Design Process of Three-Dimensional Multi-User Virtual Environments (3D MUVEs) for Teaching Tree Species

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ABSTRACT

This study aims to realize the concept of biodiversity, which is one of the subjects covered by environmental education, with 3D virtual worlds platform and to realize the biological richness of users in their environment and to provide awareness of the species they see in their immediate surroundings. It is aimed to design 3D MUVE to teach tree species to pre-service teachers within framework of Instructional design process in 3D MUVEs based on problem-based learning approach. Four different design groups are third year undergraduate students (N=21) from the Department of Computer Education and Instructional Technology in the Faculty of Education at a large state university. For design process, participants with collaborative work designed 3D environments with a problem-based learning approach. The design process of 3D MUVEs was realized with the participation of researchers as trainers, guides, technical support personnel, and observers during the 16 weeks within the scope of the course. Also, participants were involved in the role of both learner and instructional designer.

INTRODUCTION

The environment can be defined as the space units of living beings that are connected and influenced by vital bonds, as the habitat of the living creatures/creature's community, and in short, it can be defined as all of the external factors that affect the living creatures (Atasoy, 2006). Based on this context; air, water, soil, vegetation, animals and everything else on or off the Earth is included in the concept of environment (Atik, Öztekin, & Erkoç, 2010).

Individuals in society interfere with their environment to survive and influence their environment through various activities. The following can be given as examples of today's environmental problems: rapid population growth, uncontrolled urbanization, industrialization, air pollution in cities and pollution in water, global warming and a decrease in biological diversity (Kocataş, 2006). The existence of human beings depends on both acting by the ecosystem they live in as well as helping to protect the balance and biodiversity (Atasoy, 2006). The destruction of biological diversity, a strategic asset that humanity has but cannot fully realize its importance, will be the major cause of worldwide poverty. For this reason, biodiversity constitutes one of the most important parts of the world heritage (Çepni, 2005).

The aim of the biodiversity training in environmental education aims to raise awareness of individuals about the importance of biological diversity and to provide them with the responsibility and competence to protect biological diversity. However, since environmental education in Turkey is made up of biology courses that students take until they graduate from high school, these courses are insufficient for effective environmental education. Since students study by memorizing the information given in the courses for the exam, this information cannot provide the desired behavioral change in the individual (Özcan, 2003). For this reason, it is possible for the students to know about the local species by observing the plants and animals directly through the education of biodiversity, i.e. through an effective training process (Lindemann-Matthies, 2002; Şahin, 2018). At this point, pre-service teachers have great responsibilities as future teachers. In this context, it is very important to determine the perceptions of pre-service teachers in the preparation of the course content that meets the expectations of environmental education (Özmen & Özdemir, 2016).

The convention on biological diversity, which is a vital issue, and the protection of this diversity is under human responsibility, but the future generation is not sufficiently level of direct interaction with nature and its concerns about the future include the reduction of biodiversity (Bergseng & Vatn, 2009; Şenel, 2015). Therefore, biodiversity education, which is a subject of environmental education, is one of the most important issues within the conceptual framework of biology education (Mercan & Köseoğlu, 2019).

Integrating technology into the field of education has increased the use of technological resources in learning environments. One of them is three-dimensional (3D) virtual applications. In the 21st century, 3d technology, which is popular all over the world, affects educational technologies to a great extent. Three-dimensional virtual worlds with a convenient interface are accessible environments where online users log on with the help of a virtual character (avatars). In these environments, users can communicate with each other through audio or instant messaging tools and with authentic content. 3d virtual worlds also provide users with socialization, research and learning environments (Güler, 2014). In particular, three-dimensional multi-user virtual environments (3d Muves) can be used to reveal the effect of spatial perception. In these environments, individuals can move around with avatars that represent themselves in the authentic world. Besides, these environments consist of many places or sub-worlds where users can walk and communicate with each other in 3d Muves (Campbell, Wang, Hsu, Duffy, & Wolf, 2010).

Student-centered teaching approaches are important in these environments where students are not only active but also play a role (Dillenbourg, Schneider & Synteta, 2002). In these environments, teaching and environment designs should be conducted according to these approaches. Scenario-based, event-driven, and problem-based approaches offer learners many advantages in 3d Muves. One of these approaches is problem-based learning and student-centered activities within the framework of an authentic problem, the interaction of small groups and also the teacher is a guide in this process (Barrows, 1986). This approach enables effective use of 3d Muves. However, in the study of Duncan, Miller and Jiang (2012), in which they examined the use of virtual worlds in education, it is stated that these environments are mostly used for cooperative learning. Studies conducted on problem-based learning (PBL), didactic learning, and interactive learning are relatively rare. Also, it is observed that it is not sufficiently focused on how to design 3d Muves based on the problem in the field (Işık et al., 2008; Tokel & Cevizci-Karataş, 2013). Based on this information, it is aimed to develop a learning environment using 3d Muves to enable pre-service teachers to recognize the trees around them and to create awareness of tree species.

