Educational Gaming and Use for Explaining Alternative Energy Technologies

Kenneth A. Ritter III, Terrence L. Chambers
College of Engineering, University of Louisiana at Lafayette, Lafayette, USA
E-mail: kar4499@louisiana.

Abstract

Raising awareness of energy issues to high school students using traditional teaching methods can be tedious and unproductive. However, letting a high school student engage in an interactive 3D game can not only stimulate general interest but can also captivate and educate. During 2013, several demonstrations were given in a virtual reality lab at the University of Louisiana that explained solar thermal power concepts and other alternative energy technologies. These were given on three 150 inch screens in a concave design, immersing the user in a 3D educational experience. Several software technologies were used in the creation of the game, the main ones being Solidworks, 3ds Max Design, and Unity 3D. The scene of the game was constructed using a scale model of the Cleco Alternative Energy Center in Crowley, Louisiana. This paper gives a literary review of educational games and explains the design process of the interactive 3D game and the educational experience from demonstrations during 2013.

Introduction

Finding new innovative ways to capture students' attention and make learning a more natural and fun experience rather than the less attractive traditional one can be challenging. The new generation of learners, termed Net Generation, are more comfortable with image-rich rather that a text-only environment [1]. Even with the aid of Power Points, the visually literate Net Generation of students have trouble keeping alert and captivated so that they can focus on and absorb the information. To tap into the multiple intelligences and learning styles of the Net Generation the audio and visual components of a video potentially provide a best fit [2]. How can current educators reach the Net Generation of children who are more visually literate than earlier generations?

A 3D game was created using a scale model of an existing Alternative Energy Center. This serves to not only inform students of the Center but also to educate them on various alternative energy technologies. Using visual aids is beneficial in explaining and a walkthrough game seems to increase focus and make learning fun. It also gives students a near hands-on feel. The focus of the game explained how a solar thermal power plant captured energy and converted it into electricity. This was animated in various ways such as the solar troughs tracking the sun throughout the day. The game allowed the user to walk through the model where informational popups explain the various alternative energy technologies.

The 3D game was created with the intention of explaining the various technologies of an alternative energy center. This power facility was first modeled using Solidworks 3D CAD software. This model was then brought into 3ds Max Design where textures were added and animations rendered of the concentrating solar power collectors collecting solar energy and converting it into electricity. Then to add to the educational experience, the 3ds Max Design model was brought into the Unity 3D game engine where a walk-through game was created. This allowed the user to walk through the solar field using a PlayStation remote to see the various alternative energy technologies. Next, the game was animated in various ways such as the solar troughs tracking the sun throughout the day. To further the user experience, interactive capabilities were added giving the user control of the solar tracking system and real time visual power generation.

This paper looks into the importance of introducing educational games for learning engineering concepts. The potential for significant educational benefits of video games are explored through a presented a literary review of educational games. The game created helps explain various alternative energy technologies. These technologies are presented briefly as they are the content presented in the game. This paper also explains the design process of the interactive 3D game and the educational experience from demonstrations during 2013.

Educational Gaming

There is deep concern about the United States' ability to sustain its scientific and technological superiority through this decade and beyond according to a report by the Business Roundtable [3]. As the world continues to change, continuing to provide the same types of education to students will not serve them well [4]. High-tech industries require proficiency in math, science, computer literacy and engineering. To teach difficult scientific concepts traditional lectures and laboratory sessions are not adequate [5]. Many students leave high school and college physics courses with faulty mental models and this cumulative effect of large numbers of misconceptions may undermine students' comprehension [5]. Many students label traditional schooling as boring and are not motivated or inspired to work. Nearly half of the high school dropouts said that classes could not keep their interest [4]. The educational system needs to reform to prepare students for a much more technology driven, interconnected and competitive world[4]. The ability of our children to compete and prosper is highly dependent on innovative new methods to accelerate education, increase proficiency and reduce training costs [3].

With the current video game industry approaching revenues of $15 billion and with approximately 3.38 billion hours of game play it is of no doubt that games are effective in enhancing motivation and increasing student interest in the subject matter [6]. Due to videogames being fun, it is easier to achieve and maintain a person's undivided attention for long periods of time. This fun and excitement provide an innovative way of learning where participants experience novelty, curiosity and challenge [7].

