CHAPTER 4

Usability Testing of a Three-Dimensional Library Orientation Game

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EXECUTIVE SUMMARY

Games require constant interaction, which makes usability one of the fundamental elements of the game development process. A high level of usability in games developed for educational purposes is important for sustaining the user's game experience. Orientation is crucial for freshmen at universities. Performing orientation in a three-dimensional

virtual and gamified environment enables users to feel like they are in a real environment and to experience an entertaining and sustainable process. With this aim, the Hacettepe University Beytepe Campus Library Orientation Game was designed and created in a three-dimensional virtual environment. This study conducted two different usability studies of the three-dimensional library orientation game based on user participation. The first asked users to fill out a survey after their gaming experience to collect their subjective data. In the second, a usability evaluation was done to collect objective data based on the users' eye tracking. This study presents the results of these two approaches.

ORGANIZATION BACKGROUND

University orientation is among the initial steps students take to get to know the university. Orientation informs them about the psychological counseling and guidance provided for freshmen in order to help them to adapt to this new environment and cope with any difficulties they may encounter. It also informs them about the university's facilities and services as well as its principles and rules, and allows them to explore the campus, departments, dormitories, libraries, and the city (Kutlu 2004).

The introduction to the library, which the students will frequently visit during their education, is also part of orientation. The primary purpose of the library orientation is to let students know about the resources that will contribute to their studies. The second purpose is to encourage students to do research to acquire the information related to their general education and professional formation (Walsh 2008).

Research on orientation programs indicates that they are useful and necessary (Sevim and Yalçın 2006). Different environments are used for orientation, most commonly traditional physical environments. Yet there are also web-based virtual and online orientation environments (Çukurbaşı et al. 2011; Özdinç 2010). The traditional physical environment is an interactive environment and allows students to meet faculty members and other students (Forgues 2007). Considering its cost in money and time, physical orientation programs may not be most appropriate and flexible (Granholm 2007). Three-dimensional multiuser virtual environment (MUVE) orientation services that are delivered over the Internet save the students from the obligation to be physically present in this environment. Thus, students may be offered the flexibility of time and students are able to visit the unit when they need to learn about it.

Holding orientation in a three-dimensional virtual and gamified environment ensures that users feel like they are in a real environment and experience a sustainable process. The aim of this case study is conveying the practice of participatory usability methods, with subjective and objective data, through an authentic project as a means to address the usability-related challenges faced in computer games.

CASE STUDY DESCRIPTION

To stimulate users and improve user experience, gamification, which is the addition of game components into an application, has become a growing trend (Fitz-Walter et al. 2011). Gamification has been defined as the use of game design components within a nongame context (Deterding et al. 2011). Prensky (2001) lists the structural elements required for

an environment to be deemed a game: (1) rules, (2) goals and objectives, (3) outcomes and feedback, (4) conflict/competition/challenge/opposition, (5) interaction, and (6) representation or story. In this study, the components suggested by Prensky have been taken into consideration during the gamification process of virtual library orientation. These elements informed the design of the Hacettepe University, Beytepe Campus Library Orientation Game in a three-dimensional virtual environment.

The three-dimensional library orientation game was developed using the game engine, Active Worlds, which is a MUVE. Maher et al. (1999) defined MUVE as an environment which enables the users to navigate and accomplish activities in a virtual environment where users can also communicate with each other at the same time. In recent years, MUVEs such as Second Life and Active Worlds have become popular and have been used in a variety of fields by users. MUVEs allow for navigation, exploration, and communication, and they may be more helpful for acquiring reliable and permanent information than real life experiences (Jones and Warren 2008). MUVEs can also be used to animate real environments in virtual worlds. Data are kept on a server in the MUVE environment, and users access their virtual worlds through interface software. After users install the interface software on their online computers, they must be authorized by the administrators of the virtual world to be able to access the virtual world where the game is located (Tüzün 2010).

To provide maximum design usability, system flexibility, and optimal feedback for users, the coherence of the systems must be in line with design principles (Dix et al. 2004). This study implemented the user-centered design principles suggested by Norman (2002) during the development of the Hacettepe University Beytepe Campus Library Orientation Game. Norman's seven principles (Dix et al. 2004) are: (1) use both knowledge in the world and knowledge in the head, (2) simplify the structure of tasks, (3) explain and show what is to be done and how to do it, (4) include the user within the system, (5) define system controls clearly, (6) organize feedback for errors made by users, and (7) there may be small differences in the interface, but critical control elements must be standardized.