The Aim and Importance of the Study

3d virtual worlds, which have become widespread in recent years, provide both educators and students with opportunities such as navigating in a virtual environment, representing themselves with avatars, communicating by voice or text while in different places and interacting with 3d objects present in the environment. In these environments, educators can design interactive environments related to the subject and content they want, and students can access these virtual content simultaneously and get miscellaneous feedback. Thanks to their flexible structure, virtual worlds become attractive as an educational environment and can be used for many different disciplines and subject areas. New 3d technologies emerge every day, offering a variety of opportunities for traditional and distance education. With these opportunities, it is predicted that 3d virtual worlds will have an immense impact on education in the future and will be used more widely (Dillenbourg et al., 2002; Tokel & Cevizci-Karataş, 2013).

3d Muves can create effective learning environments for all disciplines. This study, which integrates environmental education and technology, has an interdisciplinary approach. In this study, it is aimed to bring users together with nature and provide them a positive learning environment in a 3d virtual context to teach tree species. Three-dimensional applications increase the motivation of users, providing the opportunity to learn by living and facilitate the establishment of effective communication. In this respect, 3d applications are distinguished from other learning environments. Therefore, the study aims to provide pre-service teachers with the opportunity to learn the tree species. For this purpose, 3d Muves were designed by participants who are students at the Department of Computer Education and Instructional Technology in the Faculty of Education at a large state university in Ankara, Turkey. Target audience of designs is pre-service teachers. Also, this research aims to design a problem-based learning environment that addresses the familiarization of the nearby trees using the OpenSimulator (OpenSim) application platform from 3d virtual environments. OpenSim is among the most important 3d open-source application that supports virtual learning and provides learning environments. OpenSim ensures a 3d interface that allows users to access and design these environments from anywhere via 3rd party viewers such as FireStorm. It also enables customization of virtual worlds created by users and provides server services under the control of researchers and users with open source code support. OpenSim was preferred in the research because of these features. Depending on the purpose of the scenario, designs were implemented to provide users an immersive environment. To realize the purpose of the research,

photographs of trees that users can see most in their surroundings were taken by experts through their field trips. Selected tree species were limited to 24 trees.

Another aim of the implementation is to emphasize the concept of biodiversity and lake and forest ecosystems have been added to the platform in this direction. Human beings must continue to exist and act by the ecosystem they live in to help protect the balance and biodiversity (Külköylüoğlu, 2009). The destruction of Biological Diversity, a strategic asset that humanity has but cannot fully reach its significance, will be the major cause of worldwide poverty. For this reason, biodiversity constitutes one of the most important parts of the World Heritage (Çepni, 2005). Furthermore, it is thought that tree awareness will provide a more effective learning for users. In a 3d muve where technology and education are integrated, it might provide permanent learning for users.

BACKGROUND

The focus of this part of the chapter is the literature review about biodiversity and environmental awareness and three-dimensional multi-user virtual environments (3D MUVEs). Moreover, 3D MUVEs design process and problem-based learning are the other important foci of this chapter.

Biodiversity and Environmental Awareness

Biodiversity is the differentiation between land, sea and other water ecosystems and living organisms in all sources, including ecological structures that are part of these ecosystems. In other words, it is a living nature. Biodiversity is the foundation of living resources, which has an indispensable place for meeting the basic needs of people, especially food, and has vital importance for people like the chemical structure of the atmosphere and the climate of the world. In addition, it provides services that can only be provided by the continuity of healthy and complex ecosystems. Half of the drugs used in medicine are derived from living creatures and relatives of wild animals. Today, wild species are used to obtain new varieties of agricultural products or to improve existing ones according to the needs of people. Ecosystems also gained importance as a result of the interaction of living and non-living creatures with each other and within themselves to maintain the existence of wild species, evolve, diversify and gain new genetic features. Furthermore, it is complex depending on the environmental conditions and has acquired different structures and functions, each of which is different from the other. The integrity and diversity of ecosystems are important in maintaining natural balances, such as climate, rainfall regime, and species sociology (Ekim, 2005; Elçin, Erkoç, Öztekin, Atik, Sarıkaya, & Selvi, 2010).

Today, living resources, which are important for food and agriculture and are increasingly decreasing, are among the most important advantages a country can have. Agricultural areas and water resources of the world can be quickly polluted and destroyed. Scientists believe that people will face serious food and water problems soon. In light of these developments, the biological diversity of countries is becoming a major challenge, especially in terms of genetic resources, because wild living resources are used for the development of varieties that are resistant to environmental pressures (Erten, 2004).

Turkey is a rich country in terms of biodiversity due to its geographical location in Asia and Europe, topographic structure and climate effects in the regions. Also, the number of endemic species is quite high in Turkey. As a result of the studies, over 3.000 plant species from about 12.000 plant species in Turkey flora are endemic. It is also estimated that there are about 80.000 animal species in the Turkish

flora and three of the 34 global high diversity points (Mediterranean, Caucasus & Iran-Anatolia) in Turkey. Despite the history of Turkey's intense natural resource exploitation and human land use over 10.000 years, it has rich biodiversity heritage as a center of genetic diversity. Since biodiversity has an important cultural and commercial value for approximately 20 million rural people in Turkey, conservation of this heritage also requires a great responsibility (Şekercioğlu et al., 2011; Şenel, 2015).

