people's learning [22]. In addition to that, computer-based game environment provides active interaction, competition and innovation as proven by post-test [29]. It is proven that competitive environment enhances learning independently from contextualized advisement support [30]. It is emphasized in the researches conducted among math students some of whom are in competitive environment with no connection to contextualized advisement got higher scores in post-test. However, the remaining ones, in a non-competitive environment with connection to contextualized advisement, had higher scores in the post-test [31]. On the other hand, competitive learning activities have some possible negative effects which are diminishing authority, impeding performance on several tasks, promoting anxiety, and difficulty increase in their learning [32].

Enjoyment-Fun-Excitement

Game interfaces can be used in making activities enjoyable in addition to providing imaginative and fun experience by suggesting interesting and engaging challenges. Game presents enjoyment in realistic virtual settings with the game technologies. Studies report that these technologies can be used for entertaining quality for health, public policy, training, education, and strategic communication objects [1].

Goal

Entertainment is usually the most important game design element, but nowadays it is used to enhance other application areas like serious games. Although a special purpose, not restricting the explanation of the non-game content any further for any specific utilization, aim or content, is present initially, serious games have also

created themselves into all kind of contents because there is no specific benefit of such limitation [33]. In order to guide the player achieving the game goals in a serious game, the requirements and the rules of the game to be reached and to be followed for the players should be clearly provided in the beginning of the game [34]. If it is not provided well, the player can become confused and it would be harder to measure the learning performance during the game. In literature, it is shown that the players' flow experiences are improved by goal directed activities [35]. In addition to that, when the missions are clearly defined in terms of goals, there is a higher concentration in game. Most of the time the aim of serious games and simulations made for educational training is to supply learning medium to achieve a certain level of knowledge for the provided field of discipline.

Repetition

Repetition can be defined to support trial and error type of learning as well as creating limitless and more reliable game environment, time and location independent experiences. As it is stated in notable resources, games are unlimited experiences as the player has information and consciousness of simulations in game, which are the indicators of repetition [36]. On the basis that repetition efficiently providing many benefits, it can be said that repetition is one of the most vital parts of simulations and games.

Score Board

Score board and the level of the game are the most popular compounds of a game. A score board shows some information about the players' current situation on the game such as the complete level, the time durations and the total score gained so far [37]. According to the relevant literature, games should include rule-based, challenging performances, and also the previous actions of the former players should be shown to the current player of the game on the screen [38].

Feedback

The game design contains the feedback system characteristic in the game. Some researchers state that feedback helps players to figure out their performance in the game and give information about their action [39]. Moreover, feedback rewards the

players on their improvement and success in the play. Thus, the players are well-informed about their status, directions and performance [40].

Reward

Reward is used as a game mechanism in designs. It can be commonly seen in every field of life: from gas stations distributing mobile phones or water glasses to shopping malls giving out gifts. These make people much keener to win awards. Such triggers encourage people to be more ambitious and make an effort to get this type of rewards. In addition, being given presents makes people happy and entertained. The whole situation gives an interesting formula:

Requesting + Entertainment = Commitment [41]

Active Learning Alternatives

In traditional learning environments students are usually passive. Teachers provide instructions in front of the classroom and students try to understand the provided instructions. It is not always possible to create active learning environments in such traditional learning settings. However, in games and simulations, learners are active participants of the environment [58]. For instance, competitive learning environment creates an interaction and motivates students. Games have recently turned out to be new and better means of making students or participants more actively-involved and motivated. Moreover, research conducted in medical education proves that the interactive characteristics of games make learning more efficient [42]. According to studies, simulations and games supply the improvement in eye-hand coordination, awareness and rapid reaction times in surgical education [8]. In this way, active learning is achieved.

Examples of Gamification Applications

Gamification is used in many different areas through different applications such as Foursquare, Keas, Nike+, The Speed Camera Lottery, Recyclebank and SCVNGR. Below a summary is provided by analysing how gamification has been implemented in those applications.

Foursquare Application

One of the most commonly known applications is Foursquare [43]. Within this application, the users "*check-in*" when they go somewhere so that they can collect the scores. Therefore, they can reach the "mayor" status making "*check-in"* in the most visited places. A lot of users make an effort to gain a statue of "mayor", and go to these places even if they normally do not visit the place frequently or like it so much. The marketing is by far the most effective business using Foursquare's feature giving their customers free coffees when they make "*check-in*" in five different Starbucks coffee shops, one of the popular cafés. In addition to this example, AFM Cinema Company gives customers a pair of cinema tickets for their first "check-in". These examples show that the gamification features of the Foursquare Company create a new business.

Keas Application

Keas application is an employee wellness program that emphasizes three things to incentivize exercising: game mechanics, social interaction, and small groups. The game mechanics involve a series of points and status mechanics to drive positive reinforcement. Employees then socially interact with these elements through competitive statistics and community Q&A forums. All participants also must form small teams of six people. If one or two people in each team stop participating, then the entire team is unable to play and feel under social pressure to exercise. In this way, this application related to healthy living illustrates the power of positive reinforcement. It aims to help people who want to give up smoking and lose weight through a gamification approach [44].

Nike+ Application

Nike Company, a popular sports shoe companies, is one of the brands which use gamification method. Nike has made cooperation with Apple Company, a computer company, and the cooperative application is called Nike+. Using this application, when people do sports, they can see the calorie which is burnt and the distance that is run or walked. In this application, the users can determine a target and they can see how close they are to their goal [45]. This application is also a well-known and

popular one in the marketing.

The Speed Camera Lottery Application

Speed Camera Lottery is the winning idea for the Volkswagen Fun Theory. The concept was to have a modified traffic light taking pictures of every car that passed by. When a car passed by this traffic light by exceeding the speed limit, it was given a summons and a fine. The money from these fines would then go into a pot. Every car that passed by that device and obeyed the speed limit was given a chance to win the money from the pot. The idea was actually put into practice in a 3-day period in Stockholm and generated a 22% average speed reduction of drivers who passed by the light [46].

Recyclebank Application

Recyclebank helps creating a more sustainable future by rewarding people for taking everyday green actions with discounts and deals from more than 3,000 local and national businesses. Through its online platform and partnerships with municipalities, haulers, small businesses and corporate brands, Recyclebank is empowering individuals to make a collective impact on the environment by increasing household recycling, reducing household energy usage and taking other environmentally-preferred actions. It is an enjoyable and environmental website that provides information about energy saving and recycling for consumers. Besides, consumers who are conscious about the environmental area are awarded with the point system [47].

SCVNGR Application

SCVNGR is all about going places, doing challenges and earning points. It is very similar to Foursquare. Players discover new cool places, find new fun activities to do, share their activities with friends and can even earn virtual rewards. Individuals and institutions can build on SCVNGR by adding custom challenges at their favourite places. It was developed for mobile phones based on locations for customers and companies. The players complete the mission going to different places, so they win points. These points are transformed into digital badges,

discounts or gifts from the real world awards [48].

2.2. The Borderline between Serious Games and Simulations

As described previously, games and simulations designed for instructional purposes provide numerous benefits. Literature shows that there are some similarities between these instructional design tools as well as the distinctions that appear in between. Key characteristics of these systems are analysed and examined to better comprehend the borderline between serious games and simulation.

Therefore, as seen in Figure 2.1, helping the learner to better reach the instructional objectives and outcomes for the specific domain is the main aim of both serious games and educational simulations that are developed for educational and training purposes.

