GAMIFICATION IN NEUROSURGERY EDUCATION

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Abstract

Nowadays, gamification is becoming popular as a new form of education in healthcare applications, due to the need of creating more effective educational practices. Educators in healthcare field are currently applying strategies used in popular games to create more engaging learning environments. Studies in the literature show that, creating learning environments by using gamification leads to better improved learning. The main goal of this approach is to increase the motivation of the participant. Accordingly, this study aims to examine the effect of gamification on learning in neurosurgery education. In order to better understand this effect of gamification on learning, a surgical simulation game “Wire Haptic in Dark” is developed in two versions by applying gamification techniques as a part of Endoneurosurgery Education Project (ECE). The scenario is developed in two versions: one containing some gamification attributes and the other one not including any gamification attributes. The gamification version of the scenario is designed by showing the time passed to perform the task successful, the score of the participant on the screen while playing the game and including sounds in case of the collision during the game, whereas the other version is created without sound, time and score information. The experimental results of this study reveal that gamification enhances the performance as well as the motivation of the participant. As motivation increases, participant performance in a given game task becomes more effective. The results of this study aimed to help the surgical educators and the instructional system designers to improve the benefits of using gamification in learning environments for the surgical education programs.

Keywords: Gamification, surgical simulation, neurosurgery education.

1 INTRODUCTION AND BACKGROUND OF STUDY

Today there are several studies showing the potential benefits of computer games in learning [1-5]. Studies also show several benefits of games on health domain. For instance, a study reported that integrating games in surgical curricula may improve the surgical training of new generation of learners [6]. According to the results of another study, serious games may be applied to train technical and non-technical skills of surgical residents [6]. Studies report that in contrast to the simulations that are often lack of being enjoyable for learners [7], games provide more controllable, active learning environments [8]. For instance, Clarke et al. have conducted a research with neurosurgery trainees to identify instruments during a simulation-based surgery procedure through game-based simulation training for learning neurosurgical instruments [9]. Earlier researches have reported that motivation of users to practice, sharpen skills and compete with colleagues can be improved through gamification techniques such as scoring and time challenges [9-11].

In the literature, even there are several studies showing potential benefits of simulations, the studies on gamification (applying the game elements on a serious topic) and its impact on learning are limited. Even there are several studies addressing the impact of game-based learning on education, there are very limited studies conducted to demonstrate its efficacy for health professional training [10, 12]. Especially for the surgical skill improvements, there are very limited experimental studies showing possible impact of gamification on the surgical skills. According to Kapralos et al.’s study, before application of serious games in surgical education and training, studies need to be conducted to better understand the factors that have an impact on learners’ skill and knowledge transfer [13]. Hence, this study aims to attempt to better understand the gamification effect on neurosurgical skills.

2 METHODOLOGY

This study aims to examine the effect of gamification on learning in neurosurgery education. In order to better understand this effect, a surgical simulation game “Wire Haptic” was developed as a part of Endoneurosurgery Education Project (ECE). This scenario developed to be played in light or dark environment (Fig. 1).
In this study, the participants played the scenario in a dark simulation environment, controlling haptic tool using their both hands. In this scenario, one haptic was used as the light source and the other was used as the tool to move the ring along the wire. The simulation game was developed in two versions: one containing some gamification attributes and the non-gamification version not including any gamification attributes. The ‘gamification’ version of the scenario was designed by showing the time passed to perform the task successful, the score of the participant on the screen while playing the game and including sounds in case of the collision during the game, whereas the ‘non-gamification’ version was created without sound, time and score information. Time, number of collisions and success information were recorded automatically by a system.

2.1 “Wire Haptic in Dark” Scenario

In this scenario, participants have to pass the ring along the wire without touching. The scenario starts by clicking on the start button when the participant is ready. There are five target points (representing five tasks in scenario) on the wire, when the participant reach to the target point in a given time, his/her score is increased by 20 points. The time passed during the game and score information is shown on the screen in ‘gamification’ version. The general layout of the scenario with gamification and non-gamification version is provided in Fig. 2 and 3, respectively.

During the game, when the ring touches the wire, a ball appears on the point of the contact and the participant should wait 3 seconds to continue. Moreover, in ‘gamification’ version, the participants are warned by the system, giving a warning sound, in case of collision. Three measures are collected in this scenario; ‘time’ is the duration to complete each task, ‘success’ implies if the task is performed successfully in a given time and ‘collision’ refers to the number of hits to the wire while performing tasks.
2.2 Participants

The experimental study is performed by a total of 28 surgeon participants (21 doctors and 7 interns) from the Department of Neurosurgery (12 participants) or Otolaryngology (9 participants) in Hacettepe Medical School. Detailed information about participants is provided in Table 1.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Department</th>
<th>F</th>
<th>M</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hacettepe Uni. Neurosurgery</td>
<td>1</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Hacettepe Uni. Otolaryngology</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Hacettepe Uni. Neurosurgery (Interns)</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6</td>
<td>22</td>
<td>28</td>
</tr>
</tbody>
</table>

