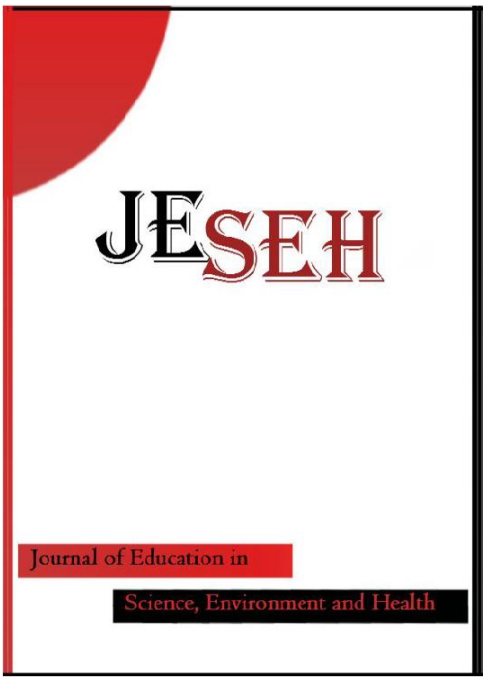

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Design Considerations of Online Infertility Prevention Training (OIPT): Development and Evaluation

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Abstract

Health-related internet sources should contain accurate, reliable and updated information, and their usability should be high to enable people to navigate successfully. This study aimed to develop interactive Online Infertility Prevention Training (OIPT) and to reveal design principles by evaluating the online training. The development, design, and redesign processes of this study included four iterations: 1) needs analysis, 2) implementation as a usability test, 3) implementation with the target group in a class, and 4) comparison of iteration II and III, and decision; and two outputs. The research process included the participation of the target audience in the design process and there were continuous corrections to the design. In the study, a design-based research approach was used. In the qualitative dimension, the data was collected with "User Information Form", "System Usability Observation Form", and the system usability interview form, and task cards. In the quantitative dimension, Infertility Knowledge Test, System Usability Scale, and also database records were used. The data obtained from tools were analyzed descriptively and predictively. As a result, this research claimed that design, development, and evaluation belong to health-related sources on the Internet should include field design principles and techniques and specific methods, although designers use prevalent techniques. The results indicated that gender's effect on media and material design, the importance of the use of expert authority in the presentation of content knowledge that system usability significantly increased from iteration two to three. Therefore, gender differences in media and material preferences except for content knowledge and also expert views may be considered in the design of health-related online training. In addition, while teaching concrete parts of the human body, interactive animations and visuals may be useful to motivate and increase engagement students to use the content again and again. Furthermore, the results of this study show that feedback design is crucial in the navigation of online learning environments. Overall, this study strengthens the idea that while designing online education environments, it is important to determine users' needs and expectations at first, afterwards conducting usability tests to specify the design challenges.

Introduction

A significant part of the information searched on the Internet is related to health information (Harvey et al., 2017). Prior research (TUIK, 2018) showed that the ratio of households who have connected to the Internet in the last three months and searched for some issues about health is 68.8%. Several studies showed that patients used the Internet to search for health-related information (Harvey et al., 2017; Trotter & Morgan, 2008). Thus, people can learn health-related information not only from doctors but also from the Internet, which is a relatively recent development. For example, people might consider the symptoms they experience and search the combination of symptoms on the Internet to obtain information, consulting a doctor afterwards if their search yielded a result that may be of concern. Indeed, it seems that accessing information on the Internet is very advantageous on the one hand due to the rapid accessibility of information, however, if the information is inaccurate, this could be harmful. In this respect, it is very important to create reliable information sources about health and to work on accuracy.

The Internet Sources about Infertility

Another advantage of easily accessing health-related information on the Internet is the opportunity to obtain information about issues that people might feel uncomfortable asking their friends, families, and even health professionals. Because of social labelling, infertility, is one of the health-related issues that individuals are often reluctant to ask questions about and express themselves to others. Infertility is defined as the failure to produce a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse (Zegers-Hochschild et al., 2009). In a study conducted with 549 infertile individuals, 87.9% of the participants (93.7% of female, 80% of male) searched for information about infertility on the Internet (Zelkowitz et al., 2016). A different study showed that the Internet is an important source of information for patients receiving infertility treatment (Zillien et al., 2011). However, it is known that information about health on the Internet is insufficient. For example, a study evaluated 107 websites according to the criteria of credibility, accuracy and ease of navigation showed all websites received low scores on the criteria, especially the accuracy criterion (Marriott et al., 2008).

Today, the Internet has become a key part of the education system and online training is now being effectively used due to the advantages they provide. Studies showed that the Internet can also be used as an alternative information source for sexual health education (Borzekowski et al., 2006; von Rosen et al., 2017). For example, it can serve as a mediator to obtain sexual health education that provides the important benefit of increasing the knowledge of disadvantaged groups that are difficult to reach using traditional sources (von Rosen et al., 2017). Sexual health education programs are available through face-to-face training (Chi et al., 2015; Thato & Penrose, 2013), leaflets (Wojcieszek & Thompson, 2013), online training (Deng et al., 2017) or video-based training (Conceição et al., 2017). However, infertility-related subject matter is limited in the content of these programs. On the other hand, some of the causes of infertility (e.g., smoking, alcohol use, sexually transmitted diseases, advanced age, caffeine consumption, being overweight or weak, and stress) can be prevented by participating in a training which may be effective at reducing these risk factors. Epstein et al. (2002) stated that when used correctly, the Internet can be used as an effective source to prevent traumatizing emotions related to infertility. In view of all that has been mentioned so far, the Internet may be an effective method to deliver an infertility prevention program, which was the goal of the current investigation. In addition, designing of this online education environment is a significant aspect of this investigation. The following part will address the user-based design of the current study as the base.

User-based Design in Online Education

The success and completion of an online education is closely related to the characteristics and goals of learners (Williams et al., 2018). Recent studies indicated that although enrollment rates for online courses are high, the finishing rates are low; researchers have been investigating reasons for low completion rates (El Said, 2017; Rieber, 2017). Reasons for not finishing an online course include pedagogical distance and design problems between the student and the content. A student's perception, values, judgments, and personality structure (Travers et al., 1993) affect the motivation of using the learning environment. To reduce the pedagogical distance between students and the environment, it is important that e-learning environments are designed according to the characteristics of the students, including involving students in the design processes. Therefore, in the design of online environments, user experiences should be collected before, during and after the design, and formative and summative evaluations should be made. Designing these environments based on student characteristics can increase student satisfaction and enable them to actively participate in their learning processes, ultimately affecting their success (Çağıltay, 2011; Gülbahar et al., 2008). After having addressed the importance of user-based design in online education, the next section will be discussed design-based research in multimedia learning environments, importance of usability tests, and cognitive theory of learning.