The library orientation game, which was created in the Active Worlds environment as the learning product of graduate and undergraduate design students in accordance with these design principles has been revised and a redesign process was carried by following these guidelines:

- First, exterior photos were taken to be able to replicate the library building
- Photos were taken inside the library for interior design
- Interface design documents were prepared for design guidance

Design was initiated using these data.

There are several tasks that the users are asked to accomplish in the game. These tasks were created to help individuals understand the functioning of the library and engage in more efficient learning. Users are provided with an environment that includes both

two-dimensional (within the web browser) and three-dimensional elements. In order for the users to make progress within the game, they must follow the instructions in the two-dimensional browser. Users that complete the tasks are given a certificate of achievement. Here are the tasks:

Task 1: Locate the bulletin board and find out the hours during which you can study at the library

Task 2: Locate the bulletin board and find out the general rules to be followed in the library

Task 3: Click on the marked computer and search for the book *Good-bye Panic* in the pop-up window

Task 3.1: Find the marked computer

Task 3.2: Search for the book in the pop-up window

Task 4: Take the book you searched for from the shelf

Task 5: Explore the book you retrieved in the marked carrel

Task 6: Borrow the book you searched for from the first floor

Task 7: Retrieve the dictionary from the reserve and study room

Task 8: Photocopy any page of the dictionary in the photocopy room

The game was developed as part of graduate and undergraduate courses. The development of the game by a group of five took 10 weeks. Updates in the game, arising from changes in the real environment, have been completed by two people in 2 weeks. In total, the development of the game took 12 weeks.

Usability is one of the fundamental elements of the game development process. This is because games require constant interaction. Thus user interfaces should not be just entertaining, but also functional and user friendly. Illegible text on the screen and hard-to-use controls are usability problems. Game designer, Chris Crawford, says: "If the game interface is distorted or confusing, the user will quit the game." This means that usability testing is important to ensure playability and learning outcomes (Olsen et al. 2011). The required measures should be taken in advance to improve the design process and develop a successful learning tool.

Game designers need methods to define usability problems both at the initial and prototype stages of the design. Some research are based on experts (Federoff 2002; Pinelle et al. 2008), and others are based on user participatory evaluation (Barendregt et al. 2006; Moschini 2006; Tüzün et al. 2013; Virvou and Katsionis 2008). User participatory evaluation may be done either in laboratories or in users' working environment. Variables are defined, participants are selected, hypotheses are constructed, and the research is designed. Finally, statistical evaluations are made. Interviews, observations, surveys, or scales can

be used to gather information from the users. But none of the evaluations conducted by designers or experts can replace usability tests with real users. Therefore, the usability of a game in this study was evaluated based on user participatory evaluation. A prerequisite for this type of evaluation is the need for a working prototype.

Two separate techniques were used to evaluate the usability of the three-dimensional library orientation system. The first was realized in a computer laboratory, and the other in a Human–Computer Interaction Laboratory with an eye-tracking device.

One of the important principles in usability studies is testing with people, tasks, and environments that correspond to the real target audience (Çağıltay 2011). For this reason, in both studies, people who use the library or potentially may use the library were selected, and the tasks in the game match real tasks in the library. The design process of the game environment attempted to animate the authentic library environment.

In both usability tests, users were briefly informed about the game they would play and the purpose of the test. However, related to the Human–Computer Interaction Laboratory, users were also informed about the laboratory environment (eye-tracking technology and cameras). These stages are explained in more detail in the following section.

Usability Test 1

A total of nine people, one woman and eight men, attended the usability test of the Beytepe Library Orientation Game. In these studies, just 5–15 participants are sufficient for finding 85%–100% of the usability problems (Nielsen 2000). Of the participants aged between 19 and 25, one is a graduate student and the others are undergraduate students. Five of the participants stated that they had been in such virtual game environments before. Being familiar with the game environment may have made participants feel comfortable playing and evaluating the Library Orientation Game.

The first five users did the test one by one, and the rest did it in pairs. Two people playing the game simultaneously allowed the multiuser affordance to be evaluated. Participants were observed while using the system by researchers using observation forms.

