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Exploring the potential uses of computer games in landscape architecture education

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Abstract:
Serious gaming approach and related researches shows that motivational and instructional features make computer games promising educational tools. With the pioneer of educational institutes, many researchers have focused in this potential use of computer games in learning. Even major of them have been seeking answers for educationally beneficial factors of computer games, some researchers have developed educational games in specific learning topics. This study aims to introduce serious game approach and its foundations like digital game-based learning. Additionally, an experimental study was conducted to explore potential uses of computer games in landscape education. In order to this study, a commercial computer game has been played by undergraduate landscape architecture students.

Keywords: *Landscape education, serious games.*

1. Introduction

"All work and no play makes Jack a dull boy" – An English proverb

"Today's students are no longer the people our educational system was designed to teach" (Prensky 2001). Therefore, Prensky calls this generation as "*Digital Natives"* (2001). *Digital natives* born in a time in which technology developed rapidly and they have grown up with technologies such as computers, Internet, mobile devices, computer games instead of their teachers, watching TV broadcasts, reading books, and going to theaters. They are comfortable making a video call with someone or searching something by pressing on the screen. These are what we have seen at science fiction films from the beginning of 1900s. "*Digital natives"* are not wondering about opening time of video rental shop to watch movies, they can watch via streaming from Internet. They prefer to announce their relationships from social networks instead of mailing their wedding invitations. They live in an accord with all of these technologies. As all of these new habits show us, the rapid development in technology have changed the new generation permanently, and they are happy about that. Prensky (2001) explains these changes with these words:

> *"Digital Natives are used to receiving information really fast. They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite. They prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards. They prefer games to "serious" work. (Does any of sound familiar?)"*

In other words, he points out that they are not excited with existing teaching methods that are not motivating or engaging. They want to be decision-maker on learning content and to be captured in a virtual environment that acknowledges with rewards. They like learning by creating links within information. Even though "they have little patience for slide-by-slide lectures and *tell-test instructions* because *they are not paying attention everything else they experience"* (Prensky 2001b), they are able to play video games in a concentrated focus for achieving goals and overcoming their failures. *Practicing* has an important role in active learning. As it was defined in *learning pyramid* of National Training Laboratories, "practice doing" has 75% retention rate (Lalley Miller 2007). That's why; they prefer video games even when they spend much more time than learning to solve artificial problems. Because video games are depicting virtual worlds, where everything has been created for these worlds. This world assigns them bulks of challenging work, which they need to overcome successfully. In this challenging problem-solving phase, they are experiencing the how-to-do process and are learning by doing these tasks. According to Prensky (2003), computer and video games teach players "to take in information from many sources and make decisions quickly, to deduce a game's rules from playing rather than by being told, to create strategies for overcoming obstacles, to understand complex system through experimentation". Jane McGonigal extended our understanding with her presentation in TED Conference series (McGonigal 2010). She explained that why gaming is significant for new education era and how we can use this great opportunity for "serious "purposes. In her presentation, she mentioned that how much time spending on game playing globally. A study (in Prensky 2001c) shows that brain reorganization can be possible if it is supported by deep focus and hard work, which requires "spending 100 minutes a day, 5 days a week and, for 5 to 10 weeks", that only video games may take up required attention in order to spend this amount of time.

This paper focuses on uses of video games in learning environments and outlines serious gaming approach including related issues. Moreover, this paper also brings serious game examples developed with ecological, sustainable and landscape design purposes which are part of landscape architecture education. In addition, this research also aims to find out useful ingredients of commercial video games for landscape architecture education.

Serious gaming approach is not a new invention. It has been built on substantial topics like e-learning, "edutainment", and digital game-based learning. Understanding serious gaming requires knowledge of the basics about these approaches. "E-learning" has a general meaning that includes distance learning, computer-based learning, web-based learning and training. "Edutainment" has a meaning which combines education (edu-) and entertainment (-tainment) words. Briefly, it means adding fun inside education to make it more interesting. Susi defines "edutainment" as "any kind of education that also entertains even though it is usually associated

with video games with educational aims*"* (2007). Also, it mainly focuses on elementary school education and aims to teach studies like mathematics and science. We also encounter similar (gam-ified) applications in higher education levels. Digital game-based learning (DGBL) approach has derived from game-based learning. It concerns engaging learning by using digital game softwares and presenting these aforementioned digital game softwares. Digital game-based learning approach has been handled by researchers from educational institutions like Jenkins, Prensky, Gee, Squire, Kafai, Steinkuehler and many others not mentioned at here. Their works have inspired researchers and educators to apply this methodology to their disciplines to make learning more enjoyable and effective at the same time. Their argument is that traditional educational system is not compelling and engaging enough for the new generation who are raised with movies and interactive softwares instead of books and audio tapes. They pursue information on search engines or just clicked on the link when they are interested in something instead of waiting for the next morning to go the library. Additionally, they tend to explore instead of research. They prefer to "downloading" instead of buying, "blogging" to writing, "googling" to searching. It is easy to understand, *Digital Natives* (Prensky 2001) have a different language from which is used in the traditional education system. For these reasons, they also have same expectations from learning. Serious gaming approach has been defined by many researchers from different majorities to draw a line between serious and other games (Prensky 2001, Susi 2007, Zyda 2005, and Van Eck 2006). According to Zyda (2005) serious game is "a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives". Susi (2007) defines serious games more capable as described below:

> *"The application of gaming technology, process, and design to the solution of problems faced by businesses and other organizations. Serious games promote the transfer and cross fertilization of game development knowledge and techniques in traditionally non-game markets such as training, product design, sales, marketing, etc."*

In spite of its historical origins, serious game movement has started with the release of the video game *America's Army* in 2002 by U.S. Army for military training purposes and became more prevalent after the foundation of *Serious Games Initiative* by Woodrow Wilson Center for International Scholar in Washington (Susi 2007). Google search results about "serious games" shows that serious gaming is becoming more popular each day. Serious gaming is more than 250 times more popular than 6 years ago. Growing interest in serious gaming can be observed from the search results. While 1.1 million results (Susi 2007) were rendered in 2007, in 2013 it is about 293 million [2013-10-13]. Green and Bavelier (2003) deducted that video games have high potential for improving perceptual and motor skills. They made a series of experiments, which measure cognitive and perceptual skills on video game players and non-players, aged between 18 and 23 years. After these tests, they underwent training for 1 hour per day for 10 days with one of two possible kinds of video games and they were retested again. Results showed that subjects who played action video games have improved their performance after training (Green and Bavelier, 2003). Bavelier also has presented this research on TED Conference Series.

Prensky (2001) suggests inventing computer games to teach students "by adapting existing learning materials to the language of *Digital Natives* with their language". Therefore, he headed for creating an educational video game named "Dr. Monkey Wrench Conspiracy" which was developed to teach the use computer aided design (CAD) software to engineer students. To achieve this goal, game has a well-designed scenario that is about saving a space station from attack of an evil professor. In the beginning of the game, player does not have any tool except a drawing board. Player can create his own tools and fix weapons by drawing it completely from scratch. Kurt Squire has used Civilization III computer game to engage students in learning world history. Civilization III game is an "historical simulation" (Squire, 2004) which allows players to settle up from ancient times up to near future. This study aims to allow students to learn world history including geography, economics, technology development, power dynamics, and etc. through playing the game. In this study, authors have observed accelerated learning through game play in comparison to reading.

Serious Games Institute has been established in 2007 at Coventry University (Url-8). Institute offers Master of Science (MSc) and Doctor of Philosophy degrees for students which pursue game sciences, semantic web game environments, learning design, digital games and serious gaming subjects. *Massachusetts Institute of Technology* (MIT) *Game Lab* explores the potential of play in realms like entertainment, education, art, and science to develop video games that demonstrate and conduct research (Url-12). In addition, they are collaborating with an education program, called *MIT Education Arcade* (Url-7), in order to explore meaningful and transformative experiences through game play. *The Center for Game Science* has been founded at the University of Washington (Url-9). The program focuses on creating digital games that discover optimal learning and promote human creativity, and also focuses on solving humanity's problems in a game based environment. *International Strategy for Disaster Reduction* (ISDR) organization gathered many organizations, universities and institutions to reduce the casualties occurred by natural disasters. For this purpose, organization aims to increase public awareness about the importance of prevention against natural disasters (Url-5). They developed an online game that aims to inform children how to make cities or villages safer against natural disasters such as hurricane, flood, and earthquake. This paper will present a brief review of this game in the next section. *The Commonwealth Scientific and Industrial Research Organization* (CSIRO) and e-Water non-profit organizations have collaborated in developing a serious game which aims to build knowledge about river catchment management areas in Australia (Url-6). In order to achieve this, they created a turn-based online game in which players can learn dynamic relations between ecologic, economic and social aspects. This paper will present a brief review of this game in the next section. *Games+Learning Society* (GLS) has been founded with collaboration from Wisconsin Institute for Discovery and School of Education at The University of Wisconsin-Madison. GLS organizes The GLS Conferences annually, to provide a forum for game researchers, game designers, and educators (Url-10). *Learning Games Network* (LGN) is a non-profit learning game studio, which aims to promote games, tools and communities for playful learning (Url-11). In addition, LGN aims to combine theory and practice in game-based learning.