An evolution of learning is represented by the convergence of education and gaming technologies. Games are not just looked upon as potential teaching tools but as the future of education [8]. To strengthen our system of education and prepare workers for 21st century jobs, educational gaming can be used to acquire the complex skills and knowledge needed [9]. Games intrinsically stimulate curiosity with the presence of challenges and influence learning through visualization, experimentation, and creativity [10]. In addition to their entertainment value, videogames have been successful in teaching a certain skill or addressing a certain problem [7].

Players engage in action at a distance like remotely manipulating a robot when involved in computer and video games. This action at a distance causes them to feel as if their bodies and minds have stretched into a new space, a highly motivating state which books and movies cannot do [11].

With this approach to education situated learning environments can be created. While learners play the computer games they acquire abilities and knowledge which can be applied to real world scenarios. Using these learning environments in educational computer games, students' learning interest and motivation for learning can be increased when compared to traditional teaching [12]. To apply skills learned in the games to other contexts it is critical to have a debriefing session post game [4]. Therefore, games will not replace teachers and classrooms, but only some textbooks and laboratories.

Game types

Games which follow a skill and drill format where players practice repetitive skills or rehearse memorized facts are known as Edutainment games. These games call again and again the same action patterns often failing in

transmitting non trivial knowledge. However educational video games can require higher-order thinking skills such as: strategizing, hypothesis testing, or problem-solving. These games are characterized by a system of rewards and goals which motivate players. To establish rules of engagement and situate activity a narrative context is inserted with learning content that is directly relevant to the narrative plot. Furthermore feedback is given with interactive cues that prompt learning [13].

Computer game technology used for training and education purposes, coined "serious games" teach by stimulating the imagination, sparking curiosity, and encouraging a spirit of competitive exploration. These games commonly require the use of logic, memory, problem-solving, critical thinking skills, visualization, and discovery [3]. For teaching complex procedures modern educational computer games can be effective tools because they: (1) use action instead of explanation, (2) create personal motivation and satisfaction, (3) accommodate multiple learning styles and skills, (4) reinforce mastery skills and (5) provide interactive and decision-making contexts [9].

The most stimulating and highest rated games were found to be adventure and strategy games. To maintain motivation in playing games, the game must require higher-order thinking skills with objectives and visualization strategies that influence creative problem solving and decision-making [13].

Intelligent tutoring systems can be used to identify when learners achieve learning goals and to provide suitable feedback. Offering immediate feedback can engage the learner's attention and teach through experience. The intelligent game-based learning environments are straightforward tools that can result in an emotional link between the learner and the game [14].

A constructionist approach to learning games involves designing and developing the video games rather than playing them. This involves two activities: experience-based knowledge construction and relevant product creation. The design and implementation of products are meaningful to those creating them and the learning becomes self-directed and active through this construction [13]. The learner begins to develop technological fluency by being involved in all the design decisions. This technological fluency involves using new technological tools, making significant things with those tools and developing new ways of thinking based on use of those tools [15].

Game Content

Educational game designers need to focus on combining the fun elements of games with the instructional and educational system design that includes motivational, learning, and interactive components [10]. To master complex scientific concepts students must focus or be engaged in the experience and there must be multiple instances of meaningful representations of the information. Through experience in learning-by-doing, students can extend and modify their mental models based on the differences between expected and actual behaviors of phenomena. Pedagogical tools and strategies should provide learners with experiential metaphors and analogies to aid in understanding abstractions remote or contradictory to their everyday experience. This can induce learning through experience in order for students to master complex scientific concepts [5].

Learning systems can be of greater benefit to students by taking learning styles into account. Personalizing the learning content presentations to correlate the information perceiving and processing styles of individuals can promote learning motivation and improve the learning achievements of the students [12]. There should be a meaningful and beneficial task that is sought after by the learner. Beneficial learning tasks must be made with sufficient content for learning or to aid in the learning process. For a task to be meaningful to the learner there must be motivation to perform the task [13].

Goals of different levels are found to help motivate learners to continue playing. To draw players into the storyline of the game, game designers often seek three levels of goals: short-term (collect the key), medium-

term (open the safe) and long-term (save the world) [13]. In addition to goals, the narrative may play an important role in the learning process. It also can be used for problem context as a tool to facilitate reflection and as a resource to provide the necessary advice and feedback [16]. However, the learning content must align with the narrative plot-line in order for an educational game to be effective [13].