After their participation the participants were asked to fill out a survey prepared by researchers to measure the system's usability. It includes one multiple-choice question, an open-ended question, and seven items of Likert type. The Likert-type items were scaled from 1 (completely disagree) to 5 (completely agree). The score average for each question was calculated based on the responses (Table 4.1).

The averages calculated for each Likert-type item show that

1. The three-dimensional orientation game introduces the library adequately (4.22).
2. Users can navigate the system easily (4.56). However, observation revealed that, at first, users had the tendency to use the keys A–W–S–D, which are used in game environments.
3. Users have difficulty understanding the tasks given to them in the library game (2.67). Observations showed that they had problems with the catalog search, the first stage of the book search task.

TABLE 4.1 Score Average of the Answers to Survey Questions Given by Participants

		Mean
1	I think the three-dimensional library game introduced the Beytepe Library adequately.	4.22
2	I was able to navigate in the three-dimensional library game.	4.56
3	I understood the tasks given to me in the three-dimensional library game.	2.67
4	I found the instructions of the two-dimensional web environment clear and understandable for use in the three-dimensional library game.	4.33
5	The three-dimensional library game was adequately realistic.	4.22
6	The three-dimensional library game made me feel like I was actually there.	4.56
7	Environments similar to the three-dimensional library game should be developed for other units of the university as well.	4.78

4. Users were able to understand the instructions in the two-dimensional web area (4.33). Participants suggested that instructions should help the users to complete the tasks.

5. Users find the game adequately realistic (4.22). Users who knew the real environment found the objects in the game a bit different from the actual library (for example, the game environment was wider, and its doors and tables were a bit different).

6. The game has virtual reality (4.56). Virtual reality is a three-dimensional simulation model that gives the participants the feeling of reality, and allows for communication in a dynamic environment created by computers. Virtual reality will increase our ability to comprehend and perceive the systems we design to a considerable extent (Bayraktar and Kaleli 2007). If the three-dimensional library game has virtual reality, then this game prepared as an introduction to the Beytepe Library could increase the ability of the user to comprehend and perceive.

7. When users were asked about introducing similar programs for other university units, a vast majority (4.78) were in favor. This means that users found this three-dimensional library game useful and beneficial.

Users fulfilling tasks successfully were indicated by a "1" and users who experienced problems while performing the task were indicated by a "0" in Table 4.2.

It was found that the most challenging task was T4. All users experienced a problem in this task except for a single participant. T1, T6, T7, and T8 were all successfully completed by all participants. The open-ended question asked users of the three-dimensional environment whether they saw the links that guide and help them to complete the tasks while navigating in the game and if they did, whether they understood that these were intended to help them. They stated that they either did not pay attention or look at the help option showing how to change camera angles even though they saw it. This was because they did not need help with camera angles. They made suggestions about other help links that would contribute to the completion of the task. They criticized the help links lack of clear explanations. For example, a user looking for a marked object had a hard time figuring out what kind of mark to seek. After finding the first marked object, the user expects the same

TABLE 4.2 Task Completion Results

	Tasks							
Participants	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
P1	1	0	0	0	0	1	1	1
P2	1	0	0	0	0	1	1	1
P3	1	1	0	0	0	1	1	1
P4	1	1	0	1	1	1	1	1
P5	1	1	1	0	0	1	1	1
P6	1	1	1	0	1	1	1	1
P7	1	1	0	0	0	1	1	1
P8	1	1	0	0	1	1	1	1
P9	1	1	0	0	0	1	1	1

kind of mark again. However, since the objects are marked in different ways, the user had a hard time finding marked objects. During the usability test they said, "Why are we looking for the marked computer or carrel when we can complete the task with any computer or carrel?" Suggestions for the help links concerned the content of help (help topics), the form of help (location, appearance, etc.), and the timing of help.

Similarly, regarding the design of the game tasks Rouse (2005) stated that accomplishing the task should be meaningful for the players. Otherwise, players are affected by this situation negatively. Kumar (2013) states that players will be worried about fulfilling the task when they face difficulties.

Users who used the chat module reacted positively to the help provided by other individuals in the game, while users who could not do this since no other individuals were online with them stated that they would have preferred getting help from other people. When these players were observed in the game, it was found that they followed other players' avatars to perform the tasks.