Design and Development in Multimedia Based Online Education

In the current study, a design-based research method was used to consider student knowledge and multimedia preferences in the design of an “Online Infertility Prevention Training” website. To be innovative in the design of this learning environment it was necessary to use a research method that included the target user on the design team, and constantly updated the design. Research studies that design, develop, and redesign innovative learning environments are termed Design-Based Research (Barab & Squire, 2004; Zheng, 2015). Design-based research can be characterized in terms of the designed artifact and resultant theory (Barab & Squire, 2004). This research involves a series of development and correction processes on the basis of design-based research, such as the development of the environment, analyzing design problems with usability tests, redesign, implementation with target users and evaluation. The International Organization for Standardization (ISO 9241-11, 1998) defines usability as a specific group of users to perform certain tasks effectively, efficiently and with

satisfaction (Çağıltay, 2011). Adding the usability tests to design cases helps to ensure seeing the interaction between the user and design directly.

Problems related to usability in multimedia learning environments can lead students to move away from their learning objectives (Virvou & Katsionis, 2008). This may be explained by the cognitive theory of multimedia learning (Mayer, 2009), based on dual coding theory (Paivio, 2001), cognitive-load theory (Sweller, 2005) and limited capacity theory (Baddeley, 1999). This theory states that during learning with multimedia, a student's cognitive processing capacity consists of 1) extraneous processing, 2) essential processing and 3) generative processing. Extraneous processing is the cognitive process that occurs during learning that does not serve instructional purposes and is caused by design problems. Essential processing is the cognitive process related to the content that needs to be learned and occurs when content becomes complex. Generative processing is cognitive processing that aims to make sense of the presented material and occurs as a result of focused learning (Mayer, 2009). Designers need to pay particular attention to the control of extraneous cognitive processing among them (Davids et al., 2015). By using the cognitive theory of learning, designers try to prevent users' from becoming lost during navigation in e-learning or multimedia learning environments (Altun, 2000). Therefore, the involvement of target users in the design process of online education environments is important in order to improve usability. Content is another important aspect of multimedia learning environments. When we examined the literature, there is no comprehensive online education program for university students aimed at informing about infertility and sexual health in Turkey. Generally, ads of hospitals or doctors are prevalent as online education resources. This finding has informed us in shaping the subject content in this research.

The Aim of the Study

The current study aims to investigate the design, development, and redesign processes of "Online Infertility Prevention Training" (OIPT) website. These processes are 1) Need analysis, 2) Design and Development of "OIPT", 3) Testing usability, 4) Redesign, 5) Implementation in a class, and 6) Comparison of Iteration II and III, and Decision (Figure 1). We steadily improved the design interventions as a part of the iterative design process to make them more practicable and enhance the knowledge.

Based on these iterations, the current study aimed to reveal answers to the following research questions:

- What prior knowledge do university students have about infertility and what are their preferences related to multimedia learning? (Iteration I)
- How usable is the online environment (OIPT) as a system in the usability test? (Iteration II)
- How usable is the online environment as a system for a real implementation in a class? (Iteration III)
- Is there any significant increase in system usability between the usability test and real implementation in a class? (Iteration IV)

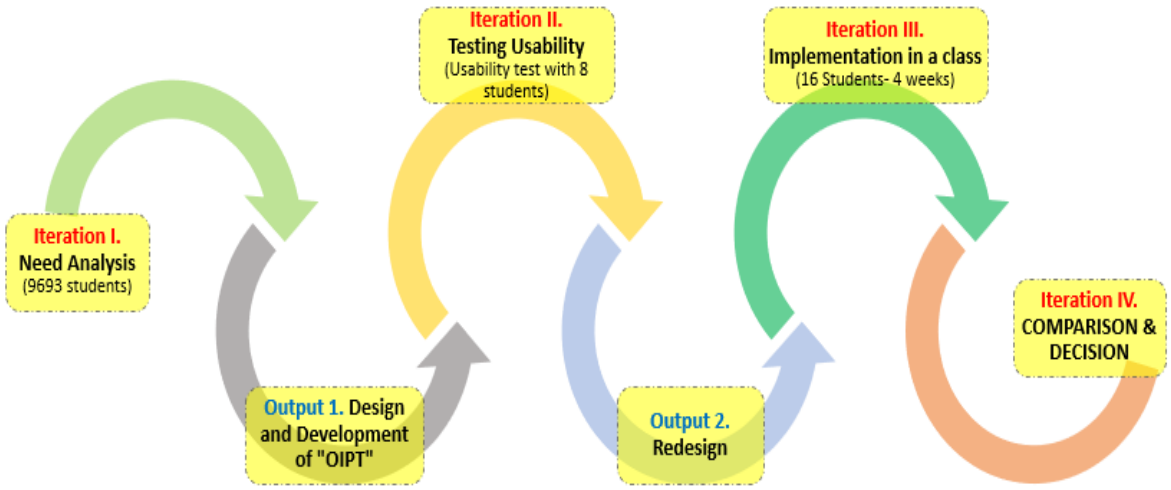

Figure 1. Four research iterations and their outputs

In the following sections, the method of study (research design, sample, data collection tools etc.), iterations and findings of each of them are indicated.

Method

Research design

This study was designed using the design-based research approach, which consists of an iterative design and evaluation process. This approach can help designers by generating, testing, and refining design and design concepts iteratively to move the research further. Multimedia design and usability are complex phenomena (Alwashmi et al., 2019). So, researchers advocate for continuous and iterative testing in order to respond to user needs, preferences, technical challenges, and faults (Adam et al., 2019; Hattink et al., 2016). More specifically, it is also important to take into consideration to target users of online environments while designing these environments to enhance learning and engagement. In this study, as a part of the iterative design process, there were continuous corrections. In the next sections, each iteration of the study, methods, challenges, and results (findings) of it, and outputs is explained in detail.

Sample

This study has consisted of four research iterations and their outputs as mentioned before. Therefore, the sample consists of different participants. Iteration I phase has consisted of 9693 undergraduate students (5002 females, 4691 male) from 12 regions in Turkey in the 2016-2017 academic year. To determine regions Statistical Region Units Classification-1 criteria were used. Iteration II phase has consisted of 8 undergraduate students from the Department of Computer Education and Instructional Technologies (n=4) and the Department of Guidance and Psychological Counseling (n=4) who were selected by convenience sampling in Dokuz Eylül University in the 2017-2018 academic year. Lastly, Iteration III has consisted of 16 undergraduate students who were studying in the Department of Guidance and Psychological Counseling at Dokuz Eylül University in the 2017-2018 academic year. These students selected an elective course titled “Sexual Health Knowledge” voluntarily and implementation was carried out within the course.