Alternative Energy Center

The Cleco Alternative Energy Center is located in a rural area of approximately one acre in Crowley, Louisiana, and is home to several alternative energy technologies. The research building is approximately 6,000 square feet and consists of several offices, a lab, a conference room, and houses a gasifier and a torrefaction unit. Right outside the research building sits a concentrating solar power field consisting of parabolic troughs with over 1000 square meters of collection area. The following is a brief description of the alternative energy technologies being researched along with actual pictures coupled with rendered pictures from the models used in the educational game.

Torrefaction

A pilot scale torrefaction unit at the Alternative Energy Center is being tested for process optimization as torrefaction technology is still being researched. Commercial scale torrefaction units can be developed using the information gained from this research. Torrefaction is the thermochemical treatment process similar to roasting or mild pyrolysis. It improves the properties of biomass as a fuel and allows superior grindability. This dried product is termed torrefied biomass or torrefied wood and has no biological activity such as rotting. Typically 70% of the mass is retained as a solid product with around 90% of the initial energy content. This energy densification is achieved at a temperature of 200 to 320° C, near atmospheric pressure and with the absence of oxygen/air.

Torrefaction is beneficial by improving the physical characteristics of biomass, and thus the overall economics of the biomass utilization process for energy production. The end product can be stored and used for several purposes including gasifier fuel [17].

Figure 1 shows the torrefaction unit that is currently being used for research at the Alternative Energy Center and the modeled version used in the game. In the game, as the viewport gets near the torrefaction unit, an informational popup arises with an actual picture and a brief explanation of the technology.

Figure 1: Torrfraction unit and 3ds Max Design rendered model of the unit.

Gasifier

A large portion of the research building houses a working gasifier. Gasification takes a waste product and turns it into an energy source which can help reduce our dependence on foreign oil and natural gas and provide a clean alternative source for electricity, fuels, and chemicals. Trash can be turned into energy through gasification making a clean fuel from biomass materials, like lumbering and timbering wastes, corn husks, wood pellets, and other municipal solid wastes. The biomass goes through a thermochemical process that converts that material to a synthetic gas. The syngas can be burned to produce electricity or further processed to manufacture a wide range of products such as ethanol, methanol, and fuels.

Several components of the gasifier at the Alternative Energy Center are shown in *Figures 2-4*. The corresponding modeled version used in the educational game is shown at right.
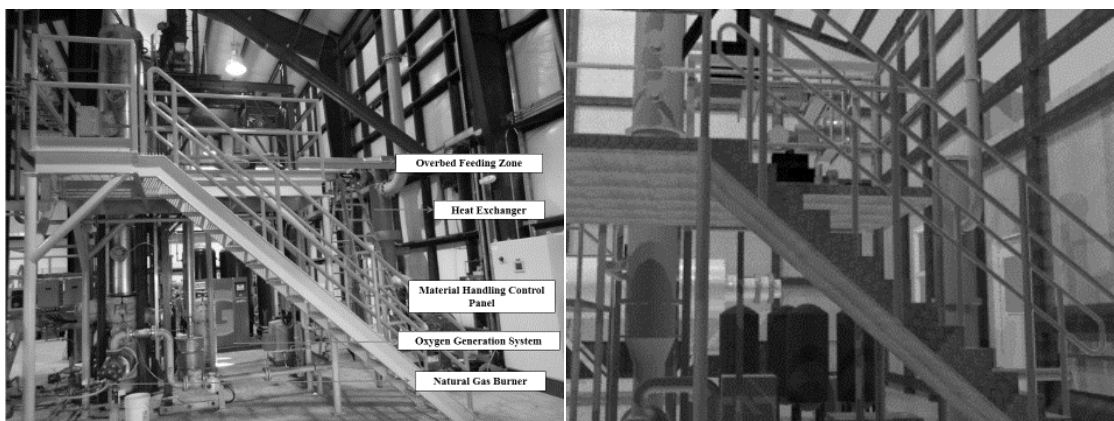