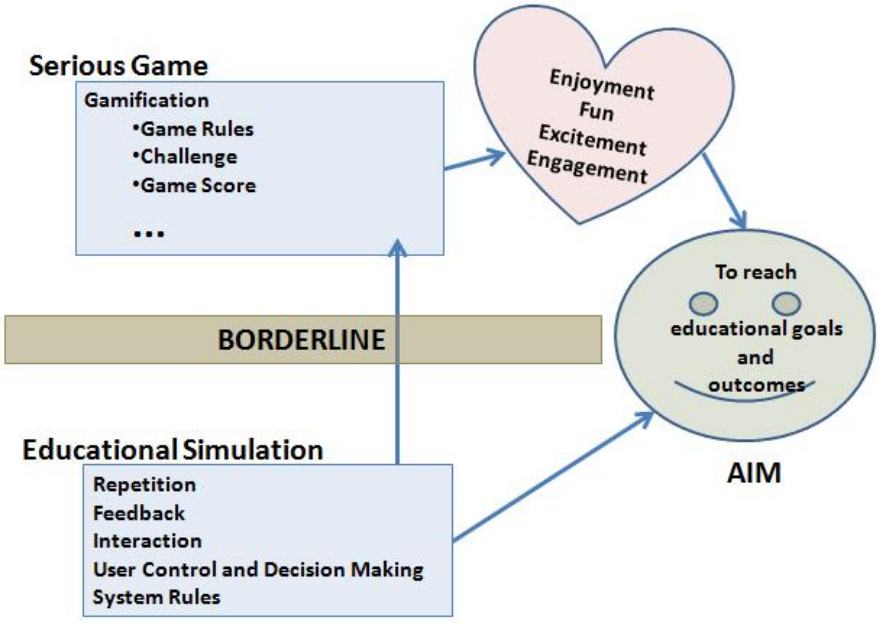


Figure 2.1 – The Borderline between Serious Games and Simulations

Thus, there is a repeating try-and-error type of learning that is presented by the simulations and games. Learners are usually assigned some tasks and asked to perform required actions. In addition to this, games provide enjoyment, fun, excitement, and engagement for reaching the same aim. Hence, the main borderline in between can be set at this point as seen in Figure 2.1. In other words, games make

it extra enjoyable over the options of simulators. Generally, through making of a challenge by the use of a number of unusual approaches which are game rules and game score, the enjoyment element in the games is enriched. Therefore, this enjoyment improves the achievement level of the predefined goals. Hence, by featuring attractive and appealing difficulties, serious games offer an enjoyable environment for the ability growth. Studies also suggest that there should be an assessment of improvement on expected skills and learning outcomes through serious games [49].

In a competitive game, the goal is to win. On the other hand, simulations create practices, different from the games. As a conclusion, enjoyment is obtained through the use of a few accessories in the serious games such as game score, game rules and tough game plan tips. The engagement of the learners' advancement happens by means of this enjoyable aspect of the games. There is a repeating try and error kind of learning that is set with the help of simulations and games. Additionally, using some tools such as game score, game rules and challenging game design strategies, the fun is provided by serious games. In a comparative way, the features of games and simulations that are summarized from the studies found in the literature are shown in Table 2.1.

Table 2.1 – Features of Games and Simulation

Feature	Game	Simulation
Chance - Uncertainty	✓	X
Rules	✓	X
Competition	✓	X
Enjoyment-fun-Excitement	✓	X
Goal	✓	X
Repetition	✓	✓
Score board	✓	X
Feedback	✓	✓
Reward	✓	X
Active learning alternatives	✓	✓

2.3. Simulations and Games for Instructional Purposes

Simulations and games include two categories: educational and health. Below, according to these categories the applications are summarized.

2.3.1. Simulations and Games for Education

Educational games and simulations are impressive tools for developing learning in both adults and children. All games and simulations contain learning activities, and there is a balance between learning elements of the game and game. Moreover, simulations and games need to be engaging for implicit or explicit learning. Educational games aim to teach participants about participants, concepts, or help them in learning [14]. These games give immediate feedback within an entertainment safe virtual environment [14].

2.3.2. Simulations and Games for Health

Simulations and serious games are growing day by day in health sector. Studies show that there are some additional advantages of serious games and simulations on training, emotional states, rehabilitation and treatment of mental conditions. For instance, patients are being prevented and rehabilitated with these games. Studies pose that serious games even increase motivation, reduce anxiety and support physical activities [51]. These features are innovative ways to improve skills for patients in health care [52].

2.3.3. Simulations and Games for Medical and Surgical Training

Related studies reveal that, through games and simulations, health professionals' skills, knowledge and attitudes can be improved [53]. Serious games have been easily applied to different domains lately. They are defined as digital games for electronic devices and associated with the advancement of competence of professionals in medicine [1]. Professionals in medicine mean individuals who are responsible for the care of patient such as doctors, nurses or physiotherapists. For instance, serious games reduce medical error and healthcare costs, improve surgical skills, promote learning, engage people and motivate them [1]. Hence, today, simulations and games are widely being used for medical education and training purposes to supply an improvement for the required skills such as improvement in eye-hand coordination, awareness and rapid reaction times in surgical education [8].

CHAPTER 3

RESEARCH MATERIALS

This study is conducted for endoneurosurgery educati on purposes as part of a project named ECE (112K287) supported by TÜBİTAK 1001 for three years (2011 – 2014). Accordingly in this chapter first a general description about this project is provided, then, the simulation environment developed for the ECE project that is adapted to this study is summarized.

3.1. ECE Project Summary

Endoneurosurgery is a medical term which includes medical surgeries for brain and nervous system diseases using endoscopic approaches. Surgeons who can perform these operations are supposed to go through a special and laborious training process. This training can be taken by people who are enrolled in the medical science and choose the branch of endoneurosurgery. These people should take six years of basic medical education. In addition to this, they should meet some requirements, which are working as a research assistant in this field after entering the specialist exam according to Turkey's system. Besides these people, people who are specialized in brain surgery and improve themselves about endoneurosurgery can receive the training within the scope of vocational-training programs. These training are really expensive and difficult as well as being long processes. Nowadays, developments in educational technology give a lot of solution opportunities for improving educational process and minimizing the problems. This project aims at developing Endoneurosurgery Education Project (ECE) system enriched by the instructional technology [54].

3.1.1. System Characteristics of the ECE Project

Scenarios in the ECE project were developed on a game engine called Unity3D. Unity3D is a really useful application to develop games using C# language. Besides, the libraries are integrated from the outside using the .NET 2.0 infrastructure. The haptic devices were integrated using DLL files which were compiled on the .NET 2.0. The devices could be used without any problems thanks to the position data taken from the haptic and the feedback sent. Besides, the scenarios were becoming more realistic with a lot of visual plug-ins included under Unity3D. For instance, some visual impacts like bleeding, tissue deformation, shining and reflection etc. could be achieved easily thanks to Unity3D [54].

3.2. The Scenario of This Study (Navigation Application)

Surgical navigators are being used for supporting endoneurosurgery operations and called as neuronavigation. These systems work like a common GPS systems used in everyday traffic work. With the expansions in optics and medical imaging technologies, these tools are used in operating rooms to guide the surgeons. There are lots of properties of these systems such as gathering the quality pictures of patients with brain or spine pathologies to construct a practical three dimensional form of the patient's head together with the brain and the spinal cord, as well as matching the definite examination of the patient with the 3D model and guiding the doctors in deepness of the brain tissue. The surgeon can direct the shortest possible method to the pathology as if he is seeing what is surrounded by the cranium with his naked eyes from outer surface of the patient's head while protecting the healthy brain tissue, and also he can leave his admission tip just over the pathology by the aid of this technology.

In order to gain necessary skills to use these tools functionally, the surgeons need to go through some additional training programs. Accordingly, the scenario of this study is designed to improve the navigation skills of the surgeons. Below the details of the navigation application are described. For this study, two versions of navigation environment have been prepared.

3.2.1. Control Version of the Navigation Application

One of the versions is general navigation interfaces of the endoscopic surgery simulation tool. For this experimental study, a gamification approach has been implemented. Both user interfaces of this experimental study are described in detail below.

Endoscopic Surgery Simulation Tool (ESST)

The developed tool of the endoscopic surgery simulation for this study is based on a three dimensional (3D) model of a simulated environment that includes changed branches of vessel like holes as seen in Figure 3.1.

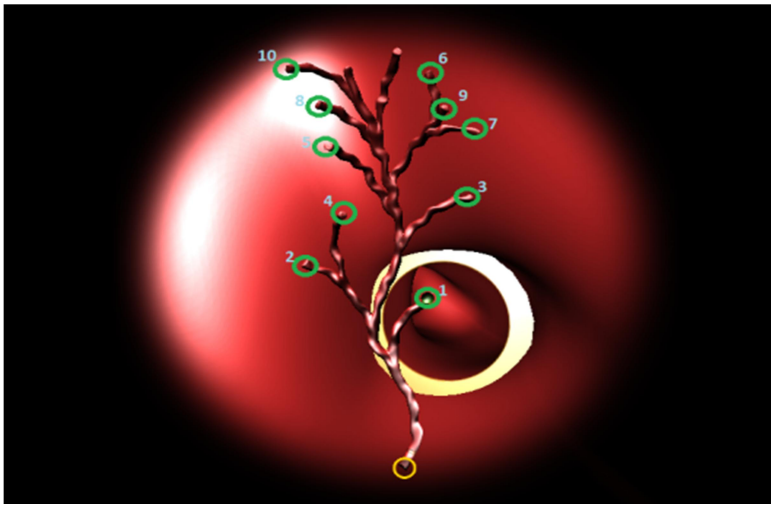


Figure 3.1 – ESST Model Branches

Beginning from the starting point, the members have the capability of moving within the 3D model. The organization of the 3D model that is used for ESST is shown in Figure 3.1. The users are able to travel within the view of 3D model as shown in Figure 3.2.