Data Collection Tools

In the qualitative dimension, the data was collected with “User Information Form”, “System Usability Observation Form”, and the system usability interview form, and task cards developed by the researcher. In the quantitative dimension, System Usability Scale (SUS), was developed by Bangor et al. (2008) and adapted to Turkish by Çağıltay (2011), Infertility Knowledge Test (IKT), developed by Seymenler (2017), and also database records were used. Detailed information on the tools is given in the related iteration steps in the following parts.

Data Analyses

The chi-square test was used to determine university students’ multimedia learning preferences based on their gender (Iteration I). In Iteration II, the usability of the online education environment was investigated by using different data collection methods and tools. The think-aloud method and system usability observation form were applied during the experiment. The system usability interview and system usability scale were used after it to collect quantitative and qualitative data (Iteration III). Quantitative data obtained from the usability test was analyzed descriptively. One of the nonparametric statistical methods, the Mann-Whitney U test, was used to compare the system usability in Iteration IV. In addition, the collected qualitative data were recorded to the MS Word program and transcribed; the data were then analyzed using descriptive and content analysis techniques. Detailed information on how to data was analyzed is given in the related iteration steps in the following parts.

Steps of the Study

Iteration 1. Need Analysis

Research Question 1

What prior knowledge do university students have about infertility and what are their preferences related to multimedia learning?

Method of Iteration 1

The development of an online infertility prevention training (OIPT) was a part of a larger project, Examining University Students' Infertility Knowledge and Attitudes towards Infertility and Developing and Evaluating Infertility Prevention Psycho-Education Program and Online Education Program, which was supported by The Scientific and Technological Research Council of Turkey (TUBITAK). In the context of the project, researchers developed Infertility Knowledge Test (IKT) and Attitudes toward Infertility Scale (ATIS) as data collection tools, conducted a detailed needs analysis and then developed a Psycho-Education curriculum and an online education environment in this study. The prior knowledge levels of university students about infertility were available in another published article (Siyez et al., 2018). The multimedia learning preferences part of the need analysis is the issue of this article. The data related to multimedia design preferences of groups was analyzed with chi-square test.

Iteration I. Challenges and Results

In this study, the needs analysis is one of the components of design cases. User needs and expectations are important for the interface design. In this context, to determine popular subjects and prior knowledge about infertility, the needs analysis about infertility knowledge was conducted on 9693 university students. Besides, several challenges had to be addressed during the needs analysis. Before starting the project, we examined the literature to identify how studies conducted about online environments related to infertility subject. But we couldn't find a satisfactory study for university students about it. Studies that are conducted were mostly to advertise hospitals or doctors, and also not planned as a training. Therefore, the first design challenge was the lack of a sample study. The second design challenge is the topic. As we stated in the 'Introduction' section, infertility is a sensitive issue, particularly in societies social rules are dominant (Gungor et al., 2013; Şahin, 2012). For instance, asking questions about it is seen as prejudicial or disturbing.

The results from the published study showed that students had some misconceptions about infertility and sexual behaviors (Siyez et al., 2018). This study was conducted with 9693 undergraduate students (5002 females, 4691 males) from 12 regions in Turkey. In addition, results indicated that more than 90% of the participants would like to learn about subjects related to "Factors affecting infertility", "Sexual health and reproductive health" and "Sexually transmitted diseases" (Baran et al., 2017; Siyez et al., 2018).

The students' multimedia learning preferences were also investigated based on their gender. The chi-square test results (Table 1) indicated that they expected rich content from their online education including "questions and answers about infertility, expert video, animation, different content by sex and different designs according to sex". Interestingly, the percentage of participants that preferred "different contents according to sex" did not differ by gender, χ^2 (1, n = 9693) = 3.69, p < .056).

Table 1. Students' content preferences in the online environment

Multimedia design preferences		Sex				χ^2	p
		Female		Male			
		f	%	f	%		
Questions and answers about infertility	Yes	4598	95.9	4273	94.2	14.61	.000
	No	195	4.1	262	5.8		
Expert (doctor) video	Yes	4491	93.4	4157	91.6	11.70	.001
	No	316	6.6.	383	8.4		
Animation	Yes	4067	84.9	3941	86.9	8.09	.004
	No	724	15.1	592	13.1		
Different contents by sex	Yes	3757	78.3	3623	79.9	3.69	.056
	No	1043	21.7	912	20.1		
Different designs according to sex	Yes	3168	66.1	3292	72.7	48.17	.000
	No	1628	33.9	1237	27.3		

Output 1. Design and Development of Online Infertility Prevention Training (OIPT)

The Online Infertility Prevention Training (OIPT) based on the results from Iteration I was divided into four units. Unit 1 included male and female reproductive systems with organs and menstruation. Unit 2 included infertility, treatment methods and biological and preventable factors (age, body mass index, sex time, nutrition habits). Unit 3 continued with other preventable factors such as sexually transmitted diseases (STD), protection methods from STD. Unit 4 was related with the other preventable factors such as cancer, substance use, stress, chemicals, and radiation (Figure 2).