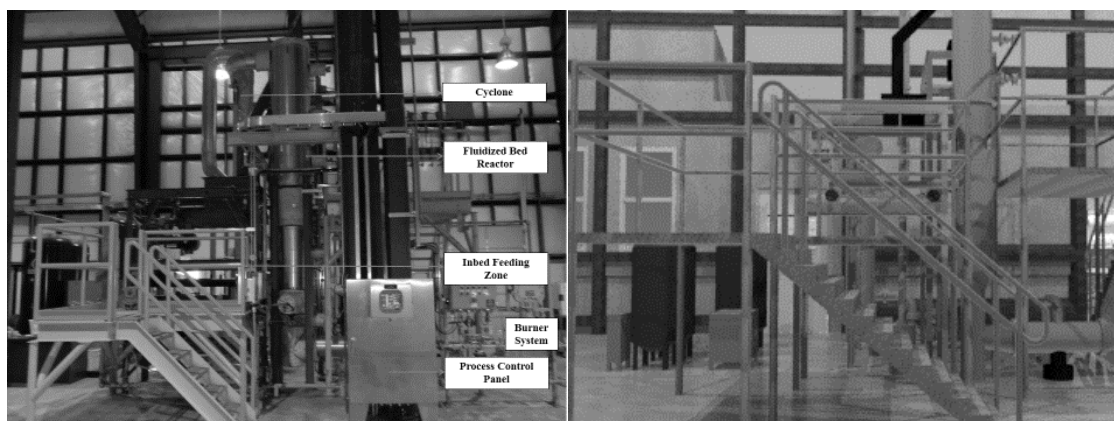Figure 2: Front view of gasifier and 3ds Max Design rendered model of the unit.

Figure 3: Side view of gasifier and 3ds Max Design rendered model of the unit.
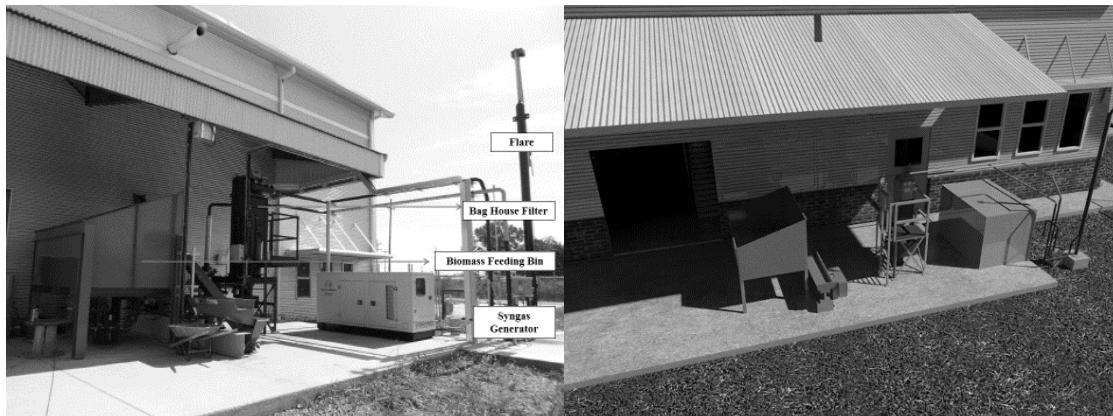
Figure 4: West side of project building and 3ds Max Design rendered model.

As the user walks through the model, informational popups with actual pictures are triggered, explaining the various components and gasification technology.

Solar Thermal Field

In late 2012, University of Louisiana at Lafayette, in conjunction with Cleco Power, LLC, constructed and commissioned a pilot scale concentrating solar power (CSP) plant. This solar thermal power plant collected solar energy by using two arrays of solar troughs tracking the sun from east to west. CSP technologies use mirrors to concentrate or focus the energy from the sun and convert it into heat to create a vapor to drive a turbine that generates electrical power. There are several different types of CSP technologies but all have similar underlining concepts.