According to the 2050 Organization for Economic Co-operation and Development (OECD) environment prediction report, forests rich in biodiversity in Turkey will be reduced as a result of the expansion of commercial forestry activities and human interventions (OECD Environmental Outlook to 2050, 2012). It is a matter of vital importance that Biological Diversity and conservation of this diversity are under human responsibility, but the lack of direct interaction with nature of the future generations is likely to diminish biodiversity (Bergseng & Vatn, 2009; Şenel, 2015).

It has great importance to cooperate with the people of the region to ensure the effective implementation of the management and conservation of a field in terms of biodiversity. Teachers working in the region play a major role in protecting the existing resources of the people of the region and ensuring that the students have environmental awareness. For this reason, the teachers working in rural areas are informed about biodiversity recognition and protection. Teachers are important keys in achieving the objectives set out in the development plans that are targeted to provide information about biodiversity with well-planned environmental education (Erten, 2004; Şenel, 2015).

The biodiversity training in environmental education aims to raise awareness of individuals about the importance of biological diversity and to provide them with the responsibility and competence to protect biological diversity. However, since environmental education in Turkey consists of biology courses that students take until they graduate high school, these courses are insufficient for effective environmental education. Since the information provided in the lessons are based on memorization of the test, this information does not provide the desired change in behavior in the individual (Özcan, 2003). For this reason, the students can know about the local species by observing the plants and animals directly through the education of biodiversity, i.e. through an effective training process. This can be achieved through educational environments in which students can examine the interactions between nature and living creatures and their interactions (Lindemann-Matthies, 2002; Özmen & Özdemir, 2016).

Three-Dimensional Multi-User Virtual Environments (3D MUVEs) and Design Process

In recent years, the rapidly expanding three-dimensional (3D) virtual worlds offer both educators and students the opportunity to navigate in virtual environments, communicate with sound or instant messaging tools with other users in different locations, represent themselves with avatars, and interact with 3d objects in these environments (Doğan & Tüzün, 2017). There are many different 3d virtual world platform examples used and the number of users is increasing exponentially since the 2000s. Today, there are some popular applications such as SecondLife, OpenSimulator (OpenSim), Active Worlds and Instant Messaging Virtual Universe (IMVU). These 3d virtual platforms provide users content creation tools (3d object libraries and modeling tools, etc.), communication tools (instant messaging, audio, video conference), customization tools (avatar library and object movements, etc.) and resource tools (Web page integration) (Dickey, 2005). Users have access to these 3d virtual platforms easily although some platforms are accessible to only specific users. However, it is seen that the SecondLife platform is preferred in studies because technical infrastructure is provided. However, due to the increase in the

use of open-source software in recent years, it is striking that different virtual world platforms are being developed (Kapp & O'Driscoll, 2010).

The most prominent features of these environments include the advanced user representation of avatars; 3d interface, permanent design, imaginative/immersive media, multichannel communication and socialization, rich interaction, presence perception and user engagement (Dalgarno & Lee, 2010; Warburton, 2009). It is stated that effective learning environments can be created in spite of the features it carries, although it used to create fantastic environments based on the power of games, entertainment, and imagination. Thus, it is emphasized that it has the potential to increase user engagement and facilitate learning through more visual and realistic experiences. For this reason, it has attracted the attention of educational researchers by separating from other environments and in recent years it has become widespread in education environments for various purposes (Dalgarno & Lee, 2010; Dickey, 2005; Warburton, 2009).

By combining educational needs and user experience, learning content can be made more interesting by incorporating entertainment factor into 3d virtual worlds offering alternative learning platforms that users can be actively involved. In this respect, it not only provides users with a real representation but also invites them to participate actively in role-playing activities by inviting them as a player to the variable learning activities that require effort. This allows users to perceive activities as a game and enjoy them, and helps to make learning easier (Minocha & Reeves, 2010; Xu, Park & Baek, 2011).

3d virtual worlds provide a high interactive framework for appropriate behavior and learning, enabling effective environments in social interaction with individuals in remote locations and various branches. It enables users in different locations to communicate. These users communicate and express their feelings and movements through the help of a voice and instant messaging, thus enabling them to perceive the environment as authentic world and engage in this experience (Masters & Gregory, 2010; Bouta, Retalis, & Paraskeva, 2012). Therefore, due to cost, time and physical distance/geographical limitation, it also helps to eliminate problems in collaborative work. Also, scenario-based 3d environments can contribute positively to their motivation and occupation to encourage individuals to learn life-long and can increase their ability to transfer academic knowledge to the authentic world (Nelson, 2007).

Studies have shown promising results that are used to support learning in these environments, and 3d Muves that is known as a new learning platform has emerged. The 3d Muves have the potential to provide individuals gain with more meaningful and long-lasting information than traditional interactive multimedia environments (Tüzün & Özdinç, 2016). There are a large number of studies in these environments in the literature and the potential and possible contributions of 3D virtual environments to education are emphasized (Dalgarno & Lee, 2010; Gregory et al., 2015; Helmer & Light, 2007; Perera, Allison, & Miller, 2012; Warburton, 2009). Educational contributions of 3d virtual worlds are listed below (Doğan, Çınar & Tüzün, 2018):

It provides social interactions and collaborations via text, VOIP (voice over IP), or some animation movements.
It provides open-source environments.
It offers active participation or learning by doing via authentic learning activities.
It influences learner engagement, motivation, collaboration, and communication.
It offers new opportunities for creativity in learning such as roleplaying mentoring.
It offers the opportunity to do things that cannot be done easily in the authentic world by embedding simulations

It provides customized environments.
It ensures broader capabilities for learner-centered activity as well as problem-based and exploratory learning.
It provides remote access.
It allows the creation of a parallel world without limits to creativity and possibilities.