Many commercial video games have been used for educational purposes. These games have been developed to take attention and capture players for

pure entertainment. They require significant budgets to develop, and educators should benefit from these games. According to Susi (2007), commercial off-the-shelf (COTS) games were used to engage players in a serious purpose other than pure entertainment. As educators, we should focus on the engaging part of games to use them as learning tools. If not, computer games will remain just as rendering softwares. For this integration, they used existing commercial-off-the-shelf (COTS) games changing the purpose, modifying or creating mods COTS games (creating games by using game editors) with own purposes or they created their own new games by coding in different language. As it was implied by *Serious Games Initiative* (Url-3), many commercial games such as SimCity (Url-4), Civilization III (Squire and Barab, 2004) have been used as learning tools in schools and universities across the globe.

2. Using game engines

Video game developers have been using game editors or development kits for simplifying game design process. These softwares have been used by various industries for their modeling and visualization purposes. They are equipped with powerful visualization features and virtual environment creation tools, and these features make them convenient to use for different purposes besides the game design. Game editors mostly have been used in the "movie industry, architectural visualization and presentation, 3D rendering, digital films and more"(Url-1). For instance, building consultancy firm, Arup has used gaming technologies to develop their real-time rendering tool ,called *Realtime,* for architectural presentations, (Johns and Lowe 2006). Game editors have been developed for creating video games. Game editors provide powerful virtual environment creating tools and ability to assign behaviors and game rules in it. Many serious games have been developed through these softwares.

2.1 Gaming technologies for landscape visualization

Relationship between landscape architecture and gaming technologies started with perception of realistic landscape visualizations in video games. Before game engines, researchers have been focusing on virtual reality modeling language (VRML) for visualization purposes. There are a few researches also available at the intersection of landscape architecture and gaming technologies. Most of them are using game technologies as design presentation tools by excluding engaging part of games. Although these projects have game features and are developed using game technologies that does not make them serious games. Susi (2007) distinguishes games and 3D applications which are using game technologies, and not game design. As referring to 3D applications, she points out that "not all 3D applications using modern game technology are games". In other words, these applications are using three dimensional environments as presentation platforms.

Fritsch and Kada (2004) have published a research about the use of game engines for indoor and outdoor photo-realistic visualization. After introduction of the popular game engines (Quake III, Torque and Unreal Engine II) and tools (GISMO, SpeedTree, SpeedGrass) with example works, they mention game engines and their possible uses in the future for landscape visualization.

Johns and Lowe (2006) have used game technologies as presentation environments for design projects in landscape architecture studio. Authors have required using *Unreal Editor* (UDK – Unreal Development Kit) software for representation of this short-time project. UDK (URL-1) is one of the game editor softwares which can be used to create game levels for commercial first person shooting game *Unreal*. Even though the project duration was six week intense course and students have not had any previous experience about game engines, authors say that students had a sudden success for creating landscapes using the software. This research has a unique meaning as it is the pioneer for integrating game technologies to landscape architecture studio and classrooms for various purposes.

Herrlich (2007) developed a support tool for landscape architecture, which can convert GIS data into a convenient format to generate a game level including terrain, buildings, and landscape elements. He used *CryEngine Sandbox* software for his research, which is a commercial computer game engine developed by Crytek game development company. This software has been developed to generategame levels for a popular first person shooter video game titled *FarCry.*Herrlich have proven that it is possible to generate 3D models easier and faster by combining GIS and game technologies. In addition, that research provides ways to experience 3D environments from with other perceptions like gravity, sound, atmospheric events (rain, snow, fog, etc.) by walking inside the virtual environment instead of watching pre-rendered animations or still images.

Mach (2010) also created an interactive game-like 3D visualization for raising public awareness about possible flood disaster in *Naturschutzentrum*in Deutschland. Project was created in Quest3D game design software (URL-2). 3D model of the surrounding environment including terrain, buildings, raising water level have been created by using real GIS data, and then they were exported to Quest3D software. Author aimed to present complex geographic and hydrologic information in a comprehensible way for every person, especially for children. For that reason, cartoon-like characters were created to guide users in application. The user is also able to navigate in space and time for interaction. Thereby, users become able to see places where they live and experience the effects of possible flood disaster.

2.2 Modifying games for educational purposes

In addition to the uses of game editors for visualization purposes, a few researchers have succeeded in developing educational games. This section will briefly introduce these researches.

Pak and Brieva (2010) have created a *Role-Playing Game* (RPG) “to illustrate how individual decisions are related with the general landscape dynamics”. They are using the RPG as an *educative tool* which provides an understanding in land cover change of the case area. Game is based on social actors, natural resources and decision rules. Authors have observed the decision processes and interviewed players to record decisions with reasons. This research showed that games can be used to represent the evolution of landscape and land cover, according to decisions given by habitants as game players. More explanation about this game and its components can be found in the relevant research paper. Games can be counted as successful examples of educational uses of games even when it is not a digital game.