There are basically two parts to the CSP system; the collectors that convert the solar energy to heat and the power block that converts the heat energy into electricity. At the Alternative Energy Center there are large aperture parabolic solar collectors using linear focus to collect heat from the sun and transfer it to the working fluid. When heated, this working fluid travels to a heat exchanger to exchange heat with a refrigerant. This refrigerant vaporizes and the vapor generated creates pressure that expands into the twin screw expander. This expander drives an electric generator to produce electrical energy and send it to the grid. *Figure 5* shows a photograph of the solar field and a corresponding rendered image of the model in the game.
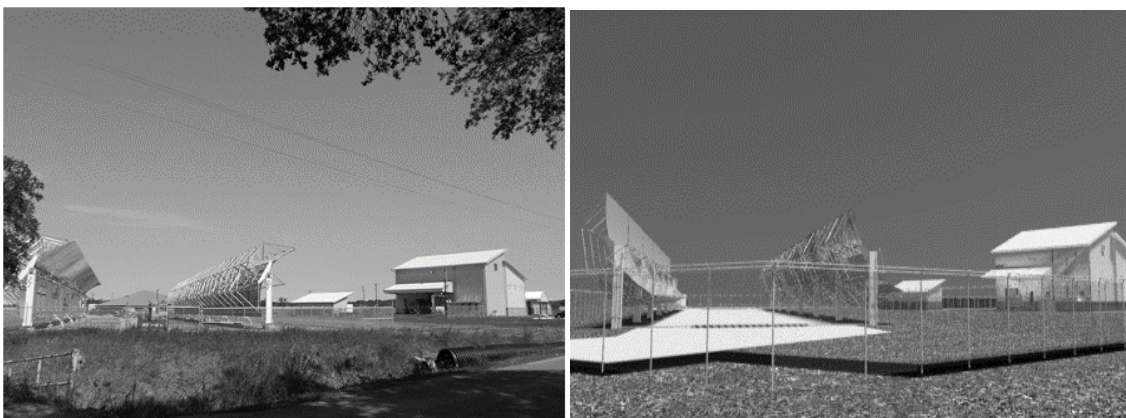

Figure 5: North view of solar field and project building and 3ds Max Design rendered model.

Several engineering concepts are used in the energy collection and power generation of the solar thermal field. To help explain these concepts the current educational game has model replications of the torrefaction, gasifier, and solar field with popups consisting of actual photographs and short explanations of the technology.

Modeling in Solidworks

The Alternative Energy Center was originally modeled in Solidworks to determine the shading effects from the building on various solar collector locations. Once the optimal field location was found the model was then used to create an animation to help explain the solar thermal power technology. The rendered Solidworks animation shows a walkthrough of the research building and an aerial view of the solar field with the troughs tracking the sun from east to west as they would during a typical sunny day. This animation was combined with actual footage of the Alternative Energy Center and presented for Innov8 2012.

Solidworks is a parasolid solid modeling CAD program used for engineering products. It utilizes a parametric feature based approach to create models and assemblies. Using dimensioned drawings of the components, parts are modeled to scale. Each part is modeled and assembled in Solidworks and then brought into the scene. Before the model was ready to be imported to the Unity 3D scene, textures were added in 3ds Max Design. These textures give the model a much more realistic view. To be able to import the model in 3ds Max Design, the model was saved as a stereolithography (STL) file in Solidworks which converted the Solidworks model into a mesh of triangles wrapped around the model. Every part was saved as a different STL file and had to be imported individually into 3ds Max Design. Although saving the entire assembly as one STL file is an option, it would not save time because the model would then have to be separated into different parts to allow different texture applications to each part.

Figure 6: Rendered Solidworks model on left with corresponding rendered 3ds Max Design model on the right

Figure 6 shows two Solidworks rendered images and similar views of the images that were rendered in 3ds Max Design. As Solidworks is primarily for engineering design, the texture mapping and shading effects are of no comparison to the capabilities of 3ds Max Design.

3DS Max Design

3ds Max Design can be used to create environments that look almost real, giving more convincing results with several modeling techniques. This software is primarily used for game development has several lighting techniques and modifiers. Beautifully colored renderings of very high resolution give it a much more lifelike dimension.