In addition to the educational potential of 3d virtual worlds, there are some problems and limitations encountered in these environments. New technology must be adopted by users. However, factors such as users' perspective on technology, social norms, and cultural differences can affect the technology acceptance process. Also, the design and implementation of such environments involves a long and comprehensive process (Gregory et al., 2015; Warburton, 2009).

3d virtual world platforms are used for different purposes in various subjects in many branches of the world. These include military, health, engineering, science, space sciences, history, geography, sociology, psychology, fine arts, advertising, marketing and education (Hew & Cheung, 2010). There are a large number of examples of educational studies and usage, where different variables are examined in the field of literature, taking into account the strengths and weaknesses of these environments as stated in educational terms. For example, one of the largest projects with OpenSim is completed by The National Aeronautics and Space Administration (NASA) between 2014 and 2017. The project is called Virtual Missions and Exoplanets (vMAX). This projects' target audience was middle school students and educators. Its' aim was to create a wide NASA resource to engage students, educators, and the public in the search for worlds beyond Earth (Doğan et al., 2018).

Thanks to the ability to bring together users from different locations of 3d virtual worlds, many universities around the world have developed virtual campuses and started to support educational processes with these environments through distance education (Bulu & İşler, 2011; Minocha & Reeves, 2010). As an example of virtual campuses established in 3d virtual worlds; Stanford, University of Texas and in Turkey, Middle East Technical University's virtual campus.

Considering the learning environments based on problems and scenarios established in 3d virtual worlds, the followings can be given as an example; the field of education (Cheryan, Meltzoff & Kim, 2011; Rappa, Yip, & Baey, 2009; Verhagen, Feldberg, van den Hooff, Meents & Merikivi, 2012), and health (Loke, Blyth, & Swan, 2012; Puterbaugh, Shannon & Gorton, 2010). Moreover, there are also environments in which real-life spaces are simulated and presented in 3d virtual worlds called spatial simulations. 3d virtual worlds are also effectively used to promote different tourist destinations. In these environments, users can navigate and experience real-life locations in 3d simulated ways (Lindgren, 2012).

Lots of 3d virtual worlds support social interaction. The following can be given as an example of the social impact in 3d virtual worlds, health (Puterbaugh et al., 2010), library (Cote, Kraemer, Nahl, & Ashford, 2012) and tourism (Denizci-Guillet & Penfold, 2013). It is observed that these practice examples are used to increase communication between individuals in professional groups. The technological and educational features of 3d virtual worlds always provide a learning environment that teachers do not need to be present. Thus, users are allowed to discover and learn (Ibáñez et al., 2011).

To use 3d virtual worlds in the field of education, these platforms must be ready for use without any design and usability problems. In particular, the visualization of 3d objects and the graphics card features used in the process of loading and Internet bandwidth plays an active role. In some applications where these environments are used, students often encounter problems with the Internet connection, graphics card, sound problems and the inability to load objects in a 3d environment (Bulu & İşler, 2011;

Warburton, 2009). Besides, such environments are 3d platforms based on a client-server connection. For example, users' access rights on the server belonging to the SecondLife virtual world platform are restricted by system administrators. In other words, although users can connect to the system server, they cannot make any changes to the server. However, on platforms with open-source code structure, such as OpenSim, users can create their servers. Moreover, they can create as many design areas as they want without paying a fee and control the design elements they create in these areas anyway they want (Doğan, 2019). In this context, like OpenSim with open-source code structure, the server infrastructure to be used in 3d virtual world platforms must be carefully selected. Besides, given the technical details mentioned on the OpenSim web site, the operating system feature of the platform must be taken into consideration for the user to have access to the virtual world platform and server. Also, it is emphasized that additional adjustments should be made, such as firewall and port configuration (OpenSim, 2015).

Problem-Based Learning (PBL) in 3D MUVEs

Problem-based learning (PBL) refers to different learning approaches in the normal context. However, in the literature, projects related to 3d Muves are characterized by both problem-based and questioning approaches. The reason is, virtual worlds are suitable for the presentation of problems from real life due to their structure. Besides, it is a structure that requires the student to perform a self-inquiry to attract the attention of the student with mysterious elements. Students can access hidden information through interactive objects in the virtual world. With the teleportation feature, they can switch to different areas, communicate their solutions to the teacher with communication tools or share them with their friends. Therefore, virtual worlds contribute positively to high-level thinking skills such as questioning, problem-solving and metacognition (Ketelhut, 2007; Pellas, 2014).

Pbl approaches are frequently used to give virtual worlds a sense of play. Interrogative learning is a type of skill that a person can gain in time and cannot learn directly, such as asking questions and setting up a hypothesis (Ketelhut, Nelson, Clarke, & Dede, 2010). Implementation of this learning approach can be quite easy in virtual worlds.