As examples of recent works, Marlow (2009) published a research about serious gaming and its pedagogical benefits for landscape architecture education. He also seeks an answer on how video games could be used in education. Then, he reviews existing computer games which have potential value for landscape architecture and environmental design education and he explains their useful features for education. After this research, a few years later his research (Marlow 2012) about making games and environmental design has been published in in 6th European Conference on Game Based Learning Proceedings. In addition to the previous research, he introduces a series of video games, which he leads the development processes. First of these games is a prototype called *Project: Design* which aims to support teaching basics of landscape design. Second game is called *Storm Water Rampage* (SWR), which aims to teach plant types using in storm water management. This game has been developed in *Stencyl* game design engine inspired from the popular game *Plants vs. Zombies.* Last game is called *Green Space* (GS), a digital board game inspired by Monopoly, which aims to teach students working in an interdisciplinary design team with horticulturalist, contractor, engineer and publicist. The game requires"solving a significant environmental design problem to win the game" (Marlow 2012).

This section has reviewed digital and non-digital games, which have been developed to be used in landscape architecture classrooms. Pak and Brieva (2010) have used social interaction, and rule-based features of role-playing games to illustrate land cover changing with decisions. In addition, Marlow (2009) has reviewed video games to find out educationally useful features for landscape education and later he created educational games for teaching landscape. All of these games are developed by changing or modifying existing games. These types of applications have great advantages such as being easy to implement learning content and create a game by using ready-to-use templates.

2.3 Creating educational games from scratch

Creating a video game from scratch is the hardest and most costly wayto develop a game. Even with these challenges, development at the gaming technologies brings big opportunities for educators and researchers. Game design tools become easier to use than ever. Many gaming companies have developed easy-to-use game design tools that allow users even who are not familiar with coding or game design to design their own games. Educators can develop video games to increase interest in learning by implementing existing learning content. This section will introduce video games, which were developed to be used in education on landscape and ecology topics.

Leafsnap game (Kumar et. al, 2012) is created as a part of its iOS application. Leafsnap application works as a plant species recognition tool. Application and plant database have been developed by a great team formed by Columbia University, University of Maryland, and the Smithsonian Institution. Game is working as an extension of this application and database, which asks user plant names by showing visuals of plant parts. User can set the gaming rule, recognition part of plant at the beginning of the game. Playing experience is suitable for understanding plant types by their leaf, seed, and fruit visual properties. Game also shows correct answers to wrong decisions of players. That feature also supports plant knowledge by the playing time.*Trails Forward* is an ecological serious game developed by Games Learning Society Center which is located at the University of

Wisconsin (Bell-Gawne et al. 2013). This game is a multiplayer video game, which could be used to inform players about environmental issues such as sustainability, climate change and food. The game allows players to enact as a lumber worker, a conservationist, and a housing developer. This role-playing game helps to understand relations between human behaviors and environments in different decision situations. *Wetland Restoration* (Figure 1) is developed by the Center of Serious Play at the Bothell campus of University of Washington. Restoration of 56 acres of wetlands for Bothell campus has been the inspiration for the development of this game. Game has been designed with real world plants and wetland restoration rules and it allows players to make plantation and grading in an area in order to these rules. Each action requires game money and volunteer labor. In addition, game rates the playing process with a rating system, called “Biodiversity Rating”, and reflects the success of the player. Integration of learning content and application of restoration rules makes it successful in landscape education games.

Both of these games, Leafsnap (Kumar et. al, 2012), and Trails Forward (Bell-Gawne et al. 2013) are developed as parts of educational researches. In addition to these, many serious games have been created for the purpose of giving information about ecologic and sustainability aspects. Damien Djaouti and Julian Alvarez (Djaouti et. al 2011) have classified video games in a collaborative database which includes 2.855 video games [2013-10-18]. They evolved a classification model, called *G/P/S model*, which identifies video games with their gameplay, purpose and scope properties (Djaouti et. al 2007). This classification system is a result of an academic research project launched in 2006. This database is still online and can be visited from http://www.gameclassification.com/ address for further information. In addition, the database allows search on topics such as ecology (including sustainability), and state & government, which can be associated with landscape.