Adding textures

Using several features in 3ds Max, such as Unwrap UVW, textures were added to the model. The quality and definition of the textures brought the model are closer to the actual appearance. When the scenes geometry is rendered the shading effects on the lighting, materials, colors, shadows and environment is shown giving a much more realistic view. *Figure 7* shows the heat exchanger used to exchange heat from the refrigerant to the water coming from the cooling tower. The first image on left is a rendered image in 3ds Max Design after importing the model from Solidworks.
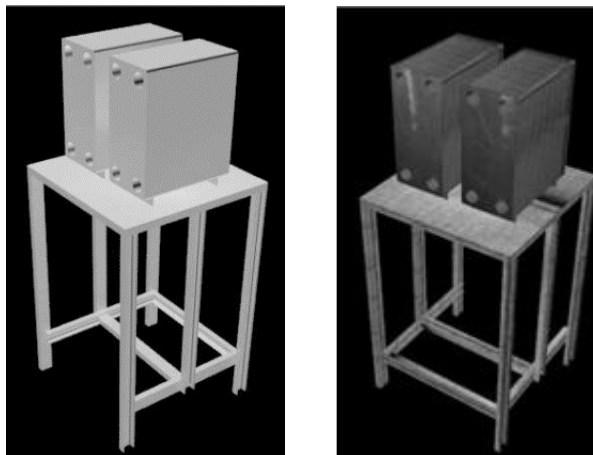
Figure 7: Heat exchanger rendered in 3ds Max Design before and after texture is applied.

The second image on the right shows the heat exchanger after a mapped texture is added giving it a much more detailed view. To add this texture initially, pictures had to be found and edited to scale. Then, using the bitmap tool and bump characteristics, the textures were applied. The unwrap UVW modifier is then used with the flatten mapping option to perfectly contour the mapped geometry. The UVW coordinate system, similar to the XYZ coordinate system, is used to specify how bitmaps are projected onto an object. The UVW modifier is applied to an object to control how mapped material appears on the surface of the object. This allows the fins in the heat exchanger in *Figure 7* to have a 3D effect without having to model each individual fin.

Animations

Viewing a series of rendered still images in quick succession allows the user to perceive them as continuous motion. This illusion of motion comes because each still image or frame is held in the vision system for a short time. Animations are not only more captivating and attention grabbing, but they also allow the user to view processes in action. Explaining how the solar collectors track the sun and collect solar energy is much easier with an animated model. Key points were shown in text boxes below the animations so that users could understand them without any instruction. The animations are a breakthrough in bringing the solar field model to life and explaining key features. *Figure 8* shows a series of images of the parabolic troughs tracking the sun from east to west throughout the day.

Figure 8: Rendered 3ds Max Design animation showing south view of the parabolic troughs tracking the sun throughout the day.

Unity 3D

A walk-through game was created using Unity 3D giving the users the opportunity to tour the model as if actually walking through it. The solar field model was imported into Unity 3D from 3ds Max Design in FBX format. A terrain was created surrounding the model adding grass, hills, trees, and wind. The first person controller prefab was dragged into the scene view from the standard assets folder in the hierarchy. The scale of the first person controller had to be adjusted to be the normal height of someone walking through the model. The first person controller was then moved to the desired start location of the game. The control of the walkthrough camera is the keyboard by default and a mouse control script was also added to have more control. In the virtual reality lab where the demonstrations are held, the projection screens are on the opposite side of the computers. Therefore a joystick script was added so that a PlayStation remote could be setup to control the movement. This way the game player could stand or sit right next to the screen while walking through the game. Unity 3D is a highly powerful game engine that is relatively simple to use and has high end graphics quality that is always improving. The support for Unity 3D is vast with online tutorials, forums, and YouTube videos. The support community helps considerably to grasp concepts and further knowledge to rapidly develop

proficiency. Unity 3D has exceptional realistic physics; softbodies, rigidbodies, colliders, and more are easily attached with components.

Importing model

Unity can import various types of 3d models, texture maps, audio, etc. For Unity 3d import from 3ds Max Design, the model is exported as an FBX file with embedded media. FBX (Filmbox) is a file format, acquired by Autodesk in 2006, that uses an object-based model allowing the storing of motion data along with 2D, 3D, audio, and video data. This allows the model to have all textures and animations when being transferred to Unity 3D.

Adding animation and sound

Animations are added to the scene such as the grass and trees swaying because of wind, smoke rising from the gasifier exhaust, and a few birds moving around. These animations aided in bringing the scene to life, giving movement instead of just only a stagnant model. For educational purposes animation is added to the solar field mimicking the mechanical activity during power generation. The solar troughs rotate along the axis, the cooling tower has water trickling down the sides, and the green machine audibly runs when approached.