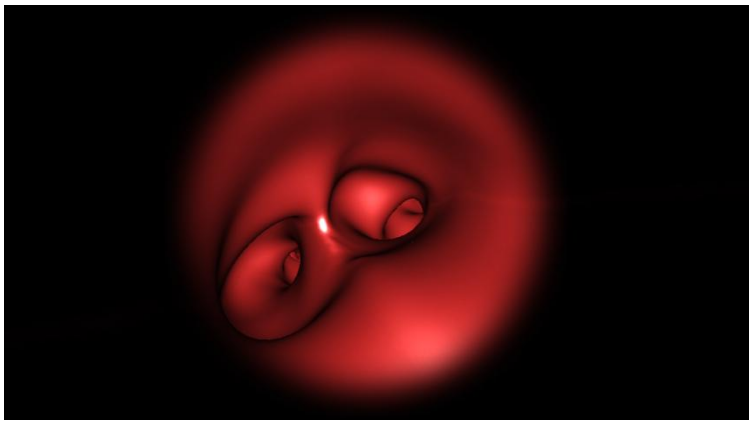


Figure 3.2 – ESST Model 3D View

The users are able to travel within the 3D modelled setting by using this haptic control with an endoscopic view. An endoscope is a tool which contains a camera screening the surgical setting in two-dimensional view. Accordingly, the simulation environment is created according to these features. A special haptic control (Figure 3.3) which offers extra senses about the simulated setting is used in this interface.

Figure 3.3 – The Haptic Interface of the ESST Model

Green balls are distributed to the branches of the 3D model as labelled in Figure 3.1. Additionally, as seen in Figure 3.2, a navigation map is also prepared for this study to provide a navigation feedback for the users which presents the arrangement of the model and the locations of each target. This design is organized based on the requirements of endoscopic surgery settings. In this setting, the haptic interface is designed as sensible as in the real environments. The participants are asked to reach a target location and clear the green ball placed in that location by controlling the

environment with this haptic interface which simulates the endoscope in these operations. Whenever they need to see their current position and the target location, the participants are free to get the navigation display by pressing a button on the haptic tool as seen in Figure 3.4.

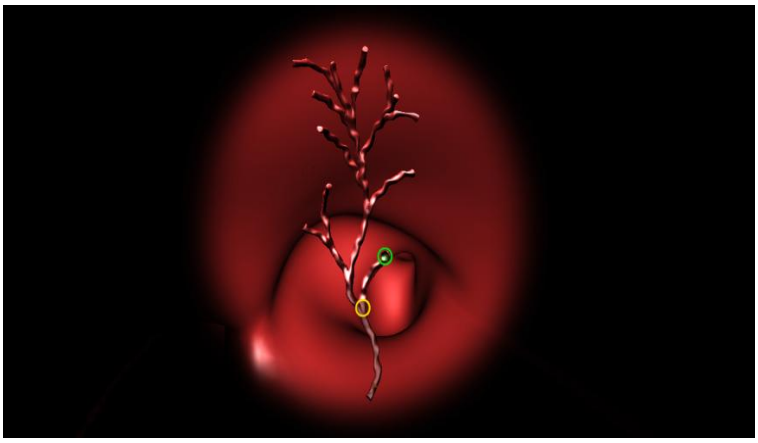


Figure 3.4 – The Navigation Interface of the ESST Model

The navigation feedback mentioned above is provided when the user requires help. Or, they are able to continue to perform each task without getting any navigation help. There is no limit for getting navigation help.

Once the participant sucessfully clears the green ball as seen in Figure 3.5, another target location is assigned and by starting from the start point of the 3D model (Figure 3.1) the participant is asked to complete the newly assigned task.

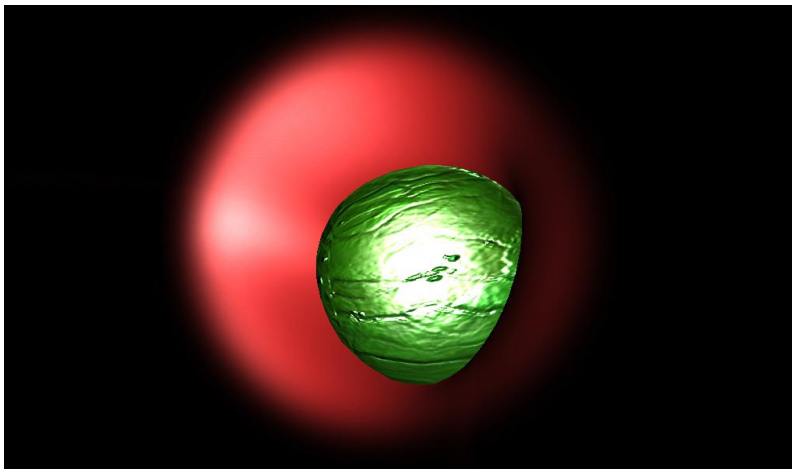


Figure 3.5 – The Target in the ESST Model

10 different tasks have been assigned for each participant. These tasks are shown as in Figure 3.1. The order of assigned tasks is indicated Figure 3.1 in the labelled orders. The participants have a maximum of one hundred seconds in order to perform each task. Otherwise, s/he is considered to have failed to perform the task, and the next task is assigned.

The ESST system records several measures while the participants perform assigned tasks in this system. These measures are summarized below:

Duration: Duration is the time spent by each participant for performing each task.

Distance: Distance is the length of the travelled path while performing each task by each participant.

Mistaken Path: Mistaken path is the length of mistakenly travelled path while performing each task by each participant.

Hits: Hits are the number of hits to the walls of the 3D model while performing each task by each participant.

Success: The success measure is used to record whether the participant successfully cleared the green ball in the assigned target location during the maximum time period or not. This is 1 if the target cleaned successfully, 0 otherwise.

Navigation Usage: This measure shows how many times the navigation button is pressed and navigation help is used while performing each task by each participant.

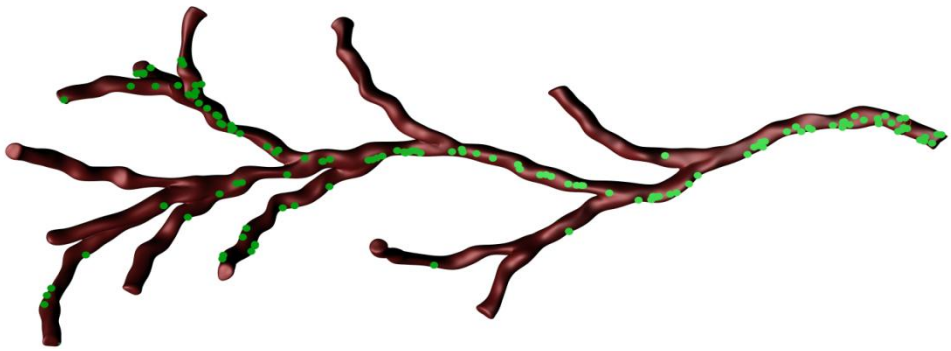


Figure 3.6 – Navigation Display Points

As seen in Figure 3.6, when the participants get navigation help, their location in the 3D model that they require navigation help as well as the number of times that they require navigation help are all recorded.

3.2.2. Experimental Version of the Navigation Application

In the gamification version of the application several features are added to the system. Below these features are described:

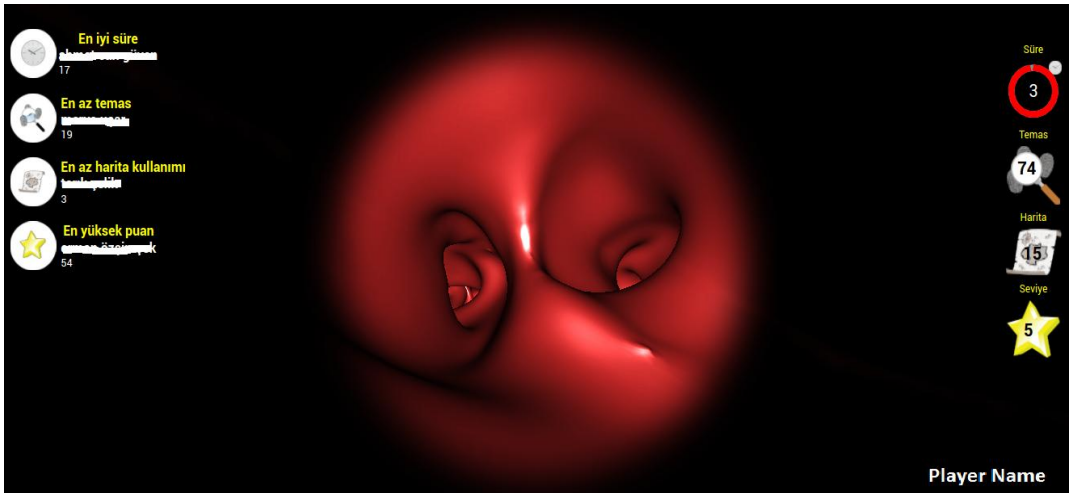


Figure 3.7 – Score Board for Experimental ESST

Score Board: As seen in Figure 3.7, a score board is designed for this application. In this score board, the best score of the previous players is shown in the left-upper corner of the user interface. These scores are categorized according to the measures collected by the system as described below:

The **best time** score "En iyi süre" represents the person who performs the current task in minimum time period.