One of the best examples of the problem-based learning approach is the Quest Atlantis project, where life-based learning and portfolio evaluation approaches are used together. This project aims to develop children's awareness of social situations such as soil, air and water pollution, environmental events, racism, and personal rights to improve social responsibility awareness (Barab, Thomas, Dodge, Carteaux, & Tüzün, 2005). The virtual part allows students to navigate through avatars, interact with various objects and avatars. Students can ask questions in the message section for ready guides (avatars) and other students. The information that the student should collect in the web browser is given in textual form. The most important task of the web browser is to provide information about the student's performance and to allow the environment to return to a real playground. This field also serves as a task to show all the information of the students, i.e. the things they have collected, messages, friends, etc., all together. In the webspace, there is also a star symbol consisting of 8 quadrangular slices and student aims to illuminate all slices. When all the island tasks are finished, 8 slices are illuminated. Thus, the environment has been given a game feature. Students are expected to solve some ill-structured problems in islands developed for each theme (each social situation). Every event that needs to be resolved is realistically at the entrance of the island. Students gather clues on the island and write their own opinions on the solution of the problem and send them to their teachers. So, this process is not automatically controlled by the teacher. Thus, the environment provides the opportunity to evaluate a portfolio. On the other hand, both the web

environment and some elements in the authentic world have been utilized to enable the environment to play feature, which is an important feature for the students to be motivated to use the environment.

Another example of the virtual world that applies an interrogator and problem-based approach is River City, which is built on the Active Worlds platform (Ketelhut, 2007). In this project, students are asked to solve epidemic diseases in a city called River City. Thus, it is aimed to increase the scientific inquiry skills in students. In this environment, students solve the problems by navigating and communicating with other students by collecting digital materials. Children gain an investigative learning experience through guides that provide little clues when they need help. Students can observe authentic simulations and interactive objects on River City Island. In addition, they can ask questions to guides who do not represent real people in the environment, examine books and other sources of information in the environment, use tools to collect and analyze data, conduct experiments, plan a research process with a scientific approach, report their answers to research, and present them orally in their classrooms. Studies have shown that students have positive developments in terms of scientific inquiry skills, learning of concepts related to biology and scientific thinking skills (Keteulhut, 2007; Ketelhut et al., 2010). Also, in the affective sense, more participation was observed in students.

Quest Atlantis and river city projects were successful in creating an appealing environment in a 3d virtual environment. On the other hand, an authentic environment is needed for students to evaluate their performance and get feedback. This indicates that the virtual world and the authentic world should be designed together for all other learning approaches.

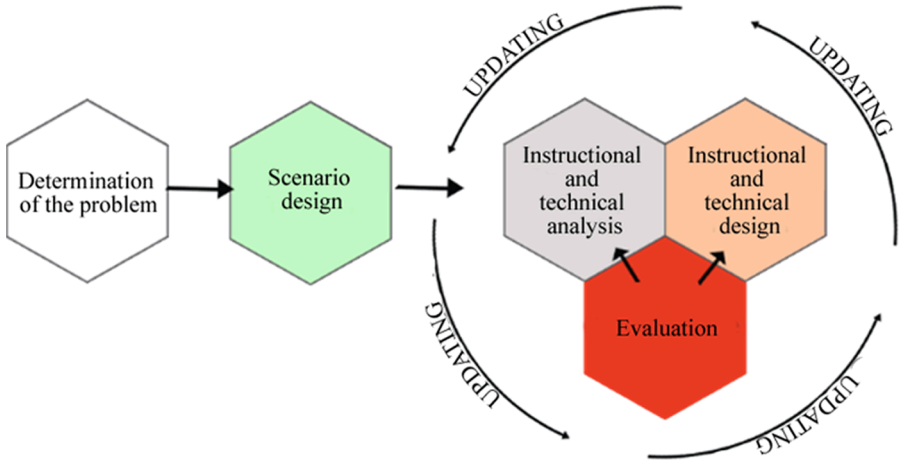
INSTRUCTIONAL DESIGN PROCESS IN THREE-DIMENSIONAL MULTI-USER VIRTUAL ENVIRONMENTS (3D MUVEs) BASED ON PROBLEM-BASED LEARNING APPROACH TO TEACH TREE SPECIES

In this study, it is aimed to design a three-dimensional multi-user virtual environments (3D MUVEs) to teach tree species to pre-service teachers within the framework of Instructional design process in three-dimensional multi-user virtual environments based on problem-based learning approach developed by Doğan (2019) to pursue an appropriate strategy for 3d Muves development process. According to this model, there are 6 stages. These stages include determination of the problem situation, scenario design, instructional and technical analysis, instructional and technical design, evaluation and updating (Figure 1).

Design Groups

The design groups are 3rd grade undergraduate students (N=21), who were taking the course Innovative Technologies and Applications and who took the Instructional Design course in previous years, from the Department of Computer Education and Instructional Technology, Faculty of Education at a large state university in Ankara, Turkey in the 2018-2019 academic year. A total of 21 students participated in the study and 11 of them were female (52%) and 10 of them were male (48%). The students participated in the study voluntarily and signed the research volunteer participation form. A total of 4 design groups were created. Two of them had 5 group members. Others had 6 group members. When determining the design groups, participants' programming, instructional design knowledge, and gender were taken into consideration.