Figure 1. *UWB Wetlands Restoration game.*

Figure 2. *Stop Disasters game.*

Stop Disasters (Figure 2) has been developed to increase public awareness and to inform about precautions to reduce loss arising from natural disasters. Game starts with five selective disaster scenarios: tsunami, hurricane, wildfire, earthquake, and flood. Difficulty of gameplay is defined with size of playing are, and it can be also selected by the player. At the beginning of the game, a small briefing appears on the screen including game objectives. Each scenario has different objectives and goals. Gameplay is not

complicated. Game visuals are good enough, and the game supports learning by revealing “key findings”. “Key findings”are hidden pop-up information, which include brief information about related disaster. They are hidden at the start and appear with gameplay. Although the game and the learning structure are well-designed, gameplay is not engaging. It could be enriched by integrating task and achievement system and by adding interactivity to engage. At last, the game has a rating system which evaluates success on gameplay duration and the success after the disaster situation. Scores are being displayed in a leaderboard at the website. *Catchment Detox*is an online game which aims to teach relations between population, economy, ecology, and environment health by managing a developing city in a virtual river catchment. Game has well-designed interface and graphics. Gameplay is easy enough to play without instructions.

Developers have succeeded to set up dynamic relations between economy, ecology, and social situation. Although learning content of the game is slightly limited for using in landscape architecture classrooms, it has high potential to be further developed. *Energyville* allows players to play the mayor ofa newly built city. This game also has similar features with Smart Grids, like monitoring players’ progress by rating on economic, environmental and security aspects. Interface of the game is user-friendly and easy-to-understand. At the end of three turns, in-game time at the end of the year 2030, an estimated report is displayed which is generated in order to show energy production decisions. This game helps to understand balance of the energy production methods and their economic, environmental and safety comprehensions. In addition, game provides a way to compare results with average scores of similar players’ if the player enters personal information like age, institution. *Smart Grids* is a game where the player can play as a user (consumer), energy manager or grid operator. This game aims to inform players by making decisions about daily works and habits. The game has focused on energy use decisions and on building an understanding the pipeline of energy production. Monitoring gameplay process allows players to track process. This interaction is important for players to relate information with the results of the decisions.

Electrocity is where players act as mayor role of the city. The virtual city has been built on a 5x5 grid. Each grid represents different land types like mountains, hills, forest, bush, river, river mouth, coast, sea. Information about properties of these lands can be obtained from the control panel. This game allows more control for players than Smart Grids and Energyville games. City has a budget, and the player can control the taxes.The game allows a player to build farmland, energy production, commercial, and leisure buildings. In addition, the game allows making money by logging forest, build mines and trading these natural resources. Player should maintain the city in equilibration of population, economy, and environment aspects. This game also provides information about gaming process.

Plant it Green is a web-based city building simulation game, which was developed with grants of National Geographic Society and General Electric. This game has more engaging features like experience and level system. The game assigns tasks to the player for building city. Task assignment feature avoids boredom by sustaining flow of gameplay. Visualization, Interface, and game dynamics are well-designed. In addition, game requires confirmation on each action to take attention. These are repetitive actions

like gathering resources from power plants or collecting taxes from habitant. That feature also helps to capture players for playing. It looks like a well-designed city building simulation game, which provides “stealth learning”for players. For instance, each element in the game has defined with its requirements and footprint points. Players have to finish the game in a range which presents ecological rating. This makes players think ecology and sustainability during the design process. Also, game environment is covered with natural areas. By the time, game compelling players to make decisions between development and nature. *2020 Energy*game starts with a captivating introduction video. Game has been based on a story, which is about living in Europe at the year 2020. At the beginning of the game, players can choose a role between three options, which are based on energy saving, energy efficiency, and renewable energy. Story of the game isbased on helping a character about his decisions. This game aims to give useful information to the player in decision process. On the first scenario, character decides to go on vacation and the player needs to make a decision between an automobile and a bicycle. Later on, the game displays the rating of decision in environment, economy and social triangle. Afterwards it shows similar example videos from the world as a result of player’s decision. *Riverbed game* is a web-based adventure game which aims to make players learn by solving a mysterious case based on Aral Sea Crisis. Game has rich visual graphics and attention capturing fluent story. Educational part of this game is more underdeveloped than the gameplay. Despite this weakness, game has powerful features to be an educational game. *Groineiland* is a 3D adventure action video, which based on a disaster story. After an earthquake, player has to survive in an abandoned island and build energy generators to win the game. The game has many captivating features like 3D environment and visual graphics. Objectives and gameplay are not clear enough. Game starts with in-screen instructions and playersbegin to play without any guide or direction. Even though this game has objectives on sustainability and design, its major focus is on surviving with main necessities. *Thisissand* is a physical simulation, which allows players to create geometries like landform sections by pouring particles like sands. Although this application has not any gaming features, it has potential to explain landforms and earth stratum by sketching in application.