The **minimum hits** "En az temas" shows the person who performs the current task by minimum number of hits to the walls of the 3D model.

The **minimum map** usage "En az harita kullanımı" shows the person who performs the current task by minimally referencing the navigation map.

Maximum score “En yüksek puan” shows the person who performs the current task by collecting maximum score. The score is calculated by the following formula:

Score = (300 - distance) **x** 0.1 + (100 - duration) **x** 0.4 + (100 - hits) **x** 0.3 + (50 - navigationUsage) **x** 0.2

Progress bar: The progress of the player is shown in the right upper part of the screen which is seen in Figure 3.7. Here the player can see his/her time duration while performing the current task and compare it with the highest one shown in the left-upper corner (“süre” red circled). Additionally, the player can see his/her number of hits to the walls of the 3D model and compare it with the minimum hits score shown in the left side of the screen.

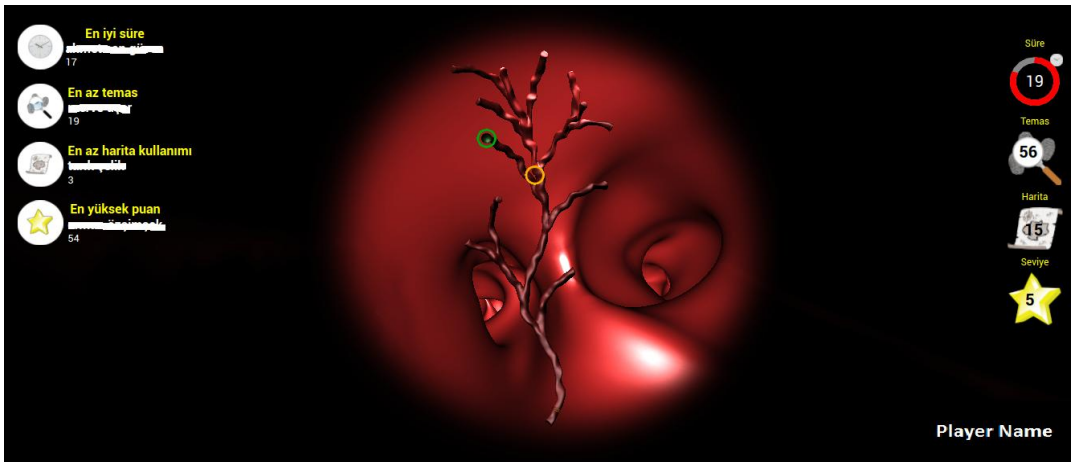


Figure 3.8 – Navigation Help for Experimental ESST

Similarly, the player is able to see his/her number of references to the navigation map and compare it with the minimum hits score shown on the left side. Finally, the players are able to see their score for this task and compare it with the best score shown on the left side of the screen. Also, the same players may need navigation help in the experimental version of the ESST as seen in Figure 3.8. When the player successfully reaches at the target location, they see it as shown in Figure 3.9, in the experimental version of the ESST.

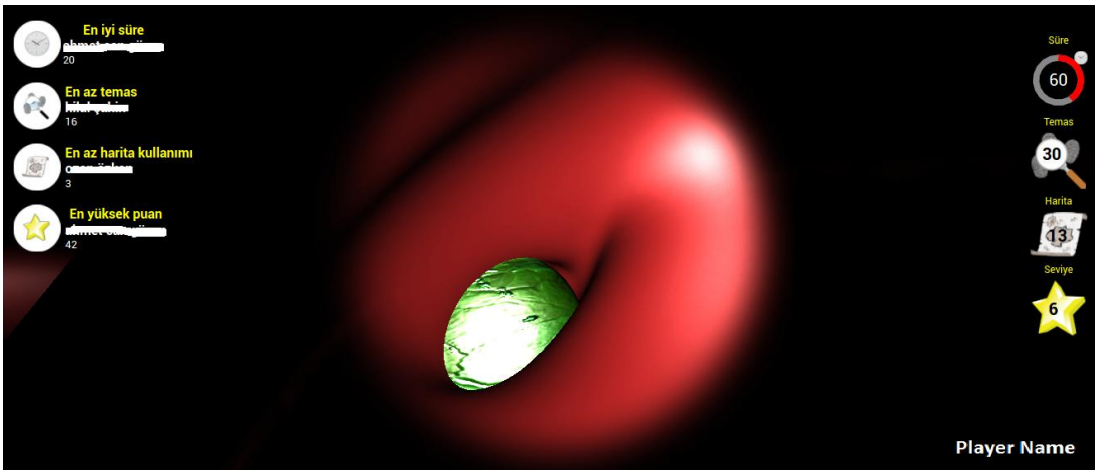


Figure 3.9 – Target for Experimental ESST

CHAPTER 4

RESEARCH METHODOLOGY

In this study, our main aim is to better understand the effect of gamification on skill-based educational environments. For this purpose, the learners' time duration spent while performing each task, distance travelled, number of mistaken path (number of wrong ways), number of hits to the walls, their success rate (if they have successfully reached the target position and cleared the target), and navigation usage (number of references to the navigation map) are all recorded. Students are randomly assigned for one of the gamification (experimental group) version of the educational material or the simulation version (control group). Accordingly, the research question of the study is determined as below.

4.1. Research Questions

In this study to understand the effect of games on surgical education with respect to simulation environments, we developed two versions of the endoscopic surgery simulation tool. Experimental and control groups used the navigation interface of the endoscopic surgery simulation tool. Behaviours of both groups were analysed to more thoroughly understand the effect of gamification. Hence, the main research question is set as below:

> **RQ:** Do the success, duration, number of wrong ways, number of hits and travelled distance, change between experimental and control groups?

4.2. Research Procedure

At the beginning of the study each participant was given a description regarding the study. Additionally, the haptic force-feedback interface was described and helped to practice, two test-tries were provided as well. The game started with the test version

of the simulation and gaming environment for each participant. After they got used to haptic device control and environment, the game or the simulation was opened. The participants were divided into the experimental version (gamified version) or the control group (simulation version) of the environment in a random manner. Figure 4.1 shows a participant who is playing the gamified version of the environment.

Figure 4.1 – Gamified Version of the Experimental Study

As seen in Figure 4.2 the control group used the simulation version of the educational material.

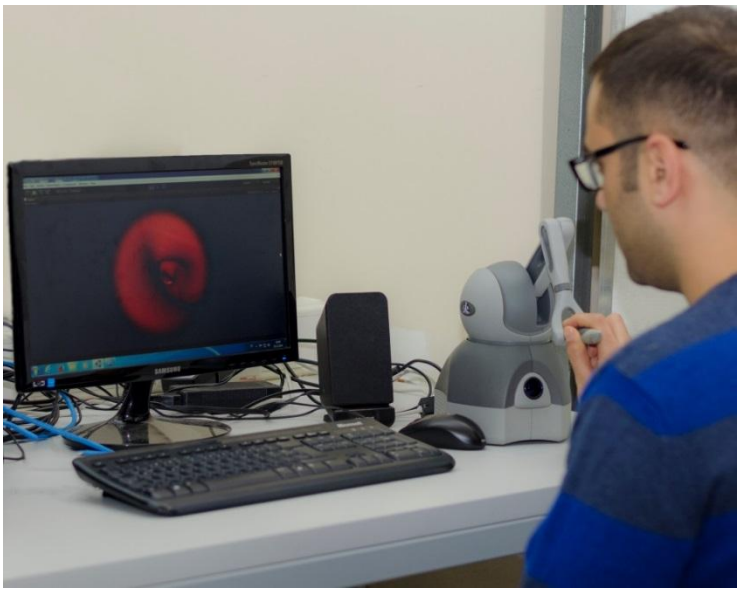


Figure 4.2 – Simulation Version of the Experimental Study

After the game or simulation ended, each participant filled out the questionnaire given in Appendix A. The English version of the questionnaire is provided in Appendix B.