Usability Test 2

Visual information processing is one of the most important components of how a user perceives a gaming experience (Kenny et al. 2005). One of the methods used to measure the usability is through eye tracking. Studies with eye-tracking devices are more useful than the other techniques in terms of providing more accurate and detailed data. Thanks to the usability studies with eye-tracking technology (Goldberg and Kotval 1999; Goldberg et al. 2002; Pernice and Nielsen 2009) the system can be evaluated through the eyes of users, readability of text can be tested, and difficult and easy tasks can be determined.

Over-gazing and selective attention become apparent in the eye-tracking process. In this way, what interface elements are misused can easily be revealed. Therefore, the second usability test used an eye-tracking device in a Human–Computer Interaction Laboratory. Three people participated in this test, one of whom was a student at Hacettepe University and knew the actual environment of the Beytepe University Library, and two of whom had never seen the actual environment of the Beytepe University Library. Eye tracking conducted with only three people may be considered a limitation of this study. Therefore,

the think-aloud technique is used together with the eye-tracking method in order to obtain more data.

Laboratories are special places where eye-tracking studies are conducted. A unique monitor, cameras, and audio recorders are located in laboratories. Therefore, environmental conditions within the laboratory must be controlled before making the study that may cause problems. Prior to the implementation, each user was calibrated with the eye-tracking device. Calibration of the eye-tracker and the introduction of the game environment took approximately 6 minutes. The users were taken into the Human–Computer Interaction Laboratory one by one and navigated the orientation system on their own. The first user was familiar with the real library environment and the game was completed in 21 minutes and 12 seconds by the first user. The other two users were not familiar with the real library environment. One of these users completed the game in 53 minutes and 9 seconds and the other user in 48 minutes and 55 seconds.

Users played the three-dimensional library game, and these sessions were recorded by the eye-tracking device. Due to the inability of one user to fixate on the screen, that user's data has been omitted from the evaluation. Users were given tasks to complete in the game. The eye movements of users were examined while they were performing the tasks.

The eye-tracking device reveals where and how long users focus during task completion, the elements that attract their attention, and the elements that fail to attract their attention. Data were analyzed using the Tobii Studio (version 1.3.14) program. In addition to recording eye movements, fixation points, case history, screen content, user voice and image, keys pressed, and mouse clicks as well as replaying all these operations, Tobii Studio can also produce statistical data for finding fixation points and densities. This study's parameters include eye movements, fixation lengths, and heatmap during the tasks.

Fixation Length

In their eye-tracking analysis, Just and Carpenter (1986) claim that long fixation of the eyes indicates that users are either having a hard time extracting information or have found an object that attracts their attention. With this in mind, the areas in the system that will enable users to complete their tasks were marked or rendered distinctively to try to attract users' interest. Data analysis indicates that fixation length increases when users encounter objects that will enable them to complete their tasks. As Figure 4.1 shows, when the user finds the computer that will enable completion of the task, the user becomes fixated on that computer and clicks on it. Thus objects provide clues for task completion.

Similarly, the system indicates an increase in attention span when users get closer to their goal, the intensity of which increases gradually. However, it was observed by the cameras located in the laboratory that during the book finding task, users fixated on the illuminated object offered as a clue near the book, and for this reason had a hard time finding the book itself. Regarding this situation, Albert (2002) claimed that when users fail to fixate on an area that is considered to be important in the system, that area must be relocated or made more distinctive.