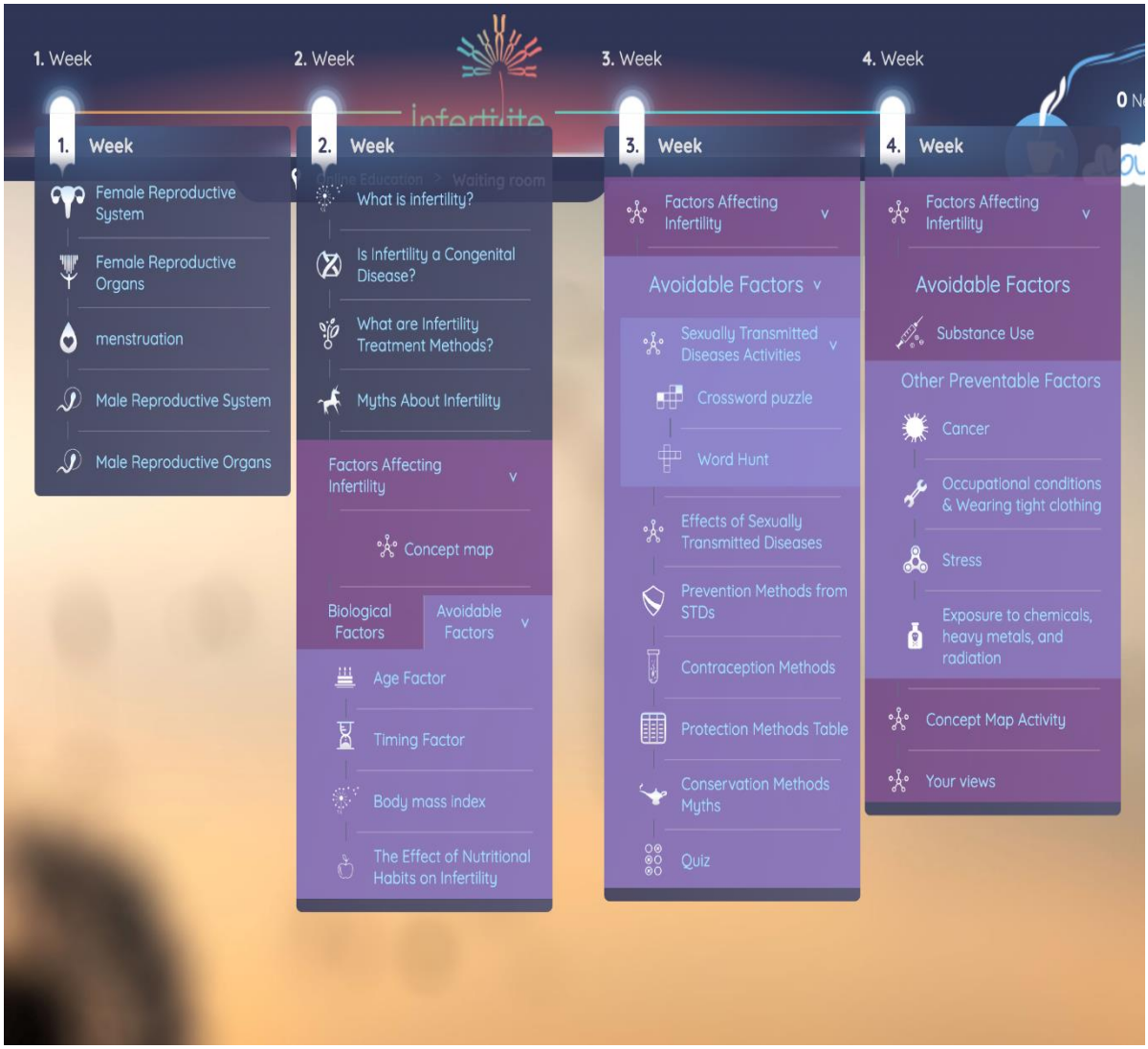

Figure 2. The content of the online infertility prevention training (OIPT)

Male and Female Reproductive System

Two interactive animations of the female and male reproductive systems were used to teach the 1) functions, 2) spelling and 3) places of the reproductive organs (Figure 3). The side and front view of the reproductive systems was also designed. More specifically, if the aim is to teach a specific organ (e.g., Fallopian tubes) in the female reproductive system, this organ blinks on the page to attract the attention of users. The aim was to teach the function of an organ, and the verbal and vocal information (with a speaker symbol) were presented to describe its function to users. To teach the spelling of an organ, a drag and drop game was used. Users had to drag letters to the correct place in the game. Then, they received positive verbal and visual feedback if they succeeded. To teach the locations of an organ in the reproductive systems, another drag and drop game was designed. The users identified the location of an organ in the female reproductive system and received positive verbal and visual feedback.

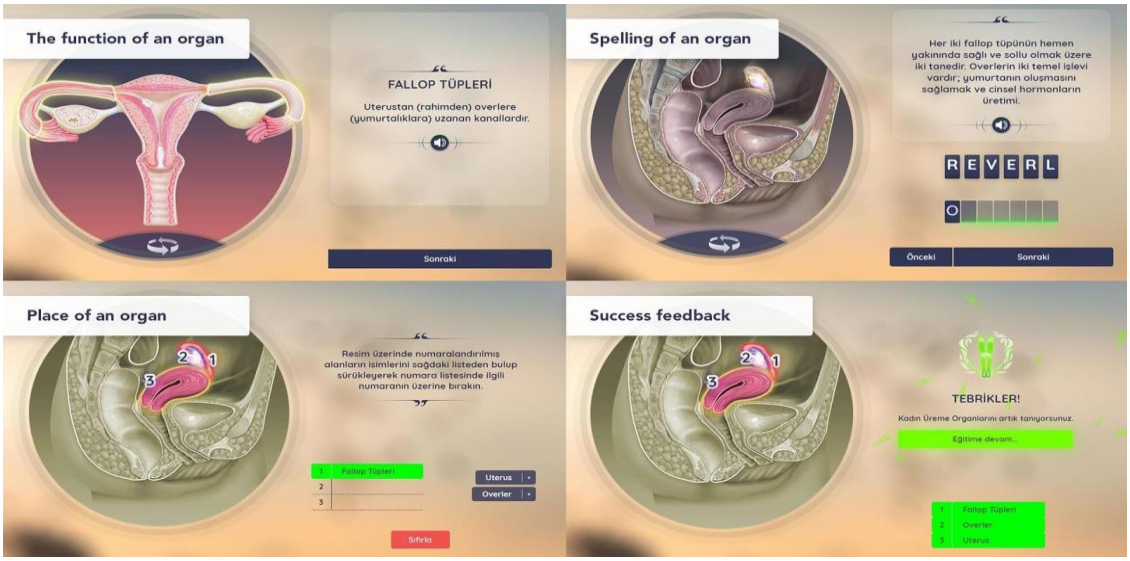

Figure 3: Teaching the female reproductive system: 1) the function of an organ, 2) spelling of an organ, 3) location of an organ, 4) feedback design when a user succeeded

Video

Doctor videos and 3D animation videos showing the menstrual cycle were used for subject narration (Figure 4). The videos included answers from students' misconception about infertility, which we have learned from iteration I (need analysis). Multiple choice questions were posed before and after the video. When a user wanted to skip the video, the skipped video was marked on the video page, and users were not allowed to complete the activity without watching the video.

Body Mass Index tool

This interactive tool was designed to teach the importance of infertility prevention factors such as sex, age, weight, and height (Figure 4). Users received different feedback while the values of risk factors (age, gender, height, weight) changed. For example, the infertility risk rate is higher when a woman's age is 40 than when her age is 34.

