Use of Video Games to Enhance Construction Management Education

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ABSTRACT

Educators have been using the same traditional teaching methods for a very long time. New technologies that are being rolled out on an almost daily basis have a high potential in elevating the educational experience for both students and teachers. Using video games in education has been proposed and implemented on small scales. However, a complete transformation of the educational experience using video games has yet to be implemented. This paper discusses the theory behind such a transformation. In addition, the potential for video games to elevate the level of education in different subjects is explored. Finally, a brief outline is proposed for implementing the use of video games for teaching in the field of construction management.

INTRODUCTION

For centuries, teachers have been giving their students a segment of a topic and expected them to understand and apply that little part of the puzzle in a test environment. When the students pass that test, they are then introduced to another tiny piece of the topic. Even though these bits and pieces of the topic often build on each other, students usually fail to see the big picture that puts them together. On the other hand, the idea of introducing the students to the entire spectrum of a topic at once would not be feasible or effective, because the resulting information overload will deter students from even trying to comprehend what they are being taught.

Technology has given teachers new tools to present a subject to their students. From computers and projectors to PowerPoint presentations, the way to demonstrate the topic at hand has evolved substantially. Although this technology has enhanced the way teachers convey information to students, the teaching method has remained the same. The topic is still given out in small pieces that build on one another. This way of teaching shifts the majority of the responsibility to the student where they try to take a step back every once in a while to see how these pieces work together and form the system of the topics. This method of teaching has been in use for a very long time. However, an evolutionary method is starting to take hold and be applied for a better and faster understanding of many topics. Video games are a new medium in which students can gain endless knowledge while actually enjoying the process.

EDUCATION

The educational process evolved from the early days where knowledge seekers would gather around a master to gain all the wisdom they can grasp to the modern classrooms we have today. Even though the modern classrooms have a much more sophisticated means for demonstrating the materials taught, the teaching approach has not changed significantly. It is still based on the long-standing principle of having one expert conveying his or her knowledge to the surrounding pupils. This teaching method almost never gives the students the opportunity to explore and discover the subject on a personal level (Annetta 2008).

Education is in a great need for an evolution that would not only enhance the quality of current graduates but also make it more approachable to the next generation. The current generation is growing with various technologies around their daily lives that make finding any information as easy as pressing a button. This was not the case for the previous generations because they had to go through a more complicated process to find the same information. This, of course, does not imply that the new generation is smarter or more capable of applying the information and forming knowledge. It simply means that the new generation of students requires different ways and methods of teaching that would incorporate the current technologies they have access to. In addition, education should feed the curiosities of wondering minds instead of overloading them without their consents. Students should get excited about starting a new day at school and ask questions that they have been wondering about before going to bed the day before. Education should focus on painting a big-picture puzzle about each topic and allow the students to reflect on the little pieces they receive and try to make sense of the system rather than focus on the piece itself. Moreover, students should be encouraged to try and predict what the next piece of the puzzle will reveal and how it would complete the system and work with the other pieces.

The current educational system has worked for many decades and succeeded in educating brilliant minds that were able to add to the body of knowledge of many different sciences. However, the needs of the new generation of students are different and require a different approach in order to reach similar or even better results. Several professors around the U.S. understand that problem and have proposed different ways of conducting college classes (Hanford 2011). Just like driving a car, the learner cannot develop that skill unless he or she gets behind the wheel and drives. No amount of lectures or written tests can teach anyone how to drive without the practical part. Higher education should function on a similar way by encouraging students to discuss and conduct hands-on experiments.

Technology in Education. The new generation is being raised with technologies that the current generation is barely keeping up with. In addition, the new generation gets bored and uninterested in education the way it is now. The current education system does not seem to communicate using the same means that the new generation of students use. Therefore, using the same technology that students relate to might just be the most logical solution to revolutionize education. Research studies have shown that using interactive multimodal learning has increased higher order skills in participating students (Metiri Group 2008).This indicates that applying such an

approach is more favorable in higher education.