4.3. Participants

The experiment was analyzed to understand the gamification effect with 46 participants who are the students of Atilim University. These participants were seperated into two different groups (experimental group and control group) arbitrarily. Totally, 23 students participated in the experimental group, and also the same number of students took part in the control group. The students participated in the experiment were from different departments. These departments are Computer Engineering, Software Engineering, Information System Engineering, Metallurgical and Materials Engineering, Electrical and Electronics Engineering, International Relations, Architecture, Mechatronics Engineering, Industrial Engineering, International Trade and Logistics, Public Relations and Advertising. Table 4.1 shows participants' departments and gender distributions in the experimental group.

Table 4.1 – Participants of the Experimental Group (Game)

Department	**F**	**M**	**Total**
Computer Engineering	6	4	10
Software Engineering	2	1	3
Information System Engineering	1	1	2
Metallurgical and Materials Engineering	2	1	3
Electrical and Electronics Engineering	0	1	1
International Relations	1	0	1
Mechatronics Engineering	0	1	1
Industrial Engineering	0	1	1
Public Relations and Advertising	1	0	1
Total	13	10	**23**

Table 4.2 shows the information about participants of the control group such as their departments, their gender and total number of group members.

Table 4.2 – Participants of the Control Group (Simulation)

Department	**F**	**M**	**Total**
Computer Engineering	2	4	6
Software Engineering	1	3	4
Information System Engineering	2	3	5
Metallurgical and Materials Engineering	0	2	2
Electrical and Electronics Engineering	0	3	3
International Relations	1	0	1
Architecture	1	0	1
Mechatronics Engineering	1	0	1
Total	8	15	**23**

CHAPTER 5

RESULTS

The results of this study are given under two sections: the experimental study results and the questionnaire results.

5.1. Experimental Study Results

We have performed independent sample t-test to compare the difference in the measured values of this experimental study for both groups. The results of t-test are given in Appendix C. According to these results, the distance (the travelled distance while executing each task) did not change significantly between the experimental group (mean = 576, SD = 321) and the control group (mean = 584, SD= 398).

In this study, the number of wrong ways also did not change considerably between the experimental group (mean = 0.72, SD = 1) and the control group (mean = 0.72, SD = 1.02).

Similarly, the number of hits to the walls of the 3D model did not change significantly between the experimental group (mean = 36.48, SD = 27) and the control group (mean = 40, SD = 32). Additionally, the success rate of the participants did not change meaningfully between the experimental group (mean = 0.9, SD = 0.34) and the control group (mean = 0.9, SD = 0.34).

On the other hand, the duration (time spent to perform each task) is statistically significant within 0.05 confidence interval, with $t(458) = 2.33$, $p = 0.02$. This result indicates that the participants working on experimental version of the educational environment spent more time playing the game (M = 48, SD = 29) compared to the other group (M = 41, SD = 30). Figure 5.1 shows the distribution of durations for performing each task between those groups.

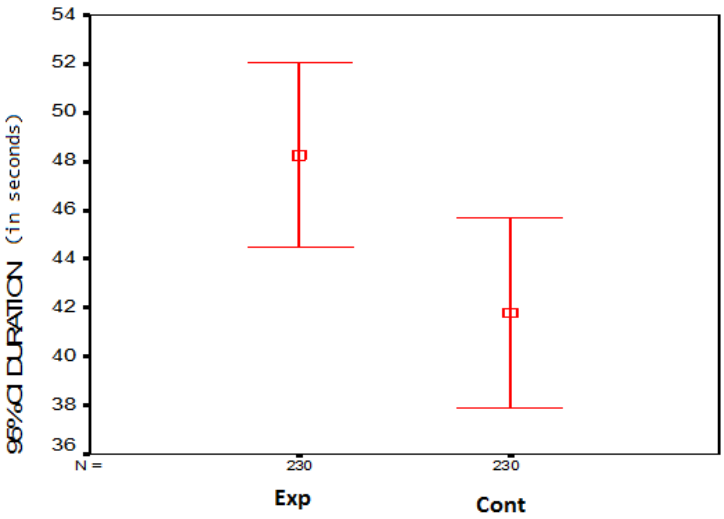


Figure 5.1 – Distributions of Durations

Additionally, we have compared the number of clicks (references to the map) for both groups. The results reveal that the number of clicks is statistically significant within 0.05 confidence interval, with t(4025) = 3.04, p = 0.002. This result means that the participants working on experimental version of the educational environment referred to the map less frequently (M = 6.99, SD = 5.4) compared to the other group (M = 7.54, SD = 6.0). Figure 5.2 shows the distribution of those groups.

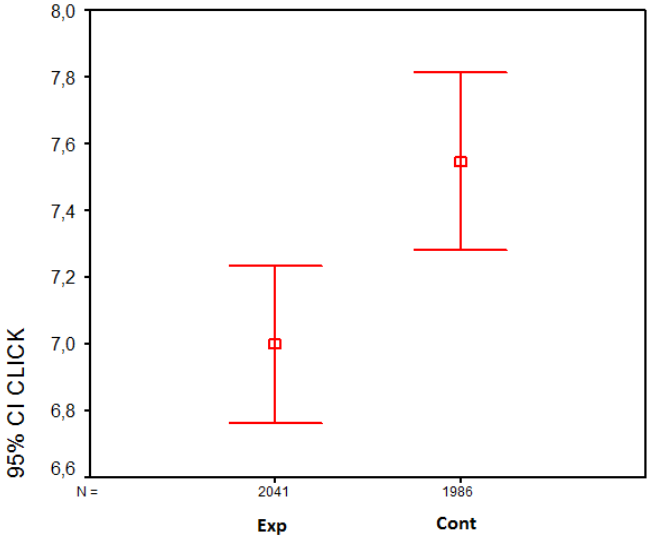


Figure 5.2 – Distribution of Number of Clicks for Referring to Map

5.2. The Questionnaire Results

In the questionnaire, the items between Q1 and Q11 include the participants' ratings about the system rated as 5 (strongly agree) to 1 (strongly disagree) for experimental group. In Table 5.1 these questions have been analysed as in the questionnaire items, and participants' responses are summarized.

Table 5.1 – Survey Questions for Experimental Group (EG)

ID	Question	5	4	3	2	1
Q1	System was fun	14	8	0	1	0
Q2	I had difficulty in performing assigned tasks	1	8	2	10	2
Q3	I want to play the game again	10	9	2	1	1
Q4	I was excited when playing	6	10	2	4	1
Q5	I used a tactile device for the first time	15	2	0	3	3
Q6	I do not like playing games	1	3	0	4	15
Q7	It is possible to learn by playing games	14	8	0	1	0
Q8	I prefer to learn by playing games	12	9	1	1	0
Q9	I like playing games on social media	7	5	0	6	5
Q10	I like following people who are social media phenomenon	2	7	2	4	8
Q11	I enjoy when people like the things I share on social media	4	9	5	2	3

5: Strongly Agree, **4:** Agree, **3:** Have no Idea, **2:** Disagree, **1:** Strongly Disagree

As seen in Table 5.1, participants in the gamification group (experimental group), strongly agree or agree that the system was fun (22 participants, 96%). Only 9 participants (39 %) stated that they had difficulty while performing tasks. 19 of participants (83 %) like to play the game again and exited playing (16 participants, 70 %). They mostly used the tactile (haptic) device for the first time (18 participants, 74 %). Also, they mostly like playing games (19 participants, 83 %), think that they can learn by playing (22 participants, 96%) and prefer to learn by playing (21 participants, 91 %). Only 12 participants (52 %) play games on social media, 9 participants like following people in these platforms (39 %), and 13 participants (57%) enjoy when people like their sharing in the social media.

Table 5.2 summarizes the EG group participants' responses on Q12 and Q13, which explain their time spent for playing game and social media shown 1 to 5. As seen

from Table 5.2, participants in the gamification group (control group) mostly play 1-3 hours a day or a week (14 participants, 60 %), and spend 1-3 hours a day or a week (14 participants, 60 %).

Table 5.2 – Time Questions for Experimental Group (EG)

	Question	1	2	3	4	5
Q12	How often do you play games?	4	6	8	2	3
Q13	How much time do you spend on social media?	8	12	2	0	1

1: More than 3 hours a day, **2:** 1-3 hours a day, **3:**1-3 hours per week, **4:**1-3 hours a month, **5:**1-3 hours per year

In the questionnaire, the items between Q1 and Q11 include the participants' rating about the system as rated 5 (strongly agree) to 1 (strongly disagree) for control group in Table 5.3.