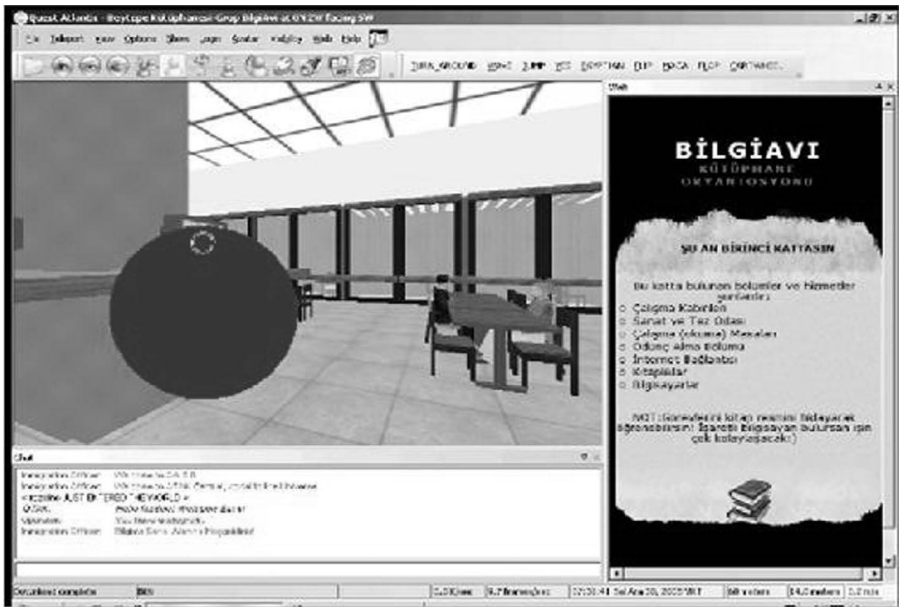

FIGURE 4.1 Areas of eye fixation.

Eye Movements

Goldberg et al. (2002) determined that short eye movement indicates that the users are not focusing on a particular point. Their study also observed that eye movements are longer when users are looking for their targets. Figure 4.2 shows that a user scans all parts of the three-dimensional screen to find out which direction to take. Fixation counts rise with the difficulty of the task.

Fixation Count

Depending on the difficulty or ease of the task, users' short fixation counts either increase or decrease. Goldberg and Kotval (1999) showed that a high short fixation count indicates that the user did a lot of searching. Considering the data, short fixation counts increase before users find their targets or guess where they are. Short fixation counts decrease and are replaced by long fixation when users find their targets or are close to completing their tasks (Figure 4.3).

Heatmap

Figure 4.4 is a map of the places on the screen where users focused the most. The central area indicates the most focusing and the surrounding area indicates the least focusing. Other areas on the map indicate areas that were almost not focused on at all. While users were navigating the three-dimensional area, they focused on the middle of the screen. Therefore, the dense area is predominantly in the middle of the screen. Users did not have a tendency to look at the edges.

In particular, when task 3 and task 5 were examined, it was found that the players did not pay attention to the affordances in the game. El-Nasr and Yan (2006, p. 1) state: "many

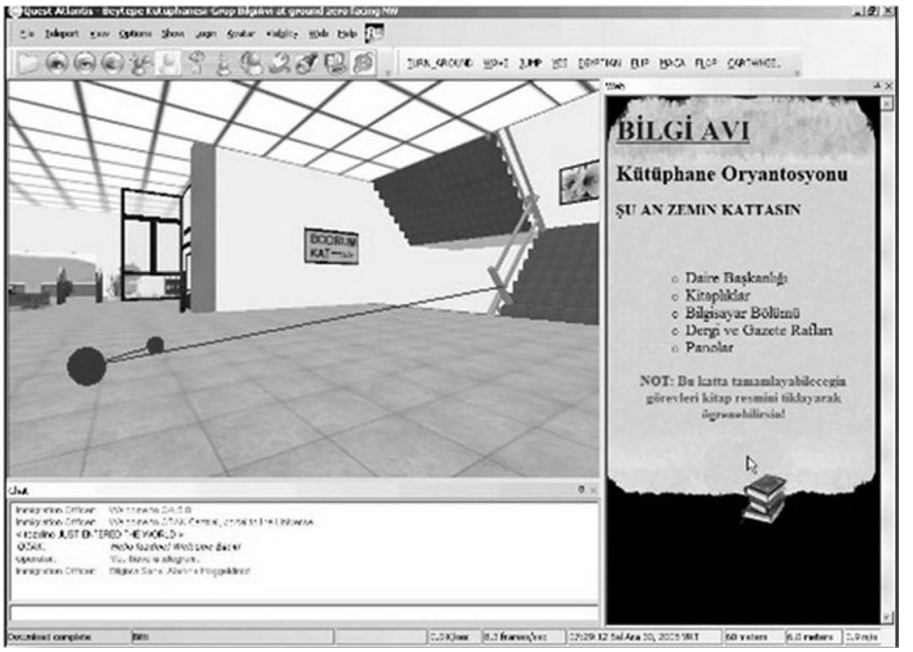

FIGURE 4.2 Eye movements.