Many new technologies have already found their ways into schools and colleges. The use of these technologies is a good start in changing and revolutionizing the current education system. However, introducing the technology does not necessarily mean changing the method of teaching. Many schools have introduced new technologies such as the Smart Board and Apple's iPad but did not change the teaching approach or curriculum. Subjects are still being introduced to students using a piece-by-piece approach that does not emphasize, or even reflect, how the topic works as a system. Moreover, the same teaching method conveys the information for students as plain text that they have to take, understand and memorize for face value. In other words, the students are being fed the information without any interaction or hands on applications.

VIDEO GAMES

When the words "fun" and "interactive" are mentioned in the same sentence, the new generation tends to always think of video games. Video games are highly interactive virtual environments where users spend hours of playing every day without any complaints or regrets. The idea of spending that much time on a game can sound preposterous to an older person who comes from a previous generation and had no such exposure. However, the current generation spends a lot of time and money on video games. About 70% of American households own and play at least one type of video game (Foster 2011). Moreover, that number is expected to rise in the near future with the announcement of the latest technologies that will enhance the video game experience. The video games industry has become a large segment of the entertainment industry and will probably continue to expand even more as it gets developed and upgraded further.

Today, the video game industry has an estimated business value of $65 billion (Reuters 2011). The fact that video games have a huge share of the media sector enforces the value and impact they have on users. People are willingly spending so much time and money to play these games. More importantly, video game players would rather spend their time playing these games over studying or reading a book. This last statement might raise a flag to some who fear that the new generation's intellectual ability is in danger of degrading. However, the positive attributes of video games show that this fear is exaggerated.

Can Playing Video Games Make an Educational Contribution? Several scholars in many different fields have asked that same question. The logic behind it is that since the new generation is already spending so much time and putting so much effort in playing these games, why not use it in a way that would add to their knowledge rather than take away from it? When young adults spend, sometimes in a sneaky way, long hours playing a video game, their study time is cut short. Combining the two would produce a healthier environment where the students are gaining knowledge while enjoying it. However, the question still remains; is it doable?

Several game developers and educators have already fathomed the opportunity to produce such games that would elevate the level of education for different fields. Educational games for several fields including algebra, geology and biology have been developed and tested on a number of students yielding up to a 40%

learning increase over regular classes (Mayo 2009). This, of course, is a positive step toward creating a better educational experience and the potential for this approach is much higher. In addition, Foster (2011) demonstrated that participants in a study were able to gain disciplinary knowledge and skills after playing a video game based on strategy. All of this lead to the undisputable potential of video games serving as a good educational means. More importantly, video games offer a level of interactivity and involvement that makes them a suitable medium for education (Aldrich 2009). The question then shifts to a more focused one asking: What makes a video game educational?

When a hardcore teenage gamer is asked about any aspect of the fictional world in a game he or she plays, the answer to the question tends to be very thorough and complete to an astonishing level of detail. Many video games are based on complete fictional worlds that have rules and laws as far away from reality as possible. That fact does not deter dedicated gamers from learning every little detail about almost every part of the game. Players would have a complete understanding of what factors affect each other and how to manipulate them for their best interests. That aspect in itself is very astonishing and raises the point that almost every video game teaches the players about its content; be it real or fiction. The next question would be: How much would a video game that mimics real life in a simulation mode enables the players to learn about well-established sciences and processes?

Virtual Simulation vs. Video Games. Virtual reality simulations have been used for a variety of educational exercises from operating and flying an airplane to helping soldiers cope with post-traumatic stress syndrome (PTSD) by mimicking the battle environment to help them overcome the stress. Simulations have played a major role in giving educators in those, and several other fields create a better tool immersing their trainees in a controlled environment that would help them understand and learn on a higher level. The graduates of such programs gain not only the knowledge of their specific field but also an application of that knowledge which would empower them with a bit of experience at the start of their real work. Virtual simulations are more accurate in mimicking real world scenarios and effects than video games. However, video games have a very great potential in producing similar results where learning about the process or order of a system are involved. The main difference between virtual simulations and video games is the level of immersion associated with each of them. The main drive in virtual simulations is usually the educational factor. While the educational factor still remains in video games, a fun factor is the main drive in them. Fun would add another factor to educational video games, which is desirability. Students would have a higher desire and anticipation of playing a video game, regardless of its educational goal, than in going through a sheer virtual simulation.