Game in iOS and Android

Using Unity 3D software, the same game can be exported to several types of mobile devices including: iOS (iPhone, iPad), Android, Blackberry, Windows 8 phone, along with a web and flash player that can be accessed from some mobile devices. The model was originally brought into Unity 3D so that an iOS application could be created allowing the game to run on an iPhone. In order to do this, the control setup had to be changed to tap control so that the walkthrough game can be controlled with the touch screen device using projected thumb pads. The file size of the model was an issue in that the app would run very slowly. The walkthrough game was then put on a Galaxy II tablet to resolve this issue. The tablet ran the Ice Cream Sandwich version of Android. This version had a 40MB limit for the application before it would crash. The application does run but many of the models in the game were taken out to decrease the file size. This left the game relatively bare with just the solar field and research building models.

Decreasing the size of the model is not an easy task due to multiple software platforms being used. The file would initially have to be reduced in Solidworks by saving it as a coarse STL file, then again in 3ds Max Design by decreasing the poly count. Afterwards, all textures had to be reapplied in 3ds Max Design before exporting as a FBX file to import into Unity 3D. The imported models in Unity 3D then had to be minimized. Models such as furniture, appliances, computers, plants, boxes, crates, vehicles, etc., were imported to mirror the actual Alternative Energy Center.

Adding interactive capabilities

In Unity, one can code in UnityScript, C#, or Boo. Which UnityScript is similar to Javascript, C# is similar to Java and Boo is similar to Python. There are also a few visual scripting solutions in the Asset Store. The UnityScript is used for various purposes in this game. The initial scripts added were popups showing actual photographs and explaining different technologies in the research center. This consisted of adding triggers and colliders to the scene and scripting the popup display. Next, triggers are brought into the scene that allow the

user to turn on various components of the solar thermal system, such as the solar tracking system, the cooling tower and the green machine. These are animated showing the parabolic troughs rotating to track the sun throughout the day, water trickling down the cooling tower to be air cooled, and the green machine audibly running to produce the electricity.

Student Demonstrations

Demonstrations were held in the VR lab during several events throughout each semester such as Innov8 and Engineering and Technology Expo Week. During these demonstrations, groups of students were brought in and given a virtual tour of the Alternative Energy Center on three 150 inch rear projection screens set up in a cave design. This immerses the students in the educational demonstration.

In *Figure 9* a demonstration of the parabolic troughs collecting energy for the sun is shown to a group of high school students. The project building is on the left screen, the parabolic troughs in the middle and the power block for the solar thermal plant on the right.

Figure 9: Game demonstration to high school students in VR lab.

Initially the students are given a virtual tour that takes them through the project building, visiting the office, lab and warehouse where the torrefation and gasifier units are housed. Informational popups appear with actual photographs during various points of the tour explaining the research center and various alternative energy technologies. Afterwards the tour extends to the solar field where students are given an explanation of the components of the solar thermal power plant and the process of collecting energy from the sun and converting it into electricity. During this tour an additional scene is entered when approaching the Green Machine. The Green Machine is the main component of the power block and is responsible for turning the heat into electricity and sending it into the grid. In this scene an enlarged view of the Green Machine is shown and gravity is removed so that the user can float around the machine while various components of it are explained.
Only one person can control the game at a time so that after the initial narrated demonstration students are given an opportunity to play the game themselves. The students are very eager and excited to have this opportunity and take turns exploring the solar field and Alternative Energy Center.
Students describe the immersive demonstration experience as feeling like they are there in the virtual world. A comment was made that it makes learning more interesting as it almost feels hands on. The overwhelming

majority of other demonstrations given that day around the College of Engineering were said to be boring and hard to understand. Not only were these demonstrations described as being interesting but, students also commented that they were able to understand the concepts and it aroused their curiosity to learn more as questions were asked following the demonstration.

Future Goals of the Project

There are many goals for the future of this project and several areas of potential improvement. Currently, control scripts are being written to give the user more interactive capabilities throughout the game. There could be several more scenes the user could enter with different learning objectives in each scene. Several more components such as the newly added sun tracker could be modeled and added to the scene. Once the scene and interactive capabilities have been maximized, then introducing a narrative with directly linked educational content will be explored. Several levels of learning goals and rewards with immediate feedback can be added to motivate players. If increasing the scene size to better accommodate the game would be of interest, then surrounding structures would be modeled and added to the game.
Having the game web based with the ability for students to play in a web browser is of interest. That way it could be easily accessed remotely and utilized without having to download any software. There could also be a way students could log in and have profiles and assessment percentages associated to their user name. This way teachers could access there learning progress to make sure they are keeping up.