These games are mainly focusing on pipeline of energy production to consumption and relations of decisions in cause and effect. These games can increase public awareness on energy consumption by building an understanding in these topics. Although all of these games have developed for educational purposes, they are able to give common information about ecology and sustainability. These games constitute a base for developing educational games by merging real world contents with gaming.As a summary of the section, digital game-based learning approach has started an action and its application areas are increasing with great acceleration. Although there are not many existing applications and researches, landscape architecture should exploit more this opportunity. What should we do now? As Richard Van Eck (2006) and Marlow (2012) state in their research, many researches exist about the educational potentials of video games, but now it is time to bring more serious games into education and retrieve the results to use these for development. Marlow (2012) states the situation with these words; “there is much written about the potential and value of video games in education, but not emerged enough to the impact of video games on environmental design education”. All of these games are

just the beginning of an educational revolution for both of students and public.

3. Experimental study

Computer games in landscape architecture education can increase students' motivation for learning, provide an experimental learning environment and help students to learn complex systems in relationship to knowledge of information. While computer games make players "interested, competitive, cooperative, results-oriented, actively seeking information and solutions" (Prensky, 2003) educators should also benefit from this opportunity. To explore the potentials of commercial computer games for landscape education, an experimental study was evaluated with 19 participants, who are undergraduate landscape architecture students in Istanbul Technical University (ITU).

This study was evaluated as a part of computer aided landscape design course during two weeks of course time. This two week experimental study centered on a park design which requires using RollerCoaster Tycoon 3 (RCT3) commercial computer game,instead of mainstream drawing and modeling softwares. RollerCoaster Tycoon 3 (RCT3) game has selected for this study because it has high potential to be used in landscape architecture education with many features. The game requires building an amusement park and managing it within the given objectives. Despite game examines management and economy skills of players, it has good features and modeling tools for landscape architecture. Game allows players to design their parks with given pre-modeled architectural buildings, grading landscape, planting with non-specific plants, create lakes and waterfalls, paving with a variety of materials. The game successfully simulates the natural and artificial environment dynamics. In addition, time and cost management could be used as design restrictions. Landscaping tools are convenient to model any form of landscape. Weather conditions and day/night time are also dynamic design parameters of this game. Thoughts of guests can be considered as receiving user feedbacks for designers as players. Landscape contours and elevations are also provided as optional visual information. Interface of the game is well-organized, and visuals of command buttons are designed in order to function and deducible. In-game navigation can be controlled by mouse movements, and the game allows different views from eye-level to god-view. Players can walk and experience the park like guests. In addition, the game has a video recording feature inside which allows players to record what they see on screen. This feature can be used for preparing animation for design presentation.

During the first session, the participants have questioned with a pre-test, which investigates the students' computer skills and familiarities with computer games. However, two of the students that had no prior experience of computer games. Except these, 17 participants answered that they like to play video games in leisure times. In addition, there was a consensus among the use of computer game as a part of landscape education. After pre-test, instructor briefly introduced thestudy and RCT3 game. Students have briefly informed about objective,interface and gameplay of the game. Then instructor allowed them to learn gameplay and commands via starting from tutorial level. This study also aims to measure software knowledge requirements of the game and compare with mainstream CAD softwares. Regarding to the user friendly interface, all students easily started to use

RCT3 with in-game instructions.At the end of first course, instructor introduced the video recording feature of the game and required to prepare a presentation video of their designs for next session. This requirement forces them to present their landscape designs by using in-game integrated video recording and navigation. Game allows players to capture screen real-time by navigating freely inside the game environment. Player can navigate in different scales, from eye-level of a guest, plan or isometric perspective view. It provides opportunity to save time and effort rather than rendering process of mainstream modeling softwares.

In the second session, they have been evaluated with a post-test, which aims to investigate the participants' gameplay experiences and their thoughts about using the game software as a landscape design and presentation tool. After the post-test, they presented their videos through a projector andtheir impressions were generally satisfied about the results but at same time they some ideas about using a computer game in a purpose out of mere entertainment. Although some students have navigation issues (as two students indicated in post-test), presentation videos were mainly eligible to present their ideas. In addition, post-test results show that some students

4. Discussion and conclusion

This paper presented serious games, which have potential to be used in landscape architecture classrooms. Then, the research examples presented in this paper highlight educational games, which have purposes to interact with the player and transmit information about landscape, ecology and sustainability topics. While most of these games have been developed for educational purposes and they meet main expectations, only a few of them have learning content usable in landscape architecture classrooms. Of those discussed, each game has a unique potential to be used for educational purposes. Adventure games like *Riverbed game* present a learning environment in an engaging and fluent way with small doses of learning content. This feature avoids possible boredom that can occur from excessive use of learning content. Simulation games like Plant it Green, Energyville, Smart Grids, Electrocity, provide experimental learning mediums allowing players to behave according to restrictions. In addition, simulation games offer players a challenging design environment. Although all of these games can be enough to increase public awareness about ecological problems and sustainable energy consumption, these games are not eligible to be used in classrooms with their existing content. As a successful simulation game, *Wetland Restoration* game is separated from other simulation games with its realistic and well-integrated landscape design rules. *Groineiland* provides students like experiencing the landscape in a realistic three dimensional environment with from eye-level as walking inside of it. Physical forces and animation of atmospheric events increase reality of perception. Even though the objectives are not clearly defined, this game has powerful opportunities to be used in classrooms. Lastly, *This is sand* application takes part in this research as it can be used as an innovative landscape sketching tool.