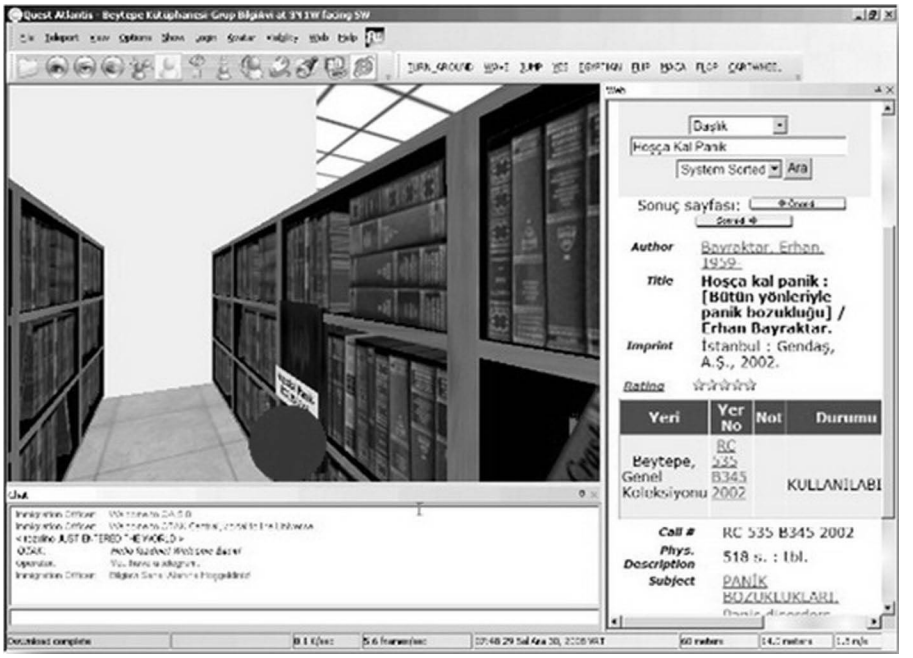

FIGURE 4.3 Short fixation count.

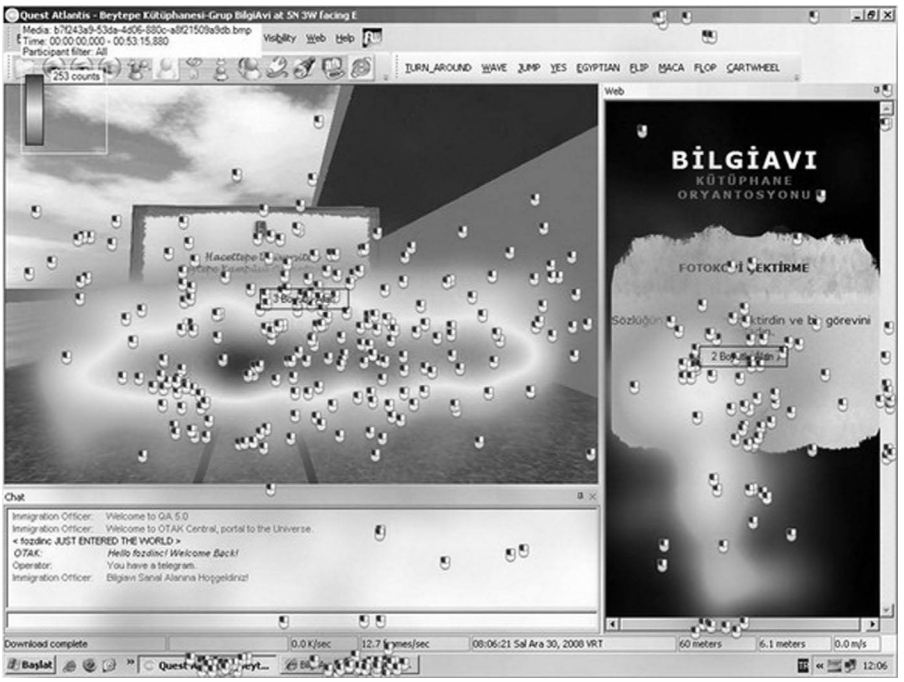

FIGURE 4.4 A section from heatmap.

nongamers get lost in three-dimensional game environments, or they don't pick up an important item because they don't notice it." In addition, in the task of finding the books, they thought that there was a barcode on the book as in the real world and they examined the books to find their barcodes.

CHALLENGES

Users were taken into the laboratory one by one. Since the table on which the computer monitor with eye-tracking technology is located was geostationary, a tall user was not comfortable while playing the game. Since this user was too tall for the table, playing required constant neck bending, and when the user straightened up a bit to feel more comfortable, data loss occurred as the eye-tracking device could not detect the users' eyes.