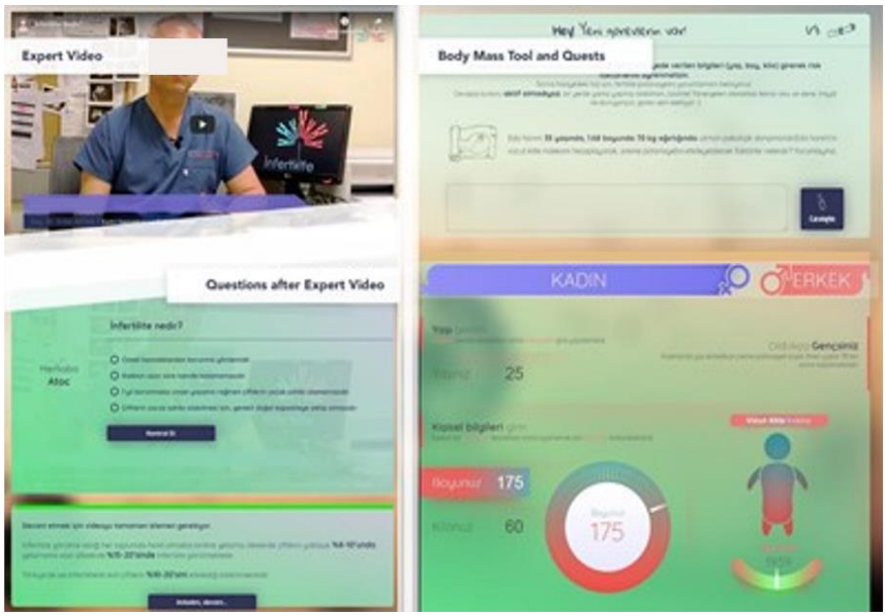

Figure 4: Example of the expert video and a multiple-choice question asked at the end of the video and the body mass tool with questions

Iteration II. Testing Usability

Research Question 2

How usable is the online environment as a system in the usability test?

Method of Iteration II

Eight undergraduate students (six female and two male) from a public university in Turkey volunteered to participate in the experimental study evaluating the usability of the online environment. This study used Nielsen's (2012) recommendation to determine the number of participants. He suggested including at least five users to reveal basic problems related to a system in usability studies. The characteristics of the participants should be defined before a usability study because experienced and inexperienced users show different behaviors (Çağıltay, 2011). This current study defined the participants' personal computer ownership, computer and internet usage experiences, internet usage level, online education experience which may affect the results of system usability with the User Information Form. Seven of the participants have a personal computer; computer usage experience range included 10 years (n =2), 7-9 years (n = 4), 4-6 years (n=1) and 1-3 years (n = 1); internet usage experience range included 10 years (n=1), 7-9 years (n=4), 4-6 years (n=2), 1-3 years (n=1). Three of the participants defined the level of internet use as "sufficient", one of them as "very sufficient", and three of them as "somewhat sufficient". Also, two participants stated that had an online learning experience before.

The usability of the online education environment was investigated by using different data collection methods and tools. Before the experiment, user information form was applied to the participants. The think aloud method, task cards and system usability observation form were applied during the experiment. The system usability interview and system usability scale were used after it.

- *Think Aloud Method:* The aim of this method is to explore the interaction between participants and the system (Boren & Ramey, 2000). The method requires that users vocally express their thoughts while performing their assigned tasks.

- *User Information Form:* This form was used to collect detailed data about participants. With this form, participant number, gender, department, computer ownership, computer experiences of participants, level of using internet etc. data were collected.

- *System Usability Observation Form*: Start/end time, duration of the task, number of errors, completion status of the task, and the need for assistance was recorded.

- *System Usability Interview Form*: Opinions of the participants about the tasks, their experiences, and suggestions about the online education environment were obtained.

- *System Usability Scale (SUS):* The scale was developed by Bangor et al. (2008) and adapted to Turkish by Çağıltay (2011). It uses a 5-point Likert type scale consisting of 10 items. Five items are inversely scored. The points for each user were summed and the total score was multiplied by 2.5 to obtain the scale score for each user. The possible range of scores was 0(lowest)-100(highest). Bailey (2006) stated that if the SUS score was between 65-70, the environment had moderate satisfaction.

- *Database records:* Participants' data related to tasks during the experiment was recorded in the database.

The participants performed seven tasks during the experiment. The tasks included both a simple task such as finding a piece of organ on a visual and a complex task such as realizing a task by using multiple interactive tools. The tasks were completed on a desktop computer in a research lab. A task started with the researchers giving the task card and ended with either the successful or unsuccessful completion of the task.

- *Task 1. Signing in the online education:* The participants were expected to log in to the website with the e-mail address and password given to them. http://infertiliteyionleme.deu.edu.tr/course/.

- *Task 2. Listening to the definition of "Cervix" in the female reproductive system:* The participants were expected to click on the speaker icon next to the "Cervix" (Figure 4).

- *Task 3. Answering the question at the end of the video titled "What are the methods of infertility treatment?":* The participants were expected to watch the doctor video (Figure 4) and answer the multiple-choice question at the end of the video.

- *Task 4. Completing the first mission on the "Body Mass Index".* The participants should click on the text "Hey, you have a new task!" to start the mission. Then, the mission task window opened (Figure 4). Participants were expected to carry out the mission by using the "Body Mass Index" tool.

- *Task 5. Examining "Tubal Ligation" method, one of the birth control methods.*

- *Task 6. Finding and crossing out the word "Syphilis" on the Word Hunt puzzle on the sexually transmitted diseases page* (Figure 5).

- *Task 7. Matching the function of "Penis" with the figure of it:* This drag and drop activity (Figure 3) required correctly matching male reproductive organs with the related numbers on the right side of the image.

In addition, while implementing the usability test, task duration was examined. Although a usability test conducts qualitatively mostly, sometimes it can be really helpful to keep track of design progress and users' behaviors. With this perspective, we investigated the task duration and applied the System Usability Scale to the participants.

Tasks

When database records and observation form results are examined, it was found that tasks 1, 3, 5, and 7 were completed successfully (Table 2). The participants' uncompleted tasks are shown as X1, X2, X3, X4 and X5 in Table 2. Effort duration for the uncompleted tasks was 128 seconds (X1), 168 seconds (X2), 85 seconds (X3), 75 seconds (X4) and 234 seconds (X5).

Table 2: Time distribution of the participants while performing the tasks

	Time of task (second)							
Participant Number	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Total
1	40	**X1**	228	**X2**	32	85	28	413
2	37	23	219	**X3**	17	32	29	357
3	41	62	238	254	43	32	12	682
4	26	24	169	100	33	**X4**	9	361
5	70	44	134	280	35	36	16	615
6	50	100	221	**X5**	30	80	30	511
7	49	85	295	135	24	26	41	655
8	21	46	256	105	25	24	25	502
Total time (second)	334	384	1760	874	239	315	190	4096
Mean time (second)	41.75	54.86	220	174.8	29.88	45	23.75	

System Usability Scale

The SUS scores of the first working group are shown in Table 3. The highest score was 87.5 and the lowest score was 35. The mean SUS score was 69.38 (SD = 18), indicating that the online infertility prevention training had moderate satisfaction.

Table 3: SUS scores in Iteration II

K1	K2	K3	K4	K5	K6	K7	K8	SD	X
70	87.5	57.5	85	87.5	62.5	35	70	18	69.38

Output 2. Challenges and Redesign of the online environment

The roles of the design team in this implementation are as follows; 8 participants, 1 web designer, 1 content designer, and 1 expert in multimedia learning. The following challenges emerged while performing tasks and then the following updates as a solution were made after the implementation as the usability test of the system.