Table 5.3 – Survey Questions for Control Group (CG)

ID	Question	5	4	3	2	1
Q1	System was fun	17	4	0	2	0
Q2	I had difficulty in performing assigned tasks	0	9	0	10	4
Q3	I want to play the game again	12	8	1	2	0
Q4	I was excited when playing	6	10	2	3	2
Q5	I used a tactile device for the first time	14	1	1	4	3
Q6	I do not like playing games	2	3	1	3	14
Q7	It is possible to learn by playing games	16	5	1	1	0
Q8	I prefer to learn by playing games	17	3	2	1	0
Q9	I like playing games on social media	5	8	2	6	2
Q10	I like following people who are social media phenomenon	3	7	5	5	3
Q11	I enjoy when people like the things I share	5	13	3	0	2

5: Strongly Agree, **4:** Agree, **3:** Have no Idea, **2:** Disagree, **1:** Strongly Disagree

As seen in Table 5.3, participants in the simulation group (control group), strongly agree or agree that the system was fun (21 participants, 91 %). Only 9 participants (39 %) expressed that they had difficulty while performing tasks. 20 participants (87 %) like playing the game again, and are exited playing (16 participants, 70 %). They mostly used the tactile (haptic) device for the first time (16 participants, 65 %). They

predominantly like playing games (17 participants (74 %), think that they can learn by playing (21 participants, 91%) and prefer to learn by playing (20 participants, 87 %). Only 13 participants (57 %) play games on social media, 10 participants like following people in these platforms (44 %), and 18 participants (78%) enjoy when people like their sharing in the social media.

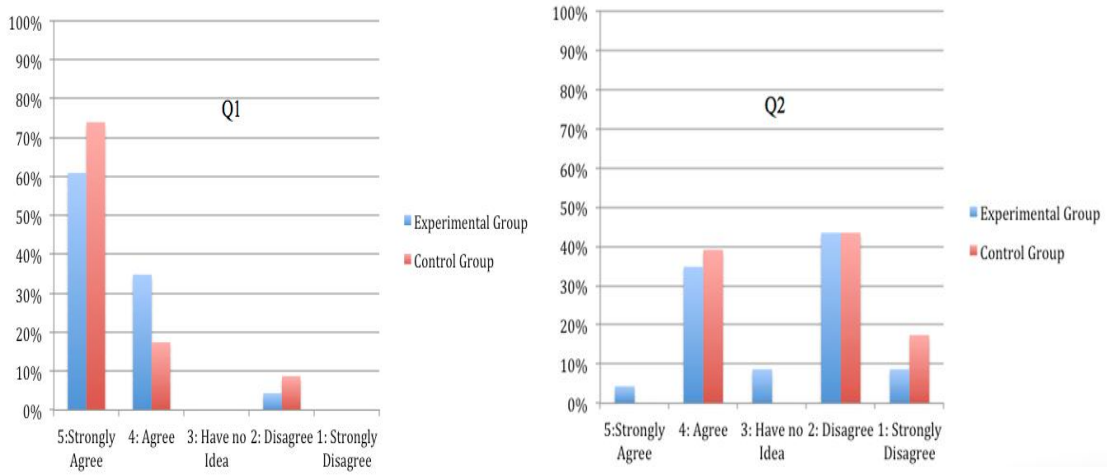
Table 5.4 shows the CG group participants' responses on Q12 and Q13, which include how much time they spend for playing game and social media. As seen from Table 5.4, participants in the simulation group (control group) mostly play 1-3 hours a day or a week (14 participants, 60 %), and spend 1-3 hours a day or a week (12 participants, 52 %).

Table 5.4 – Time Questions for Control Group (CG)

	Question	1	2	3	4	5
Q12	How often do you play games?	4	10	4	3	2
Q13	How much time do you spend on social media?	11	9	3	0	0

1: More than 3 hours a day, **2**: 1-3 hours a day, **3:**1-3 hours per week, **4:**1-3 hours a month, **5:** 1-3 hours per year

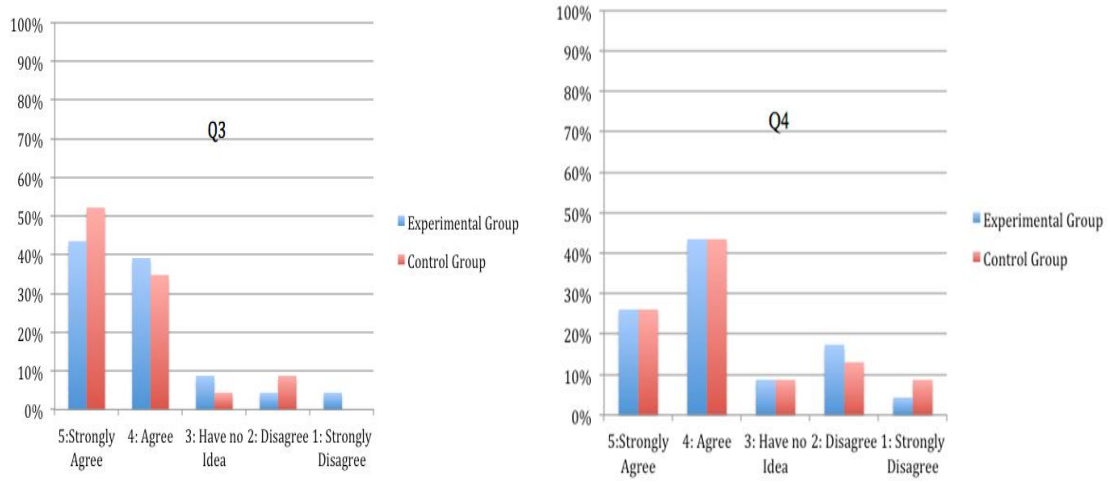
In order to provide a comparative view, the percentage distributions in both groups for each questionnaire item are provided in Figure 5.3 below. For "Q1 System was fun", as seen in Figure 5.3-a, both group members mostly responded as "strongly agree" or "agree". Similarly, for "Q2 I have difficulty in performing assigned task" as seen from Figure 5.3-b, both group members responded similarly. Half of the participants in general found the tasks difficult to perform while the other half do not agree with it.



(a) (b)

Figure 5.3 – The percentages of Q1 – Q2 for each group

For "Q3 I want to play again", as seen from Figure 5.4-a, both group members mostly responded as "strongly agree" or "agree". For "Q4 I was thrilled when playing", as seen from Figure 5.4-b, both group members responded as "agree".

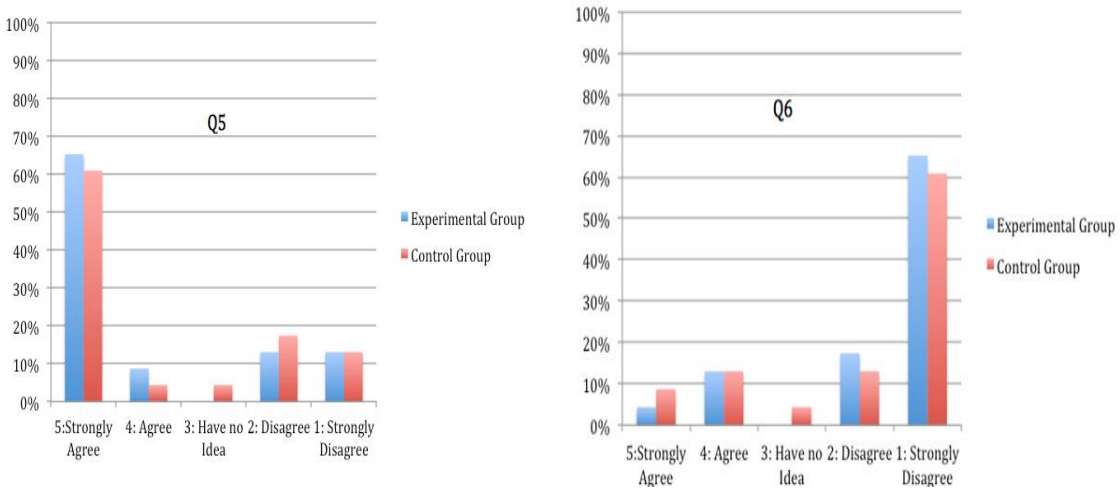


(a) (b)