SOLUTIONS AND RECOMMENDATIONS

Since the game has as its purpose orientation, it was designed for people who had never used the actual library before, used it only a few times, or had just enrolled in the university. However, individuals who had just enrolled could not be included in the research since the usability test was carried out during the semester. In case study 1, nine volunteer students who had never used the library or knew it very little were selected. In case study 2, a Hacettepe University student who was familiar with the library and two other students from other universities who did not know the library were selected. The researchers should implement the three-dimensional orientation about university units (library, dormitories, dining halls, etc.) at the beginning of the academic year, because first time students, who

do not have knowledge about university units, will put forward more authentic results. The data set, which is obtained from students who know about the university, will affect the validity of the study.

For usability test 2, the computer laboratory was visited and analyzed by the researchers beforehand, and software problems were detected in the eye-tracking device. These problems were eliminated prior to the test. Data quality was reduced due to one user who constantly looked away from the screen during the data collection process. This user's data was excluded from the analysis done with the Tobii Studio program.

CONCLUSIONS

In this section, results regarding the usability study of three-dimensional library orientation game and suggestions for the development of the system are presented.

The best way to collect information on the actual use of the system is to observe users interacting with the system (Dix et al. 2004). One of the methods used for the observation of users is the "Think-Aloud Method." This method is widely used in usability studies which include people's opinion on the working principles of a product or interface. Supporting this method by asking questions, provides the personal experiences of users in usability studies and their opinion on the functionality of a product/interface. In the studies investigating thinking strategies, Wim et al. (2008) and Hong and Lui (2003) asked players to think aloud during the game. In this way, they aimed to collect some data on how players think in the game. In one of the studies conducted in the medical area, Rudling (2007) has both observed the participants and also noted their comments. He obtained appreciable feedback by allowing participants to speak aloud within a limited time interval. Asking the participants to think aloud provides a more interactive environment than observing them passively. In this study, users worked on a prototype of the system, and usability tests of the system were conducted by observing user behavior. First, observation and survey evaluation techniques were used. Then think-aloud and eye-tracking methods were used in tandem. Bailey (1993) also suggests that more sensitive information can be obtained in the studies conducted in Human–Computer Interaction laboratories.

Both approaches to testing the game's usability observed different implementation processes, results, obstacles, application suggestions, and suggestions for improving usability. Thus, the use of a variety of usability tests during game development and with diverse users enables the detection and solution of different usability problems. Similarly, Johansen et al. (2008) state that presenting quantitative results using statistics, maps, and graphs to supplement more qualitative observation-based results might prove more persuasive than the qualitative results alone.

Case study 1 provided information on the general aspects of the user experience, whereas case study 2 offered the opportunity to examine the experiences of the users in more detail. The participants in case study 1 have a positive approach toward the usability of the game based on the survey. The participants in case study 2 had difficulties playing the game, and the difference is because in the second case, objective information was obtained regarding where and how long people focus on the computer interface, whereas in the first usability

test users' subjective answers give an idea to designers about the usability of the game. To improve the usability of the game, both objective and subjective data obtained from users need to be considered, examined, and compared to identify usability problems. This led to the design suggestions given below.

Usability Results and Recommendations for Usability Test 1

Users with positive opinions of the game who encountered several problems with the game revealed several usability issues. Suggestions for those are as follows:

- When the users are navigating to find the dictionary on the lower floor and entering the carrel on the upper floor, since the door shuts immediately after the users open the door, these areas were hard to enter. The door remains open for 4 seconds in these areas. This duration should be extended.
- A map showing where the library is located is used when users first enter the system. When the users click on this map, they enlarge the screen and view the entire map. In order to be able to do this, instructions should be given or the map should be provided on another page. Tüzün et al. (2013) state that menus can be designed in the drop-down style. This method will eliminate the complexity of the menu and it will allow them to reach where they want in a short time.
- When the users search for a book (designated in advance), they are asked to do so on a computer. This search can only be done on one specific computer. This computer has a different screen than the other computers. However, users looked for a sign on the computer. This computer should be indicated, or search should be enabled on all computers.
- Nevertheless, some users were observed to have forgotten the name of the book they were supposed to find when they connected to the catalog search page. This is because the two-dimensional browser where the task is written changes as users changes their location. For this reason, the task should be enabled to be visible during the book search.
- Another reason for the users having difficulties finding the book is not having information on catalog names. This information can be considered within the scope of library orientation training, and providing this information should be considered during design enhancement.
- There is no task that requires the students to navigate on the ground floor. Therefore, students did not navigate much on this floor. Tasks for the ground floor should be developed.
- In a game, when there is a too high or too low a challenge, players may want to leave the game or get bored (Barendregt et al. 2006). Thus, the high number of tasks bored the users. Instead of giving so many tasks, providing a single mission with different tasks for the orientation should be considered as an alternative.