- In the old design, email and password text boxes were visible for logging on but these text boxes were hidden for registering. Because, while performing task 1, a participant clicked the wrong button ("Sign up"). Also, three of the participants performed task 1 above the average task completion time. This was the first challenge in the design of the task. We determined the reasons of this challenge as navigating of the "Sign up" button. As we stated before, the email and password fields were open on the page, so no direct option was offered to the user. The other reason of it can be about button color because the button color is striking. According to the data obtained from the observations and the interview, we think that these design problems misled the user to the wrong button, therefore we changed the design of the login page. In the new design, textboxes were removed, and "Login" and "Register" buttons were added to the page (Figure 5). When a user clicks, the text boxes appear just above the button.

- In the old design of reproductive systems, users could listen to the information about the organs in the reproductive systems when they clicked on the speaker icon. However, if they clicked the icon again, the voice started again (Figure 3). While participants performed task 2, we observed challenges about the design. The first challenge is that participants often tried to click the speaker icon again to stop the sound. Also, some users were hesitant about whether to click the icon as well. The second challenge is that one participant couldn't complete the task, and the average completion time of task 2 is 54.86, three of the participants performed it above the average time. These findings showed us that there was a design problem about the speaker icon on the page. As a solution to it, we redesigned the speaker icon and added a directive text on the use of the icon to the page (Figure 7). In the new design, the sound stopped if the user clicked on the speaker icon a second time.

- In the old design of the Body Mass Index (BMI), a user should have clicked the warning "Hey, you have a new task!" to read and complete a mission (Figure 5). Also, the case texts were plain. However, we observed some design challenges during the usability test. While performing task 4, participants requested help from researchers according to the observations during implementation. This was the first challenge because we expected participants to complete the task without asking for help. The second challenge is that three of the participants couldn't complete the task. It was observed that instead of clicking on the case text at the top, participants went to the bottom of the page with the mouse and searched for the relevant case in the body mass index section. In other means, they couldn't notice the case texts. According to the result obtained from interviews and observations, participants stated the reason for this challenge was as a visually appealing BMI tool and misunderstanding of the directive. They stated that the directives in the case texts were not clear and understandable enough. A participant view is as follows:

  I didn't notice "Hey, you have a new mission!" warning at the top of the page and we should have clicked on it to open. But I looked below to find the case. It could have been better if we could see the details on the page below instead of clicking to open it."

  As a solution to these specified design challenges in the new design, the case texts could be seen and done on the page without any clicking. Moreover, a directive text was placed over the cases, and it was written in bold. In addition, the directive texts were re-written in a more intimate and motivating language (Figure 5).

- While participants performed task 6, they had difficulty completing the task. There was one participant who could not finish the task and one participant who needed help from the researcher. According to the observations and interviews, the challenge with this task was that the participants clicked the "Sexual Transmitted Diseases Crossword" menu instead of the "Sexual Transmitted Diseases Word Hunt" menu. There were two different crossword activities starting with the same words on the page. The reason for this confusion is to start both pages' titles with "Sexually Transmitted Diseases …". As a solution to this design challenge on the page, we redesigned it. After the revisions, a menu titled "Sexually Transmitted Diseases Activities" was added, and also "Crossword" and "Word Hunt" activities were added as a sub-menu under this menu (Figure 6). Also, the text "Solve" button in the Crossword activity was changed to "I couldn't find it."

- In the old design, the user was to correctly match male reproductive organs with the related numbers on the right side of the figure (Figure 3). However, this design had caused navigating problems on the page. While performing task 7, participants could not notice that they needed to move words to numbers, because the number field was not marked visually and there was not a directive showing how to do the activity. While performing task 7, one participant requested help from researchers. In the interviews and observations made, participants stated that the directive was insufficient, the list was not remarkable, and therefore they had difficulties while performing task 7. As a solution to these challenges, we redesigned the number field and added a directive text. In the new design, the numbers, which indicated the organ, were divided with a line (Figure 6).

- In the interviews, some participants suggested an intro video as a solution to navigating problems. In parallel with this suggestion, an informative intro video indicating the general use of the training was developed. The video was about the navigation in the menus and the use of the tools.

- In the old design of the website, menus were opened when clicking. In the new design, an arrow sign indicating submenus was designed because participants had difficulty finding submenus (Figure 6).

- While the participants were performing tasks, it was observed that some participants were not sure which page they were on. As a solution to this challenge, we designed breadcrumb navigation on a section under the main menu to indicate which page the user is on (Figure 6).

- In the old design, there was no button on the website for the user to logout. The web page was designed as session-based, that is when a user closed the page in the browser, the user was also logging out of the page. However, this design was contrary to the frequently viewed user behavior in the online learning environments. As a solution to this, a “Logout” button was added to the website in order to ensure that the user felt safe and to adapt to the users' behavior in the new design.

- In the old design, there was no symbol showing the tasks completed when a task was completed, so some participants were hesitant whether the task was completed or not. As a solution to this design challenge, we designed a figure that indicates completed activities on the page. It was added to the right of the menu titles to enable students to understand if activities were completed (Figure 6).

- In the old design, the user was not informed about how to use the buttons on the page. It was expected from the user. But this design has caused navigating problems on the page. As a solution to this challenge, we added directive texts showing how to use buttons on each page. Also, if the user wants to pass directly without reading the directives, a design has been made on the page so that they can exit from it by clicking the "Skip to explanations" button on the top right (Figure 8).

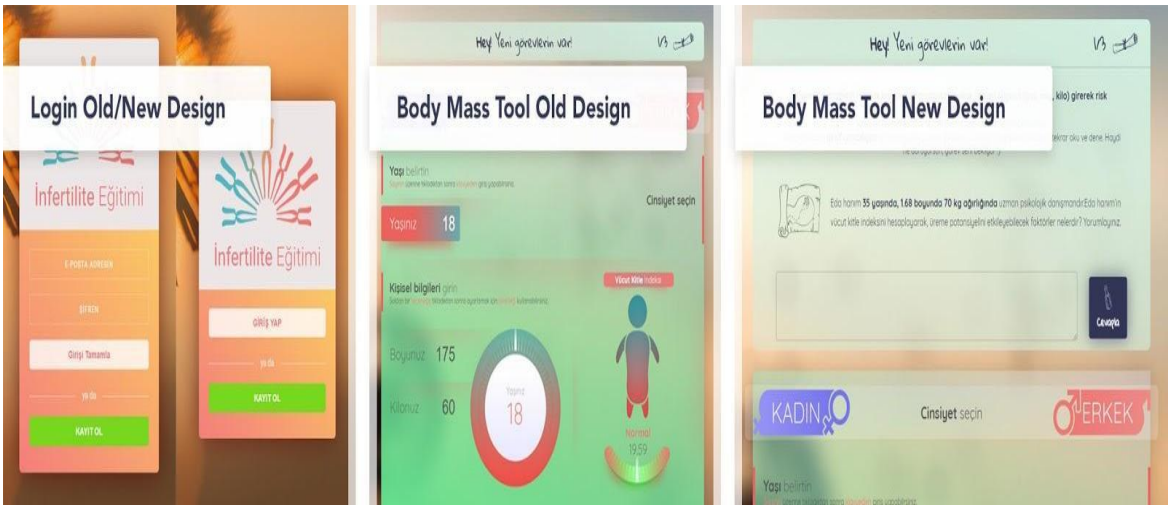

Figure 5. Screenshots of logging in and registering, and a mission for Body Mass Index