Figure 5.4 – The percentages of Q3 – Q4 for each group

For "Q5 I used a tactile (haptic) device for the first time", as seen from Figure 5.5-a, both group members responded as "strongly agree". For "Q6 I do not like playing games", as seen from Figure 5.5-b, both group members responded as strongly

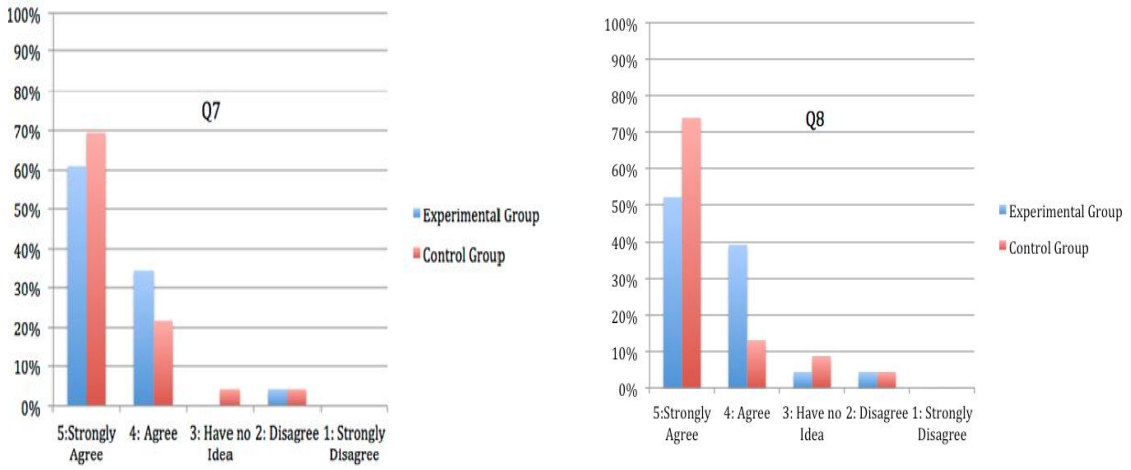
disagree.



(a) (b)

Figure 5.5 – The Percentages of Q5 – Q6 for each group

For "Q7 It is possible to learn by playing games", as seen from Figure 5.6-a, both group members responded as "strongly agree". For "Q8 I prefer to learn by playing games", as seen from Figure 5.6-b, both group members responded as "strongly agree" especially the control group.

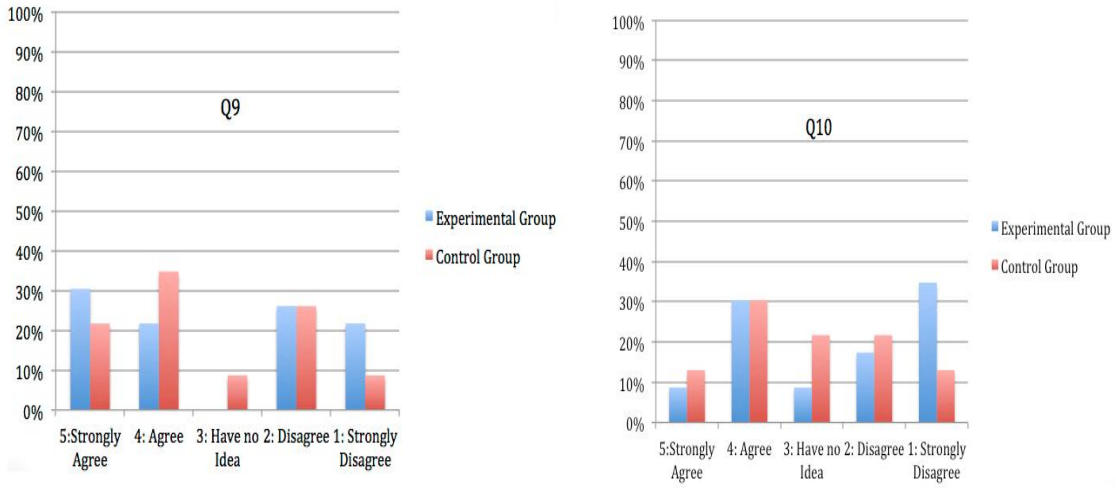


(a) (b)

Figure 5.6 – The Percentages of Q7 – Q8 for each group

For "Q9 I like playing games on social media", as seen from Figure 5.7-a, many

participants in general found that they like playing games on social media while the others do not agree with it. For "Q10 I like following people who are social media phenomenon", as seen from Figure 5.7-b, many participants agree with it, but others strongly disagree with it.



(a) (b)

Figure 5.7 – The Percentages of Q9 – Q10 for each group

For "Q11 I enjoy when people like the things I share on social media", as seen from Figure 5.8, participants agree with this case, especially control group.

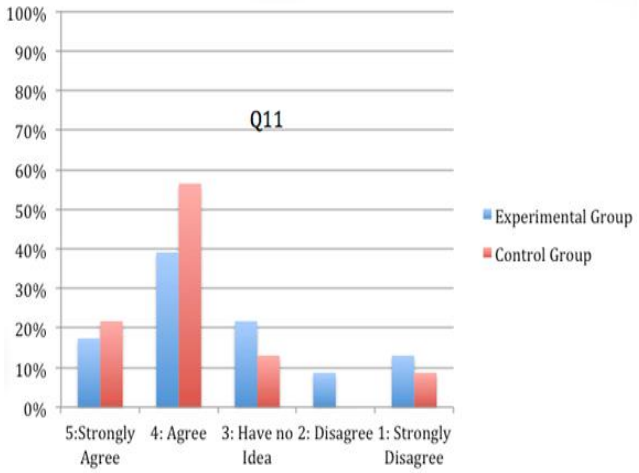
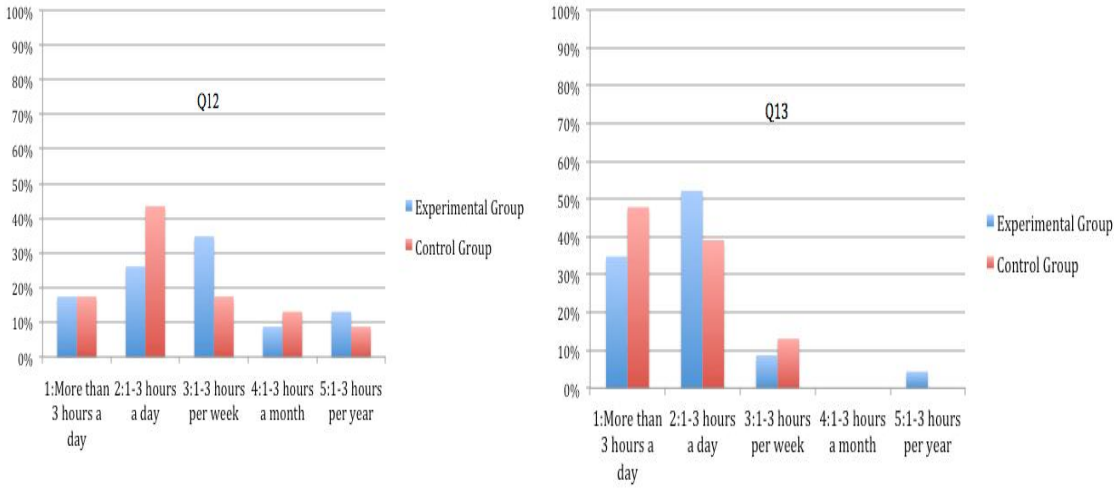


Figure 5.8 – The Percentages of Q11 for each group

For "Q12 How often do you play games?", as seen from Figure 5.9-a, participants of control group play games 1-3 hours a day, but participants of experimental group

play 1-3 hours per a week. For "Q13 How much time do you spend on social media?", as seen from Figure 5.9-b, participants of experimental group spend 1-3 hours a day on social media, but participants of control group spend more than 3 hours a day on social media.



(a) (b)

Figure 5.9 – The Percentages of Q12 – Q13 for each group

The research findings of this study can be summarized as below:

- According to the questionnaire, the navigation application was fun both for experimental and control group.
- 50 percent of the group members had difficulties while performing the assigned tasks whereas the other 50 percent did not at all.
- Both group members were excited when playing the game so they wanted to play it again.
- Both group members mostly used a tactile (haptic) device for the first time.
- Participants liked playing the game and they believed that they could be able to learn by playing a game.
- Both group members enjoy when people like the things they share on social media.
- Members of control group play games more often than the experimental group both in social media and other environments.

- Members of control group spend more than 3 hours a day, but members of experimental group spends 1-3 hours per day on social media.
- Although control group likes following phenomenon people of social media, experimental group does not like it.