Figure 1. Instructional design model in three-dimensional multi-user virtual environments based on problem-based learning approach (Doğan, 2019)



Design Environment of the Three-Dimensional Multi-User Virtual Environments (3D MUVEs)

OpenSimulator (OpenSim) was chosen among three-dimensional multi-user virtual environments (3D MUVEs) platforms during the design process of the research. The reason why this application is chosen is that the application supports individual and multi-user. Besides, it provides opportunities for all kinds of interventions and arrangements. To encourage the collaborative work of the participants who took the course for the application environment of the research, necessary technical adjustments were made to access the server by installing the OpenSim application on a server that can be accessed 24/7 by the researchers. Also, participants used FireStorm as a 3d viewer.

Design Process

The design process of the study was carried out in the computer laboratory of the department where there are 40 computers with 21 participants who took the Innovative Technologies and Applications course voluntarily. 3d Muves were designed for 8 weeks within the scope of the Innovative Technologies and Applications course. The design process of the study was realized with the participation of researchers as trainer, guide, technical support and observer during the 16 weeks within the scope of the course. During the design process, the participants were involved in the role of both learner and instructional designer. Furthermore, the participants also played different roles in design groups such as animation and visual design experts, software experts, assessment and evaluation experts, etc. Before starting the 3D MUVEs design process on the server, the design groups were given an 8-week training on 3D environment design by the researcher. According to training, 3D viewer interface was introduced and preparation of interaction via programming, animation, using media tools (web-pages, audio, video, etc.), Non-Player Characters (NPC), HUD (Heads-Up Display) menu were taught.

In the first week of the design process, the participants were asked to produce problem-based learning scenarios to be created in 3D MUVEs for the protection of tree species within the concept of biodiversity, which is a vital subject of the research. In this context, the participants were presented with sample scenarios created with 3D MUVEs. Design groups presented their scenarios. Also, each design group has found their group name according to their scenario. Researchers made brainstorming by giving feedback to the groups. One of the scenario sample is given in Figure 2. According to this scenario, there is a character called Maple. Maple is a senior at Yggdrasil Ent Academy. There is a thing he needs to do to become a tree protector after he graduates. He must recognize a forest. During the mission, he must perform the required tasks. A total of 15 quests in the forest await him. If he completed all of the quests, he will desire his Ent diploma.

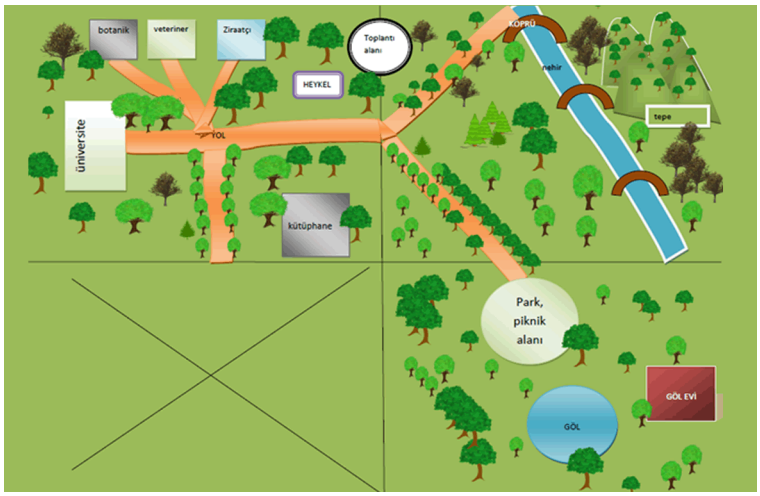
After the scenarios were created in detail, the design groups drew out the draft views of the 3d environment (Figure 3). The drawings on paper or computer help the designers to know what to do and where to start the design before starting the design of the environment. Also, it facilitates group works and collaboration process.

A total of 24 photographs of trees (remote view, leaf, trunk, and fruit, if any) that are covered within the scope of the study were given to the students to be designed. The types of trees covered in the research are; Cupressus, Willow, Chestnut, Sweetgum, Juniper, Northern Hackberry, Ladin, Lime, Hornbeam, Poplar, Larch, Calabrian Pine, Elaeagnus, Yew, Birch, Oak, Scotch Fir, Ash Tree, Deodar, Fir, Mountain alder. Trees were divided into 4 groups and each group was given 6 trees. In this way, it helped the participants to decrease the workload and progress the process faster. Photographs of trees that users can see most in their surroundings were taken by experts who take photographs from the land trips of Necati Güvenç Mamikoğlu. Trees model sample in the authentic world and 3d virtual world is shown in Figure 4.

The participants came together face-to-face with the group members and developed their designs weekly. They also work with group members on the server during 7/24. To facilitate the work of the design groups, ready-to-use object libraries were added to the environment. Within the scope of the

Figure 2. Sample of scenario

Figure 3. Example of participants' drafting work on computer



course, the students brainstormed each week with the researchers and the necessary feedback was given during the whole design process (Figure 5).

During the design process, participants prepared 3d environments with learning activities and quests according to their scenarios on 3d multi-user virtual environment (Figure 6). They modeled 3d objects (house, tree, etc.) and loaded these models to OpenSim via 3d viewer. They created animation, HUD Menu and Non-Player Characters for interaction with 3d objects. Also, they create educational content (audio, video, web page, text, photos, etc.). In addition, they used environment-specific programming language LSL (Linden Script Language) to increase interactions with objects. The designers produced different content according to the quests.