- Controlling a game is one of the most frequently mentioned usability problems in the literature (Barendregt et al. 2006; Olsen et al. 2011; Pinelle et al. 2008). Some users had difficulty controlling the game with the direction keys since they are different from the keys they are accustomed to from other games. It has been observed that although it is possible to change the movement keys in the game (for example, to the QWASD keys used commonly in today's games) users did not know about this feature. An explanation of this issue should be added to the game's help section.
- Some users (especially those who had no information about the library) thought that ground floor was used only as an archive or storage and did not enter this floor for that reason. A well-designed interface should give guidance to users on how to continue the game and should provide feedback to carry out the necessary procedures correctly (Graham et al. 2006). To make it easier for the users to find where to go when performing a task, a map that provides a bird's eye view of the library floors might eliminate such preconceptions.

Usability Results and Recommendations for Usability Test 2

With the new technology that analyzes human–computer interaction using eye movements becoming widespread, better results regarding the usability of ICT (information and communication technologies)-based systems and applications can now be obtained. Research done with eye-tracking technology has been generally conducted in two-dimensional environments. Analyzing the data obtained from three-dimensional environments using this technology is more difficult. Since most fixations take place within the center region, the data obtained from the eye movements should be analyzed qualitatively. Here are this study's conclusions on the data obtained by the eye-tracking device in a three-dimensional environment:

- The game assigns users object finding tasks so they get to know the library (find computer to do search, find carrel to study in, etc.). When the users see the object they are looking for to complete the task, they fixate on that object.
- The user scanned the entire screen when looking for the target in the three-dimensional library orientation game. This situation was recorded as lengthened eye movements by the eye-tracking device. If the lengthening of eye movements is considered as the length of the routes followed by the user to reach a target (Goldberg and Wichansky 2003), then solutions that would take the user to the target from the shortest route possible should be sought. Similarly, the number of short fixation movements increased when the user had difficulty finding the target. Thus the usability of current three-dimensional games can be enhanced by eliminating elements that either distract users or cause them to make mistakes while moving toward the target.

- Contrary to popular belief, an exact correspondence between elements in the actual environment and the design of three-dimensional games does not increase usability. In this study, the lengthening in eye movements and the increase in short movements while the users are looking for the book lending station indicated that users found this task difficult. Thus, the nondescript location of the sign in the real environment of the library emerged as a problem in the usability study. To minimize usability issues inherent in the real environment, the tasks should be facilitated in the game.
- The necessary arrangements emerged from research results and recommendations are expected to improve user satisfaction in the game. Further, the regular repetition of these tests will be important in terms of reflecting changing user needs and expectations of the game.
- In both tests, most users played the game by themselves. Collaborative play should be examined in future studies.
- To minimize user-dependent calibration errors, eye-tracking glasses and headsets should be used in future studies.

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KEY TERMS AND DEFINITIONS

Active Worlds: An online virtual world, developed by Active Worlds Inc. Users assign themselves a name, log into the Active Worlds universe, and explore three-dimensional virtual worlds and environments that others have built. Active Worlds allows users to own worlds and universes, and develop custom three-dimensional content.

Eye tracking: The process of measuring either the point of *gaze* (where one is looking) or the motion of an eye relative to the head. An eye tracker is a device for measuring eye positions and eye movement.

Gaze: To look steadily and intently.

Heatmap: A graphical representation of eye-tracking data where the individual values contained in a matrix are represented as colors.

MUVE: Multiuser virtual environment, has three-dimensional third-person graphics, are accessed over the Internet, allow for many simultaneous users to interact, and represent a persistent virtual world.

Orientation: A period of time at the beginning of the academic year at a university or other tertiary institution during which a variety of events are held to orient and welcome new students.

Think-aloud protocol: A method involving participants thinking aloud as they are performing a set of specified tasks used to gather data in usability testing in product design and development.