Conclusion

Playing video games is a fun and exciting way to learn when compared to traditional homework. There is strong potential for educational gaming to incorporate scientific concepts in which students are able to develop proficiency just by playing. As stated previously this convergence of education and gaming technologies can be the future of education. The Alternative Energy Center game has proven to be a great success at gaining attention from students and arousing interest in alternative energy technologies. With the addition of a narrative, three levels of goals and immediate feedback, the planned future of the game will provide a fun educational experience.

References

[1]   M. Evison, *Educating the next generation.*, vol. 48, no. 4. 2008, p. 196; author reply 196.

[2]   R. A. Berk, "Multimedia Teaching with Video Clips : TV , Movies , YouTube , and mtvU in the College Classroom," vol. 5, pp. 1–21, 2009.

[3]   L. A. Anetta, *Serious Educational Games: From Theory to Practice*. Rotterdam: Sense Publishers, 2008.

[4]   K. L. Mcclarty, P. M. Frey, and R. P. Dolan, "A Literature Review of Gaming in Education Research Report," *Pearson*, no. June, 2012.

[5]   C. Dede, M. Salzman, R. B. Loftin, and K. Ash, "Using Virtual Reality Technology to Convey Abstract Scientific Concepts," *Learn. Sci. 21st Century*, 1997.

[6]   ESA Entertainment Software Association, "The Entertainment Software Association - Industry Facts," 2014. [Online]. Available: http://www.theesa.com/facts/index.asp. [Accessed: 19-Feb-2014].

[7]   M. Griffiths, "The educational benefits of videogames," *Educ. Heal.*, vol. 20, no. 3, 2002.

[8]   M. Evans, *Videogame Studies: Concepts, Cultures and Communications*. Inter-Disciplinary Press, 2011, pp. 131–136.

[9]   M. Kebritchi and a Hirumi, "Examining the pedagogical foundations of modern educational computer games," *Comput. Educ.*, vol. 51, no. 4, pp. 1729–1743, Dec. 2008.

[10]   A. Amory, "Game object model version II: a theoretical framework for educational game development," *Educ. Technol. Res. Dev.*, vol. 55, no. 1, pp. 51–77, Sep. 2006.

[11]   J. P. Gee, "What video games have to teach us about learning and literacy," *Comput. Entertain.*, vol. 1, no. 1, p. 20, Oct. 2003.

[12]   G.-J. Hwang, H.-Y. Sung, C.-M. Hung, I. Huang, and C.-C. Tsai, "Development of a personalized educational computer game based on students' learning styles," *Educ. Technol. Res. Dev.*, vol. 60, no. 4, pp. 623–638, Mar. 2012.

[13]   M. J. Dondlinger, "Educational Video Game Design : A Review of the Literature," *J. Appl. Educ. Technol.*, vol. 4, no. 1, pp. 21–31, 2007.

[14]   M. M. Cruz-cunha, V. Hugo, C. Carvalho, P. Cristina, A. Tavares, K. Klinger, M. Brehm, K. Glazewski, N. Pronio, J. Romanchak, M. V. Jr, and J. Snavely, *Computer Games as Educational and Management Tools : Uses and Approaches*. Hershey: Information Science Reference, 2011.

[15]   Y. B. Kafai, "Playing and Making Games," *Games Cult.*, vol. 1, no. 1, pp. 36–40, 2006.

[16]   Y. Ma, D. Williams, L. Prejean, and C. Richard, "A research agenda for developing and implementing educational computer games," *Br. J. Educ. Technol.*, vol. 38, no. 3, pp. 513–518, May 2007.

[17]   ecoTECH, "ecoTECH Energy Group - Torrefaction Technology," *ecoTECH Energy Group, Inc.*, 2010. [Online]. Available: http://www.ecotechenergygroup.com/index.php/alternative-energy. [Accessed: 16-Feb-2014].