Figure 4. Sample of 3d trees designed by groups

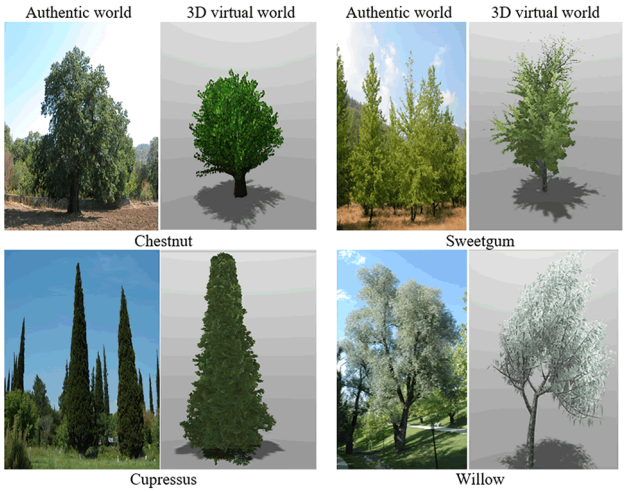
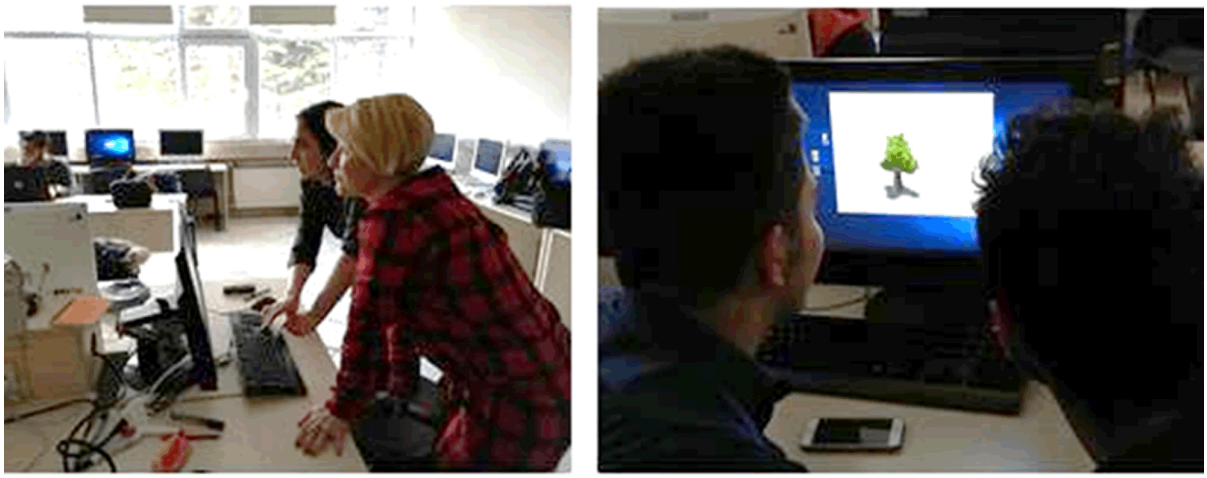


Figure 5. Participants and field experts in the design development process of the research



CONCLUSION AND RECOMMENDATIONS

Use of three-dimensional (3D) virtual worlds for educational purposes and research is increasing day by day. In virtual worlds where physical boundaries have been removed, new opportunities for global cooperation and distance education can be offered to provide equal opportunities in education. In this way, 3d virtual environments can be created in various branches where authentic and virtual environments combine. Although 3d virtual worlds have powerful features and opportunities, such as every new

Figure 6. Sample of 3d Muves design during design process

emerging technology, these environments have some weaknesses and obstacles that can be encountered. For example; users who have an account on a virtual world platform cannot be found in another virtual world with the avatar they have created because they need to create a different identity for each virtual world. For this reason, communication between the rapidly growing platforms becomes difficult. Besides, since the development and implementation stages of these environments are long and comprehensive, they should be designed in a meaningful way according to their educational purposes. So, it is important to research different application areas. The features of 3d virtual environments allow the user to discover places of interest for self-learning and to interact with objects. However, there may be problems in applications in these environments where control is left to the user. In addition, due to negative elements such as entering inappropriate dialogs with instant messaging tools, the user's problems of not being able to fulfill the task of learning, distraction, and abandonment of learning environment can be experienced. At this point, it is stated that guidance to the user is important. Furthermore, in 3d virtual learning environments, it is possible to see the different applications of guidance. However, it was determined that the teacher who has an important role in the learning process has a lack of guide role in a 3d virtual environment with the representative avatar. Therefore, new studies are needed in this field (Eschenbrenner, Nah & Siau, 2008; Kapp & O'Driscoll, 2010).

In the study, participants in the role of instructor designer in 3d Muves of the participants have assumed different roles as signs of progress in the design process. These roles determined as instructional designer, field specialist, animation and visual design expert, software expert, measurement assessment expert, media producer, etc. (Doğan, 2019). Moreover, designers have undertaken different tasks by preparing content, designing 3d models, preparing scenarios, and conducting research in the process. The designers who had to deal with technical problems in individual studies received help from the researchers as technical support when they started to work in groups.