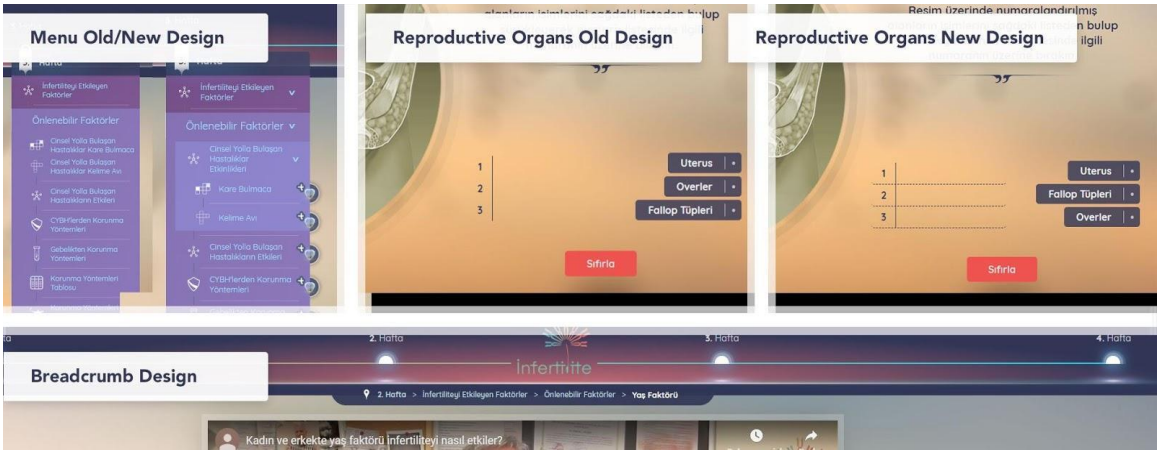

Figure 6. Old and new design of menus and submenus, old and new design of the reproductive organs matching game, and breadcrumb navigation

Figure 7. New design of the speaker icon

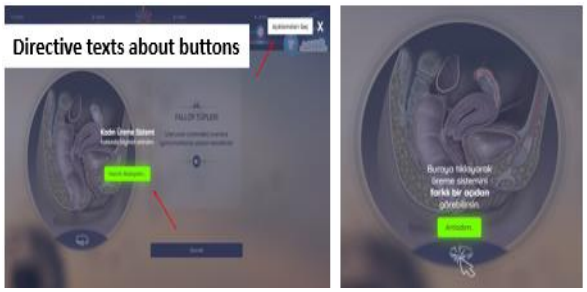

Figure 8. Adding of directive texts on the page

Iteration II. Results

The participants identified the main positive aspects of the education as interactive, rich in terms of multimedia elements and entertaining. In addition, division of content on an unit basis, separation of weekly content into titles (menus), and use of the website on different devices (smart board, computer) were the other positive features of the education. It was also stated that users had problems related to the interface design. These included: 1) navigation problems on the website, 2) inability to find some submenus under the main menu, and 3) confusion as to how to finish the education. As a solution to these design problems, a redesign was made on the relevant tools (Figure 5, 6, 7 and 8).

Iteration III. Implementation in a class

Research Question 3

How usable is the online environment as a system for a real implementation in a class?

Method of Iteration III

Sixteen undergraduate students (13 female and 3 male) participated in the implementation. None of the students had previous experience with online education. The students voluntarily participated in the study within the scope of an undergraduate course on health knowledge for 4 weeks.

The system usability interview form which aims to reveal the participants' experiences and suggestions about the online education and the system usability scale (SUS), which was used in Iteration II were used after implementation. Database records were also used after completing the implementation. The results of the observation and interview were interpreted together.

Iteration III. Challenges and Results

Design of the directions and feedback

The participants described the directions on the website as "sufficient and explanatory". They found the feedback "sincere, understandable and entertaining". Some of the participants suggested that feedback about ending the activity could be added to the end of each week.

> The directives and feedbacks were entertaining. The directions were facilitating everything. They were checking whether I am ready or not and asking in the form of "Are you ready? Here we go!". I progress easier in this way.

> A question was asked before watching the video. Then a text was shown in the form of "Let me watch!". I closed it but I liked it, I laughed and thought that "what a lovely idea". I thought that they thought well of it. It came to me very intimate, I felt I was chatting with my friend and felt like he/she was teaching something to me. The feedbacks have reduced such formality and made me feel sincere.

> The first part was over, but it didn't seem something like "it was complete". I was confused. So, I did the activities twice. It may be added something like "You've done it correctly, it is completed.

Page design

The participants evaluated the page designs as "simple, understandable, interesting and consistent". They stated as a negative opinion that circles indicating completion of weekly activities were not working on the website. As this feature was not working on the site, the participants frequently consulted the teacher or repeated the activities over and over again. This was an important design challenge while the implementation process. After that, we solved this problem.

> The design is understandable. The location of different buttons is different, and the same color is used for the same function. The design doesn't distract attention.

The content

The participants classified their opinions related to the content as "important", "interesting", "a reliable information source", "rich in multimedia elements", and "classification is guiding".

> The importance of the subject is vital to be willing to follow the whole online lesson. We know from the media/ news that sexual intercourse age is decreasing. We are 21 years old now and this is the first time to take such a course. I think this course should have been given before.

System Usability Scale

The SUS was applied in the class and the highest score was 100 and the lowest score was 65. The means SUS score of the website is 85.47 (SD = 11.26). That is, the participants found the website to be highly usable.

Iteration IV. Comparison of Iteration II and III, and Decision

Research Question 4

Is there any significant increase in system usability between the usability test and real implementation in a class?

Method of Iteration IV

This iteration compared the results of system usability scores of previous iterations as a component of design. One of the nonparametric statistical methods, Mann-Whitney U test, was used to compare the system usability between the usability test and real implementation.

Iteration IV Results

A Mann-Whitney U test was conducted to compare the system usability SUS scores between the usability test and real implementation. The test indicated that there was a significant difference between the SUS scores of the participants in the usability test and the implementation in a class, U=23.50, p< .05. (Table 4); the SUS scores were higher in the implementation class.