This research evaluated an experimental study to explore potentials of computer games for various purposes like landscape modeling, design sketching, and as a presentation tool. RCT3 commercial computer game has chosen for this experimental study for its landscape modeling and design tool features.Screenshots from participants' gameplay can be seen in Figure 3.

In this section, post-test results showed that:
RCT3 has more easy-to-use interface rather than CAD softwares, except two participants, all of them identified the interface and commands easily (as claimed by 11 out of 19). In spite of not any instruction given to students about their designs, the pre-test results show that, 12 participants have tried to apply their landscape design studio projects. Other 7 participants designed their parks with improvisational decisions.Navigation is great to see the landscape design from eye-level of users to isometric or plan views. Although major of the participants defined game navigation easy-to-use, 2 participants identified navigation hard-to-use. Design components which present in game library, allow to design faster and effortless. At same time, ready components restrict players to create their designs. As claimed by 17 out of 19, they wanted to use their design models in the game. But RCT3 game does not allow using external models as a component.RCT3 game has a variety of landscape grading tools, which allows designing various terrains. Resource management is also a part of design. In-game time and cost management features allow participants to consider these restrictions in design process. As stated by 12 participants, it is good to estimate design cost during designing. Real - time rendering virtual environment, video recording and navigation features make RCT3 a time and effort saving representation tool. Post-test results shows these features are not enough for landscape presentation. All participants agreed RCT3 have powerful features for landscape design presentation except its comic-style representation concept. Even 8 participants agreed to use RCT3 as a landscape presentation tool, 11 participants denied to use for unrealistic visuals of the game.

Figure 3. *Screenshots from gameplay of participants.*

In addition to results explained at above, they all suggested some features for RCT3. First of them is ability to use external modeled components in game for not being restricted by pre-modeled design components. Major of participants wanted to add more plant and construction components during the study. In addition, they also suggested that allows exporting CAD drawings from the game software.As this study shows that, computer games have great potentials for landscape architecture education. It allows students an easy-to-use real-time design and representation tool. Post-test results also show that, the participants think to use again RCT3 computer game for future representation and design purposes (as claimed by 17 out of 19). Some of them stated that RCT3 could be used for creating draft models for different alternatives of design easily and without effort.

To conclude, this article has illustrated the potentials of RCT3 computer game as a design and representation tool in landscape architecture education. The results of the study suggest that computer games hold much promise for taking part in landscape curriculum. The findings support the notion that the development in serious gaming topic and gaming technologies, computer games would be able to take part in various topics of landscape education. This research did not, however, illustrate how learning can be obtained by playing computer games, but the findings from results could give an idea for designing educational games for landscape architecture. We believe that this research represents a promising first step toward the objective, which could play an important role in landscape education.

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Bilgisayar oyunlarının peyzaj mimarlığı eğitiminde potansiyel kullanımlarının araştırılması

Bilgisayar oyunlarının kullanıcılara sunduğu etkileşimli ve görsel içerik bakımından zengin sanal çevreler içerisinde eğlence amacıyla üstesinden gelinmeye çalışan görevlerin, kullanıcılar üzerinde uzun süreçte olumlu etkiler bıraktığı ve birtakım zihinsel becerileri geliştirdiği gözlemlenmiştir (Green ve Bavelier 2003). Prensky' nin 2001 yılında yayınlamış olduğu *Digital Game-Based Learning* kitabında, gelişen teknolojinin insanlar üzerindeki etkilerinin yanı sıra, bu süreç içerisinde büyüyen kişilerin çocuklarından itibaren zihin ve algı yapılarının değişime uğradığını belirtmiştir. Ek olarak, algılardaki bu dönüşümün kişilerin öğrenme sürecini ve yöntemlerini de değiştirdiğini belirterek, eğitim sisteminin de bu değişime uyum sağlamasının gerekliliğini savunmuştur. Dijital oyunların eğitimde kullanılması anlayışının temelinde de bu gerekçeler yatmaktadır.