The participants were given necessary information about the design of the environment during the 16-weeks with implementation and design. The detailed presentation of all the steps in the process of developing a learning environment is important in terms of identifying the mistakes made in the process, identifying the failures and sharing the experiences gained. Thus, more effective learning environments can be developed by preventing this failure and repetition of errors. Technology such as 3d virtual worlds can be carefully designed by taking into account the various dimensions of the interface. In the analysis phase, which is the first step in developing a 3d virtual learning environment, a simple, easy-to-use 3d virtual learning environment can be created by analyzing the needs of the target audience (Akgün, Nuhoğlu, Tüzün, Kaya & Çınar, 2011; Warburton, 2009).

In the design phase, learning approaches should be based on considering that technological tools can meet the need if it is used by integrating pedagogical approaches in the size of teaching design. Also, to make the environment visually more interesting, the principles of multimedia design should be taken into consideration to select the materials suitable for the content type and to ensure interaction in the environment (Doğan, 2019). In the implementation process, the ability to determine the computer skills for the user or the students who will be trained in 3d environments and provide the necessary gains can help the students in pedagogical terms. Besides, pre-information about the 3d platform, preliminary studies in these environments, and identification of possible problems that may arise as a result of these studies can help students from a pedagogical perspective as well. In this context, before performing learning activities in 3d environments, the activities should be structured very well and students' responsibilities and roles should be clearly stated.

In the design of 3d virtual worlds, media, 3d materials, programming languages, user interface, access to 3d environment, design tools in 3d environments are import to develop a 3d virtual world. Therefore, researching these issues before starting 3d environment design will contribute positively to the design and development process. It is important to determine and eliminate the disruptions that can be encountered at all stages of the process of creating a 3d virtual learning environment in order not to have any disruptions at all other stages. Thus, the evaluation must continue throughout the process (Doğan, 2019). In this way, interesting and interactive 3d virtual learning environments can be developed, where pedagogical elements are taken into consideration, which can respond to user needs by giving the environment its final shape.

If such pedagogical obstacles continue in front of 3d virtual environments, it is seen that these environments will not have any educational appeal. Besides, many researchers believe that the positive impact of 3d virtual worlds on learning and teaching is expected to be global; however, because of these problems, the use of 3d virtual environments in education is still limited (Jarmon, Traphagan, Mayrath, & Trivedi, 2009).

Cognitive involvement of individuals with learning environment is related to internal psychological characteristics, so it is difficult to determine the individual's involvement in this direction when dealing with the task. Since there is a similar situation in 3d virtual environments, it is a very difficult process to practice and measure cognitive gains. Therefore, in academic studies, it is thought that determining strategies for the development of 3d virtual environments that meet the minimum requirements for the target acquisition in this direction will be an important step for the future of these environments.

The research, in which environmental education and technology are integrated, has an interdisciplinary approach. Three-dimensional multi-user virtual environments can create effective learning environments for all disciplines. In this study, it is aimed to provide a positive learning environment by bringing users together with nature in a 3d Muves to teach tree species. Three-dimensional applications are separated from other learning environments by increasing the motivation of users because they are prone to learning by living and providing effective communication.

FUTURE RESEARCH DIRECTIONS

This section provides design and research process recommendations for researchers planning to design in three-dimensional multi-user virtual environments (3D MUVEs):

First of all, to achieve the learning outcomes as fast as possible, the 3d virtual learning environment should be designed in such a way that it can attract the attention of the users, optimize their cognitive load, and allow the users to move around and interact without being bored and lost. Therefore, various features of 3d virtual environments should be used and the design should be user-oriented, motion-based and consistent with pedagogical principles.

It is important to create a work schedule to ensure the environment developing process proceeds smoothly, to follow up on the completed phases and to facilitate the determination of the next step. Also, the work schedule allows the detection of points and failures that do not comply with the planning and taking the necessary measures in advance to overcome these difficulties. It is important to get the opinions of the team members in determining the work schedule as this will minimize the disruptions in the process.

The basic information to be taught on the subject to be designed should be determined in consultation with the subject area experts. It should also be determined in which order users can learn content more easily. The 5E rule (Engage, Explore, Explain, Elaborate, Evaluate) should be considered in this process and detailed information about the content should be acquired. In this context, effective planning of the learning environment can eliminate all the problems that may occur in the learning process. Thus, the learning process can be made more effective and meaningful learning can be provided for the students.

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KEY TERMS AND DEFINITIONS

Biodiversity: It is the differentiation between land, sea and other water ecosystems and living organisms in all sources, including ecological structures that are part of these ecosystems.

Biodiversity Training: It raises awareness of individuals about the importance of biological diversity and provides them with the responsibility and competence to protect biological diversity.

Environment: All of the external factors that affect living creatures.

OpenSimulator (OpenSim): It is a platform with a 3D interface that allows users to access and design these environments from anywhere.

Problem-Based Learning: It is student-centered activities within the framework of an authentic problem, the interaction of small groups, and also the teacher is a guide in this process.

Three-Dimensional (3D) Virtual Worlds: It is a highly interactive framework for appropriate behavior and learning, enabling effective environments in social interaction with individuals in remote locations and various branches.