Table 4: Results of the Mann-Whitney U test

Periods	n	Mean rank	Sum of ranks	U	p
System Usability in the implementation in a class	16	15.03	240.50	23.50	.013
System Usability in the usability test	8	7.44	59.50		

Discussion, Conclusion and Suggestions

The design-based research method enabled us to design and develop an “Online Infertility Prevention Training" in an effective way that produced positive and promising evidence regarding the use of online education about health sciences for university students in a blended learning environment. User-based approaches of design-based research in this study also facilitated the researchers to determine significant user behaviors while using an online educational website. Çağıltay (2001) stated that usability studies were very beneficial when developing a digital system and could be used as a part of a formative and summative evaluation. As a whole, the four iterations and their outputs positively contributed to the development of an online educational website. However, some prior work indicated that researchers preferred to use only one iteration during design-based studies and did not report revisions due to time and resource limitations (Zheng, 2015). Conducting multiple iterations in the current study led to an increase in system usability scores. Therefore, two main implementations contributed to the improvement of the design used in the current study. All in all, conducting usability testing made a great contribution to determine design challenges and to observe users’ behaviors while they are using the online learning environment. Also, starting the design process conducting need analysis ensured us to reveal users’ expectations and to create usable knowledge relating to the content of the environment.

Prior research found the Internet is one of the important sources of health information for patients receiving infertility treatment or healthy individuals (Zelkowitz et al., 2016; Zillien et al., 2011). Unlike other online infertility education studies where the usability scores were low (Marriott et al., 2008), the usability in this study gradually increased as a result of utilizing design-based research. Therefore, the evidence-based positive results indicate that online education can enable people to investigate the source of infertility-related knowledge without usability problems and social labeling. In addition, improving system usability contributed to practical knowledge for researchers working on message design in the development of e-learning environments in the field of health sciences.

The first iteration started with the needs analysis which aimed to reveal university students’ available infertility knowledge and their preferences about multimedia design. Tripp and Bichelmeyer (1990) stated that instructional designers should begin the software development process by examining the current context and determining the needs because a computer-based system is centered on the human cognition system. It is remarkable that many studies noticed the importance of identifying learners’ previous knowledge about the subject not only in the field of health sciences but also in other fields (Hickey et al., 2017). A successful website

should involve substantial careful consideration of users' preferences in addition to the accuracy of information provided (Djamasbi et al., 2007). As a result, the obtained detailed information about the users facilitated studying the processes used by teams of instructional technologists and provided them with a road map before starting the design of the education in the current study. The practitioners were able to make design decisions more readily because they knew the expectations of the users. Moreover, data from a large sample based on users' knowledge and multimedia preferences led to increased student satisfaction and effectiveness of the system, which we evaluated in the other iterations. The needs analysis results indicated that more than %80 of students would like to see frequently asked questions and answers about infertility, expert (doctor) videos, and animations in an online training about infertility. Thus, the main design decision was to use doctor videos on topics or questions in which learners had limited knowledge. The most important benefit of using doctor videos was that learners were satisfied with the accuracy of the knowledge relayed. The usability test and main implementation results indicated that this decision increased student satisfaction.

The Iteration I result showed that there were significant differences between the preferences of female and male in the development of the online training platform, with the exception of content information. More specifically, female students preferred to see "questions and answers" and "expert videos", but men students preferred animations and different designs. There were significant differences between the preferences of female and male in most studies examining gender differences in the development of websites (Cyr & Bonanni, 2005; Djamasbi et al., 2007; Huang & Yuan, 2017; Simon, 2001). The current study considered gender-related design preferences as a whole because the ratio of both female and male involved in a design decision was comparable. Therefore, this study used of expert videos, subject matter related with the other sex, or animations in the design. We recommend that other practitioners consider both gender preferences and expectations when designing.

Before designing instruction, determination of students' prior knowledge enables designers to identify learning problems, find the appropriate teaching level, and select successful feedback (Hailikari et al., 2008). This study highlighted the importance of prior knowledge and started teaching with basic concepts of the reproductive systems and then presented biological and preventable factors relevant to infertility. In online education, the reproductive system was the favorite and the most popular section among the students, and they repeatedly used this part during their education. This result also indicated that prior knowledge must be considered in the design. Furthermore, the nature of the subject is complex because it includes many concepts that university students have not previously learned. Bruner, who made two important contributions to teaching through concept teaching and discovery learning, argued that concept teaching includes teaching the definition, its features, and its examples (Ozmen, 2004). Therefore, the design required use of the concept teaching method including first teaching spelling and then the function of a concept. The fact that the concept teaching in the online environment was realized through a drag and drop game was also a favorite element for the students.

Iteration II indicated that the participants had some navigation problems in the online environment. For example, not being able to guess what issues were under a menu, having difficulty in understanding the instructions, increasing the time to perform tasks, and not closing the web site. These challenges caused navigation problems but especially increased cognitive load for the human cognitive system (Altun, 2000). There is a significant effect of navigation design types on recall and retention in e-learning environments (Dikbas Torun & Altun, 2014). Therefore, this study indicated that it is important to fix these various navigation problems before implementation. After redesigning the navigation problems of the online environment, the system usability scores increased. In addition, Iteration II indicated that adding a limitation of skipping videos while watching doctor videos increased the rate of video viewing. Fiorella and Mayer (2018) stated that breaking the video into pieces and asking students for explanations in video breaks can help learners control essential processing or cognitive load. Similar to this study, users tended to skip videos in e-learning environments (Bayazıt & Akçapınar, 2018; Kim et al., 2014). In our daily life, students may skip videos on social media, especially when the video duration is long. Therefore, adding a limitation of skipping in videos or giving feedback about it may be suggested to other designers who want to use educational videos in e-learning designs. In addition, segmenting videos into short sections and presenting essential content knowledge can be helpful to prevent the skipping behaviors of students. Lastly, the observations and the interviews indicated that users couldn't clearly follow the instructions on the page. The instructions were revised according to Mayer's (2009) multimedia principles (signaling and personalization principles) and then were presented to the users' experience (Iteration III). As a result, they didn't have any problems understanding the instruction during the implementation in a class.

As a conclusion, the results obtained from this study show that design and user-based research approaches in multimedia learning environments about health sciences is useful to determine target users' behaviors explicitly

and design challenges. Four iterations and their outputs of the current study was made a great contribution to the designing process of the online education website and usability scores of the website positively. The results of this investigation also show that while teaching concrete parts of the human body, interactive animations and visuals may be useful to motivate students to use the content again and again. Therefore, their memorization of labels, definitions and the place of an organ can increase. Taken together, this research has shown significant findings related to students' multimedia learning preferences in health sciences, how can implement usability tests on online sexual health education environments, design principles of these environments etc.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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