The results of this study additionally illustrate that the success rates of the participants for performing assigned tasks in both versions of the application did not change significantly. On the other hand, the gamification group spent considerably more time for performing the assigned tasks by rarely referring to the navigation feedback.

CHAPTER 6

DISCUSSIONS and CONCLUSION

The effect of gamification on technologically enhanced educational environments is not clear yet; however, serious games and simulations are becoming important tools for educational environments. Accordingly, this study aims to better understand the learners' behaviours in these environments. This information is very valuable to more truly guide the instructional system designs to improve the possible educational benefits of the simulations and games.

The results of this study show that the success rates of the participants for performing the assigned tasks in both versions of the application did not change significantly. On the other hand, the gamification group spent significantly more time for performing the assigned tasks by rarely referring to the navigation feedback. According to Carrol learning is directly proportional with the time spent on the learning material [60]. In other words, the amount of learning associated with any educational program is directly proportional to the quality and quantity of student learning [59]. Therefore, when students' time-spent on the educational tasks increases, it may be an indicator that their involvement in the task is higher.

On the other hand, their success, number of hits to the walls, number of wrong ways and distance travelled to perform each value did not significantly change in either group. These results show that even the travelled distance value of the experimental group (Mean=575.83, SD=320.97) is less than that of control group (Mean=584.30, SD=397.54), and the number of hits to the walls for the experimental group (Mean=36.48, SD=26.70) is less than that of control group (Mean=39.68, SD=31.94), which it is not significant. Similarly, the experimental group success and the number of entrances to wrong ways values are similar to the control group. In accordance with these, it can be concluded that the gamification did not affect the

success, number of hits to the walls, number of wrong ways and distance travelled in either groups.When the game playing habits of the participants were analysed based on the questionnaire results, it was seen that even though the participants were randomly assigned in both groups, the simulation group (control group) played games more often. This may be a reason for the similar results in both groups. Since the simulation group plays games more often, their abilities in such environments might be higher.

Another result could be that the gamification effect may have put the experimental group in a stressful situation and they may have limited their references to the map, which in turn lowered their general performance. Hence, in the future studies, if the score for referring to the map is eliminated in the gamification version, their performance could be improved.

In conclusion, the results of this study show changes in simulation and game-based environments. Hence, deeper studies need to be organized to better understand these behaviours and their correlation between the personal characteristics of the participants. The outcomes of the research are expected to provide insights to the instructional system designers for improving possible benefits of simulations and games on different domains for different user groups.

This study has been conducted on surgical education field. Hence, the findings of the study need to be validated in other realms as well. The same study can be conducted with surgeons having different expertise levels to more profoundly understand the gamification effect on their performance. Additionally, the gamification parameters may also be experimentally analysed and re-designed to improve the positive effect of gamification on learners. In any case, the conclusion of the study is still promising because it shows that the gamification group, with a significantly limited access to the supportive information, considerably spent more time on tasks, which indicates that they have been involved in the application deeply, and they have performed similarly with the other group.

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APPENDIX A: QUESTIONNAIRE IN TURKISH

Ad Soyad :_____ **Cinsiyet** □Kadın □Erkek

Bölüm: _____ e-posta: _____

	Kesinlikle Katılıyorum	**Katılıyorum**	**Fikrim Yok**	**Katılmıyorum**	**Kesinlikle Katılmıyorum**
Sistem eğlenceliydi					
Verilen görevleri gerçekleştirirken zorlandım					
Tekrar oynamak isterim					
Oynarken heyecanlandım					
Dokunsal cihazı ilk kez kullandım					
Oyun oynamayı sevmem					
Oyun oynayarak öğrenmek mümkün					
Oyun oynayarak öğrenmeyi tercih ederim					
Sosyal medyada oyun oynamayı severim					
Sosyal medyada fenomen olan kişileri takip etmeyi severim					
Sosyal medyada paylaşımlarımın beğenilmesi hoşuma gidiyor					

Hangi sıklıkla oyun oynarsınız? □Günde 3 saatten fazla □Günde 1-3 saat arası

□Haftada 1-3 saat arası □Ayda 1-3 saat arası □ Yılda 1-3 saat arası

Sosyal medyaya ne kadar zaman ayırıyorsunuz? □Günde 3 saatten fazla □Günde 1-3 saat

□Haftada 1-3 saat arası □Ayda 1-3 saat arası □ Yılda 1-3 saat arası

Profesyonel olarak oynadığınız oyun var mı? Belirtiniz: _____

Aşağıdakilerden hangilerini kullanıyorsunuz? (Birden fazla işaretleyebilirsiniz)

□Nike+ □Recyclebank □SCVNGR □Foursquare □Keas □The Speed Camera Lottery

Size verilen görevleri yerine getirirken, eğlendiniz mi? Bunun temel nedeniz sizce neydi? Açıklayınız:_____

_____

Size verilen görevleri yerine getirirken hangi konularda zorlandınız? Açıklayınız._____

_____

APPENDIX B: QUESTIONNAIRE USED IN EXPERIMENTAL AND CONTROL GROUP

Name Surname :_____ **Gender** □Female □Male

Department: _____ e-mail: _____

	I strongly agree	**I agree**	**I have no idea**	**I disagree**	**I strongly disagree**
System was fun					
I had difficulty in performing assigned tasks					
I want to play the game again					
I was excited when playing					
I used a tactile (haptic) device for the first time					
I do not like playing games					
It is possible to learn by playing games					
I prefer to learn by playing games					
I like playing games on social media					
I like following people who are social media phenomenon					
I enjoy when people like the things I share on social media.					

How often do you play games? □ More than 3 hours a day □ 1-3 hours a day

□ 1-3 hours per week □ 1-3 hours a month □ 1-3 hours per year

How much time do you spend on social media? □ More than 3 hours a day□ 1-3 hours a day

□ 1-3 hours per week □1-3 hours a month □ 1-3 hours per year

Is there a game that you play as a professional? Please specify: _____

Which of the following do you use? (You can choose more than one)

□Nike+ □Recyclebank □SCVNGR □Foursquar e □Keas □The Speed Camera Lottery

In fulfilling the tasks given to you, you have fun? Do you think the reason for this was the basis? Please explain: _____

What issues you have any difficulties in fulfilling the tasks assigned to you? Explain: _____

_____

APPENDIX C: RESULTS OF T-TEST

Group Statistics

	GAME	N	Mean	Std. Deviation	Std. Error Mean
DURATION	1,00	230	48,2387	29,26489	1,92967
	2,00	230	41,7870	29,98336	1,97704
DISTANCE	1,00	230	575,8348	320,97518	21,16448
	2,00	230	584,2965	397,53829	26,21290
WRONGWAY	1,00	230	,7261	,99725	,06576
	2,00	230	,7217	1,02840	,06781
HITS	1,00	230	36,4826	26,69866	1,76046
	2,00	230	39,6870	31,93658	2,10584
SUCCESS	1,00	230	,8652	,34224	,02257
	2,00	230	,8609	,34684	,02287

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
DURATION	Equal variances assumed	,000	,996	2,335	458	,020	6,4517	2,76267	1,02266	11,88081
	Equal variances not assumed			2,335	457,731	,020	6,4517	2,76267	1,02266	11,88082
DISTANCE	Equal variances assumed	1,490	,223	-,251	458	,802	-8,4617	33,69052	-74,66890	57,74542
	Equal variances not assumed			-,251	438,528	,802	-8,4617	33,69052	-74,67669	57,75321
WRONGWAY	Equal variances assumed	,020	,889	,046	458	,963	,0043	,09446	-,18128	,18997
	Equal variances not assumed			,046	457,568	,963	,0043	,09446	-,18128	,18997
HIT	Equal variances assumed	3,992	,046	-1,167	458	,244	-3,2043	2,74477	-8,59825	2,18955
	Equal variances not assumed			-1,167	444,050	,244	-3,2043	2,74477	-8,59870	2,19000
SUCCESS	Equal variances assumed	,073	,787	,135	458	,892	,0043	,03213	-,05879	,06749
	Equal variances not assumed			,135	457,918	,892	,0043	,03213	-,05879	,06749

T-Test

Group Statistics

	GAME	N	Mean	Std. Deviation	Std. Error Mean
CLICK	1,00	2041	6,9980	5,43049	,12020
	2,00	1986	7,5483	6,06405	,13607

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CLICK	Equal variances assumed	29,606	,000	-3,035	4025	,002	-,5503	,18129	-,90573	-,19487
	Equal variances not assumed			-3,031	3950,790	,002	-,5503	,18156	-,90626	-,19433