Gee'nin (2003) iyi bilgisayar oyunlarında bulunan 5 öğrenme prensibini tanımlamıştır. Bu tanımlamaya göre, (1) iyi bilgisayar oyunları kullanıcılara bilgi gereksinimi duyduklarında ihtiyacı kadar bilgi sunar. Bilgisayar oyunlarının sunmuş olduğu bu özellik, bu tarz yazılımları kullanarak büyüyen bir neslin mevcut eğitim yöntemine olan bakış açısını da etkilemektedir. (2) İyi bilgisayar oyunlarının kullanıcılardan başarmasını beklediği görevlerin zorlayıcı ama aynı zamanda yapılabilir olması, kullanıcıların süreç üzerindeki motivasyonlarını arttırmaktadır. (3) Bilgisayar oyunları kullanıcılara bilgi akışı sağlarken onları pasif alıcılar olarak değil, sistem içerisinde etkin tasarımcılar olarak değerlendirir. Diğer bir deyişle, kullanıcılar oyun senaryosu ya da süreci içerisinde her bir karar ve hareket için aktif olarak katılım göstermektedirler. Bu özellik, kullanıcıların süreç üzerindeki motivasyonlarını arttırmakta ve gönüllü katılımlarını sağlamaktadır. (4) İyi bilgisayar oyunları, basit tecrübelerden başlayarak, kullanıcılara süreç içerisinde aldıkları bilgileri inşa edebilmelerine imkan veren, zaman içerisinde zorlaşan görevler ile kullanıcının kapasitesini arttırmasını sağlamaktadır. Bu yöntem ile kullanıcılar, oyunun ilk evrelerinde başa çıkamayacakları görevleri, son evrelere kadar edindikleri tecrübeler ile üstesinden gelebilmektedirler. Son olarak, (5) iyi bilgisayar oyunları kullanıcılarına verilen görevi başarmak amacıyla gereken becerilerini geliştirmeleri için özel rutinler içerisine sokarak, konu hakkında zaman içerisinde uzmanlaşmalarını sağlamaktadır. Yukarıda belirtilen bilgisayar oyunlarının sahip olduğu öğretme karakteristiklerinin okul eğitimi ve profesyonel çalışma ortamındaki kullanılan yöntemlerle ilişkisi kurulabilir. Prensky'e (2001) göre günümüz öğrencilerinin mevcut eğitim sisteminin sağladığı olanaklara uyum sağlayamamasının altında yatan temel neden, gelişen teknolojinin sunduğu imkanlar ve bilgisayar oyunlarının kazandırdığı alışkanlıklar sonucunda öğrenme yapılarının değişmiş olmasıdır. Ek olarak, mevcut eğitim sisteminin de bu değişim karşısında bilgisayar oyunlarından sağladığı kazanımlar ile kendisini yenilemesi gerektiğini belirtmektedir. Bu değişimin gerekliliğine inanan araştırmacı ve bilim insanları, bilgisayar oyunlarının eğitim sistemine sağlayabileceği katkıları ve bu değişimin nasıl yapılması gerektiğine ilişkin araştırmalar bulunmaktadır. Söz konusu araştırmaların bir kısmı, halihazırda geliştirilmiş ticari oyunları veya araştırma kapsamında geliştirdikleri bilgisayar oyunlarını eğitim sürecinin bir parçası olarak kullanarak, konuyu bir adım daha ileri götürmüşlerdir. Birçok disiplinde özelleştirilmiş bu tarz çalışmalara, peyzaj mimarlığı eğitimi içerisinde de rastlamaktayız. Bu çalışma içerisinde peyzaj mimarlığı odağında geliştirilen araştırmalara daha detaylı olarak yer verilmiştir.

Son olarak, bilgisayar oyunlarının peyzaj mimarlığı eğitiminde kullanılmasının sağlayacağı yararları araştırmak için, ticari maksatlı geliştirilmiş fakat peyzaj eğitimi için potansiyel içeren bir bilgisayar oyunu *bilgisayar destekli peyzaj tasarımı* dersi kapsamında peyzaj mimarlığı lisans öğrencilerine, RCT3 oyununun sunduğu sanal ortam içerisinde park tasarlamaları ve ortaya çıkan tasarımlarını yine yazılımın sunmuş olduğu imkanları kullanarak sunmaları beklenmiştir. Yapılan deneyin amacı, öğrencilerin karmaşık tasarım sürecini, genelde kullandıkları çeşitli çizim ve modelleme yazılımları yerine sadece eğlence amacıyla geliştirilmiş bir bilgisayar oyununun imkanlarından faydalanarak deneyimlemeleri, yazılımın olumlu ve olumsuz yönlerinin irdelenmesi ve bilgisayar oyununun peyzaj mimarlığı eğitimi için faydalı olabilecek özelliklerinin ortaya çıkarılmasıdır. Öğrencilere çalışma öncesi ve sonrası yapılan öğrencilerin verdiği bilgiler doğrultusunda, oyun teknolojilerinin peyzaj mimarlığı eğitiminde kullanılabilecek, eğitimi destekleyici faydalar ortaya konulmuştur.