CONSTRUCTION MANAGEMENT

The construction sector has always been one of the main industries in the United States and many other countries around the world. The higher demand for a skilled workforce that would oversee the complexity of construction projects has pushed construction schools to their limits. Every construction management school undergoes scrutinized re-evaluation for accreditation purposes and their programs are

then adjusted accordingly. In addition to accommodating the emerging new technologies and materials used in new projects, schools have always been trying to close the tremendous gap between the academic field and the professional one. Almost all students that graduate from a construction management school have at least the minimal required technical knowledge to perform their jobs. However, each graduate is faced with a steep learning curve when it comes to applying the learned knowledge in the professional field.

Even though students are taught almost every technical aspect about the construction project, they usually fail to see how each part of the project affects and is affected by different factors. This knowledge can only be gained through experience by going through entire projects and witnessing the effects of each decision first-handedly. Some courses in construction management schools take students on field trips to nearby construction sites in an effort to expose them to actual field conditions. However, students only get to witness a small snapshot of the project. In addition, getting several students on a busy jobsite increases the risk of injury for the contractor. The risks and potential task delays that accompany such site visits limit the amount of exposure for the students even further.

Another way of trying to minimize the gap between the educational and professional fields is the internship program. Such programs, found in many construction schools, are designed to expose students to field conditions and enable them to gain more experience. However, these internships are very short and are usually conducted during summer breaks for about three months. The students would be exposed to a very limited aspect of the construction project since most projects take much longer than three months to be completed. In addition, students would not understand the entire cycle of a construction project that starts at the bidding stage and end with commissioning and handing the building over to the owner. Short internships give students only a glimpse of what occurs on a construction projects.

Since construction projects are lengthy and would cost a lot of money and resources for a student to experiment with, the more logical approach would be to give the students the ability to run an entire project from start to finish, virtually. The virtual world has the potential to immerse students in the project environment while cutting down the associated cost and time significantly.

Virtual Simulation in Construction. Using computers to simulate construction tasks have been the topic of many research papers since the introduction of "Cyclone" in 1976 (AbouRizk and Shi 1994). Today's technology has given researchers valuable resources to conduct more accurate simulations. However, simulating an entire construction project is much more complicated than simulating one or two aspects of it independently. Construction projects involve too many tasks and have so many uncontrollable variables, such as weather conditions, that can change the outcome drastically. In addition, each task can affect and be affected by the other tasks. This complexity of construction projects is the main reason why it is very difficult to accurately simulate them. Therefore, simplified simulation for educational purposes has become the main focus for several researchers (Nikolic et al. 2011).

Several studies have developed and produced simplified simulation environments for educational purposes. Jaafari et al. (2001) developed VIRCON, a

tool for construction management students to plan and simulate projects in a virtual environment. The developed system paves the way for a more visually enhanced simulation environment. Lee et al. (2011) developed Virtual Construction Simulator (VCS3). This simulation software used is more advanced and gives students the ability to control resources to accomplish the project more efficiently. However, VCS3 can only simulate a small project and does not account for the human factor in such projects. On the other hand, Jaeger and Adair (2010) produced a discrete-event simulation software that focuses only on the human factors on construction projects. The program introduces students to different scenarios where they have to pick a response and learn how that affects the project. Although the software does not introduce users to actual construction projects tasks, the importance of human factors in construction projects make this product a valuable resource in educating the students. Lastly, Goedert et al. (2011) developed a framework for virtual interactive construction education (VICE). The product was a more visually enhanced simulation environment where students can make decisions and witness their effects on the project. The main downside of this product is scalability, since the program can only simulate a small residential project. Goulding et al. (2012) produced an offsite virtual reality training environment that would expose trainees to different scenarios in a construction project and simulate the outcomes of their decisions.