During the experiment, two participants' game data were not recorded due to a hardware problem. Hence, a total of 26 participants' data were collected and analysed in this study. The participants are divided into two groups as novices (17 participants) and experts (9 participants) according to their skill levels considering their surgical experience:

- Novices: No surgical experience, but at least one observation
- Experts: At least one surgical experience using endoscope

3 RESULTS

The results are analyzed using the collected data on time (task completion duration), success (if the task is completed in a given time period or not) and collision (number of touches to the wire) measures gathered from 26 participants (half of them played gamification and the other half non-gamification version). The results based on the descriptive statistics are given in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Gamification</th>
<th>Non-gamification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>11.05</td>
<td>12.98</td>
</tr>
<tr>
<td>Success</td>
<td>.95</td>
<td>.95</td>
</tr>
<tr>
<td>Collision</td>
<td>.63</td>
<td>1.09</td>
</tr>
</tbody>
</table>

The results show that the average task completion time for the participants playing non-gamification version (M=12.98, SE=7.66) is higher than the participants playing gamification version (M=11.05, SE=7.41). There is no difference observed between the success values for both gamification (M=.95, SE=.09) and non-gamification groups (M=.95, SE=.12). Additionally, an independent sample t-test is performed to compare the collision values (number of hits to the wire) of two groups. The test result is statistically significant within 0.05 confidence interval, with t(26) = 2.5, p = 0.02. This result implies that the collision values for the participants playing non-gamification version (M=1.09, SE=.54) is higher than the participants playing gamification version (M=.63, SE=.39) on average.

Additionally, the results are further analysed separately for novice and expert groups, to understand the effect of gamification on different skill level expertise. The results based on the descriptive statistics are explained in detail below.

3.1 Effect of Gamification on Novices’ Performance

The descriptive statistics related to the time spent to complete the given tasks, success and collision measures performed by novices on gamification (8 participants) and non-gamification version (9 participants) of the scenario are shown in Table 3.
Table 3. Novices’ performance in ‘Gamification’ and ‘Non-gamification’ version

<table>
<thead>
<tr>
<th></th>
<th>Gamification</th>
<th>Non-gamification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>12.57</td>
<td>10.66</td>
</tr>
<tr>
<td>Success</td>
<td>.93</td>
<td>1.00</td>
</tr>
<tr>
<td>Collision</td>
<td>.68</td>
<td>1.09</td>
</tr>
</tbody>
</table>

The results show that the average task completion time for the novices playing non-gamification version (M=10.66, SE=7.08) is lower than the novices playing gamification version (M=12.57, SE=8.22). Similarly, the average success value of the tasks is higher in non-gamification version (M=1.00, SE=0.00) compared to the gamification version (M=.93, SE=.10) for the novices. On the contrary, the average collision values for novices playing non-gamification version (M=1.09, SE=.61) is higher than the novices playing gamification version (M=.68, SE=.45).

3.2 Effect of Gamification on Experts’ Performance

The descriptive statistics related to the time spent to complete the given tasks, success and collision measures performed by experts on gamification (5 participants) and non-gamification version (4 participants) of the scenario are shown in Table 4.

Table 4. Experts’ performance in ‘Gamification’ and ‘Non-gamification’ version

<table>
<thead>
<tr>
<th></th>
<th>Gamification</th>
<th>Non-gamification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>8.62</td>
<td>18.21</td>
</tr>
<tr>
<td>Success</td>
<td>1.00</td>
<td>.85</td>
</tr>
<tr>
<td>Collision</td>
<td>.56</td>
<td>1.10</td>
</tr>
</tbody>
</table>

The results show that the average task completion time for the experts playing non-gamification version (M=18.21, SE=6.94) is higher than the experts playing gamification version (M=8.62, SE=5.85). Similarly, the average success value of the tasks is higher in gamification version (M=1.00, SE=0.00) compared to the non-gamification version (M=.85, SE=.19). The average collision values for experts playing non-gamification version (M=1.10, SE=.42) is higher than the experts playing gamification version (M=.56, SE=.30).

4 CONCLUSIONS AND DISCUSSIONS

The experimental results of this study reveal that gamification has an impact on the performance of the surgical residents. While performing the tasks through the gamification version of the system, a significant difference is recorded on the collision values of the participants. They performed the tasks with a less collision compared to the non-gamification version. This is an indicator that the participants were performed the tasks in a more sensitive way to the environment which is a critical factor for the endoneurosurgery skills. For the experienced participants, the time spent for each task was less and the success rates were higher in the gamification version of the application according to the non-gamification version.

As the number of experts were very limited in this study, no statistically comparisons can be applied. However, the results are very promising on showing the impact of gamification on for the surgical performance. When it is possible to conduct such a study with a higher number of participants, more statistically significant results could be recorded.

The results of this study aimed to help the surgical educators and the instructional system designers to improve the benefits of using gamification in learning environments for the surgical education programs.
ACKNOWLEDGEMENTS
This study is conducted as part of Endoneurosurgery education project which is supported by The Scientific and Technological Research Council of Turkey (ECE: TUBITAK 1001, Project No: 112K287). The authors would like to thank the support of TUBITAK 1001 program for realizing this research.

REFERENCES