The above educational tools have one main factor in common in that they are simulation tools that have an educational dimension to them. Although the educational value might be high for some of these simulations, the "fun" factor is certainly missing. Simulating a construction project is a very complex process. That is why most of these simulation tools run on a small scale. These tools have the potential to add to a student's knowledge but they lack the element of desirability. Students would learn to use them and execute what is asked from them but their potential of being used in their personal time is not very likely.

Construction Management Video Game. The main component in entertaining video games that attract hours of gameplay is "fun." Once that component is taken out or diminished, the game turns into a simulation software that might not introduce the same level of desirability. Typically, students would not voluntarily cut down video game playtime to read or study. That is why combining the two would revolutionize the way students are taught. There are many simulation-strategy video games in the market. These games are usually open-ended and users can keep on playing for an unlimited amount of time. What is very appealing about these games is that they are highly interactive in a sense that players manipulate many different items at the same time. Players would spend hours trying to achieve a higher status in the game depending on how they handle resources.

Construction projects require a high level of strategy to be successful. The project manager has to allocate resources such as heavy machinery and manpower where needed to minimize idle times and expedite the progress of all projects. That is why a simulation-strategy game is perfectly suitable for construction management education. This type of video game is a good fit for this particular use because it can be accepted in the educational community as an educational tool. Unlike other video games that might come across as childish, strategy games usually have a more serious environment and feel. This, of course, should not affect the fun factor in the game.

The proposed game, codenamed "Convex," is an under development project at the University of Florida. The game has a high potential in introducing students to the many variables in a construction project. In addition, the game is designed to be based on real construction workflows and variables. As educational as this game could be, the main drive behind the project is to produce a video game that targets students as the intended audience. The game should speak more to the students rather than to professionals.

Just like any other simulation-strategy video game, Convex would evolve as the player gains more experience and levels up. The player would start the game working as a project engineer for a newly established general contractor in a fictional city. The player would then look around the city, in a birds-eye view, looking for new projects to bid on. After the player locates an interesting project, he or she has to go through a standard data set about how much similar projects had cost per square-foot. Players can adjust the price manually to add overhead and profit. In addition, players can go into further details about the past projects' costs and adjust each discipline independently. The game's algorithm would then determine if the submitted bid could win the project or not.

After winning the first bid, the player is then taken into the project site view where they can prepare the site layout. Players would then assign resources and manpower as necessary throughout the project. The critical part of the game is maintaining a positive and healthy cash flow that would enable the company to survive and even grow. The best way to ensure the cash flow is positive is by issuing payment requests to the owner on time. Players have to be on top of every aspect of the project from ordering long-lead items early to assigning safety officers to avoid any injuries that might delay the project.

Players would have the ability to zoom out of the site view and go back to the city view where they can locate and bid on other projects. The more projects the player is handling at the same time, the more complex the game gets. Main milestones in the game would be achieved with the amount of profit the player's company has registered. The endless possibilities of such a game is what makes it appealing, especially to the video game community. The educational aspect of the game is an added layer to the main one, which is entertainment.

CONCLUSIONS AND RECOMMENDATIONS

The educational system is in need of a revolution that would improve the quality of graduates, especially at the college level. The new generation of students has different needs and communicates using different means than the previous ones. Education should try to keep up with the evolving technology that seems to be the language of the new generation. Using video games as a means to educate the upcoming generation of students should be one of the main aspects that education should focus on. The new generation spends an extended amount of time in playing such games. Adding an educational layer to such highly addictive games can elevate the level of knowledge in the near future.

Construction management education has been focusing on task related issues while almost ignoring the process and system of such projects. The proposed construction management video game has a high potential in graduating a higher

level of new entrants in the professional field. The game would add an experience level to students' learning. Even though the added experience level is virtual, new graduates who played the game are expected to have a better understanding of the industry and are expected to cost employers less to train. Future studies will involve the tracking of graduates to gather long term data to validate the effectiveness of gaming in elevating the knowledge and skills of construction management graduates.

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