Integrating Serious Games in Higher Education Programs

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Abstract

Computer games are mental challenges with the help of a computer or against it. Serious games are computer games with entertainment characteristics, but designed for serious purposes like corporate training and education. Educators could integrate serious (digital video) games into their classrooms by: collaborating, adopting, writing, creating, and adapting. Because creating a digital game is not an easy process for educators, educators adapt an existing COTS game through modification, or modding. Modding is a design process that allows game modders to explore concepts, apply skills, and test them within virtual environments that mimic the real world. Finally, there is a need for a new instructional design model to be crafted to guide teacher-designers and serious game designers to achieve a good balance between entertainment and learning in the serious game.

Introduction

Games can be defined as a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participants. Where computer games are concerned, players may be described as engaging in the same mental challenges or contests "for amusement, recreation, or winning a stake" (Zyda, 2005), either with the help of a computer (as a conduit), or against it (in which case, the computer becomes the challenger).

Although the video game industry, game developers, researchers, and academia may use different taxonomies to categorize video games, most would probably agree to the following seven genres (Gros, 2007):

(1) **Action games (platform games)** – reaction-based video games (e.g., Pokemon, Super Mario Brothers).

(2) **Adventure games** – games where the player solves a number of quests in order to progress from scene to scene (like a story) within a virtual game world (e.g. Myth).

(3) **Fighting games** – games that involve fighting against computer-controlled characters or those controlled by other players (e.g. Soul Caliber, Tekken).

(4) **Role-playing games** – games where players assume the characteristics or roles of certain fictitious persons or creatures (e.g., Neverwinter Nights, Alpha Protocol).

(5) **Simulations** – games that are modeled after natural or man-made systems or phenomena; and in which players have to achieve particular pre-specified goals to succeed (e.g., fire-fighting, flight-simulator).

(6) **Sports games** – games that are based on sports (e.g., basketball, football) or vehicle racing (e.g., Nascar, Grand Turisimo).

(7) **Strategy games** – games that recreate historical or fictional situations to allow a player to devise an appropriate strategy to achieve the end-goal (e.g. Three Kingdoms, Dawn of Discovery).

The younger learners of the 21st century have grown up playing a plethora of computer games which include a great variety of activities ranging from real-life to pure fantasy. Researchers believe that what seemed like "casual playing" to the non-participating observers actually involve "deep learning" because the players must constantly "react to the challenges presented in the game activities" in order to problem-solve and meet objectives laid out in game quests (Squire, 2006, Prensky, 2001). Such learning can be physical (pressing certain buttons in a correct sequence), intellectual (recognizing certain contextual clues or puzzle-solving), or even emotional (showing empathy with the game characters).

Serious (Digital Video) Games

The Serious Games Initiative was founded by Ben Sawyer (of the Woodrow Wilson Center for International Scholars in Washington, D.C.) in 2002 to focus the industry's attention on digital (computer) games with objectives beyond pure entertainment – including the use of digital games for health care, business, politics, and education (Joseph, 2010). Sometimes, educators may use different terms to describe serious games, these include: digital game based learning (DGBL), instructional video games, etc.

In this paper, serious games are defined as computer games with entertainment characteristics, but are designed for serious purposes: to achieve corporate training, education, health, public policy, and strategic communication objectives (see Zyda, 2005 and Loh, 2009). As such, serious games may include a wide range of digital games that are playable from personal computers (PC), to portable handled devices. They may be playable by one single player, or by multiple players. In the case of the massive multiplayer online games (also called MMOG or simply MMO), groups of players might even communicate with one another prior to game sessions, in order to coordinate their "work" (i.e., serious playing). Some of these games attract players from all over the world who are connected to the game server via internet. In order for them to communicate with one another effectively during game play sessions, MMOG players make use of e-mail and voice chat to communicate and coordinate their play (Joseph, 2010, Dickey, 2007).

Although educators believe that digital games contain "elements … that can be activated within an instructional context that may enhance the learning process" (Prensky, 2001), most

educational games (available prior to 2005) were not designed for instruction or teaching per se but were part of a larger training (software) program (Prensky, 2001). Educators tend to regard digital educational games of the time as a "marriage" between digital games and educational content. Unfortunately, this approach to creating educational games (or, edutainment) did not serve the games or the educators well, because they did poorly in both aspects (van Eck, 2006).

To explain how video games/serious games work to engage players and keep them involved in the game play, Prensky (2001), Gunter, Kenny, & Vick (2008), Garris, Ahlers, & Driskell, (2002), describe a cycle of "user judgment>user behavior>system feedback". When a player begins playing a digital game, he/she first forms an initial subjective judgment about the game: whether the game is fun, interesting, or enjoyable. This initial judgment then directs the quality and the intensity of his/her behavior. For example, a game perceived to be interesting might lead to a greater intensity of involvement during play. The level of involvement (user behavior) in the game play could then be seen as system feedback or reaction within a game context.

Taking Advantage of Game Characteristics for Learning

Digital games (serious or not), share a minimum number of traits that make them successful and engaging as learning activities. These traits include (Prensky, 2001; Garris, Ahlers, & Driskell, 2002; Dickey, 2007):

- *Back-story and story line* – every video game has a back-story, the player achieves the game goal by moving through this story line to it is end, the story line services as a rationale for the game play.
- *Game mechanics* – it controls the functions within the game and makes the game physical world behave in a certain way. Video game mechanics allow designers to build unique imaginary environments that users can't find in other media.
- *Fantasy* – video games involve imaginary worlds with no connection to real life consequences. This fantasy makes players explore new situations not part of their real life activities.

- *Rules/goals* – video games have space and time governed by rules. These rules allow players to apply a wide range of actions within the game context. Serious games have clear sequenced goals that lead to active learning.
- *Sensory stimuli (immersive graphical environment)* – video/serious games allow designers to apply sound effects and dynamic graphics to grab players' attention and motivate them to play and learn.
- *Challenge* – video/serious games have clear playing goals with uncertain possibilities for achieving them. Video/serious games usually apply progressive difficulty and provide feedback and score keeping. Educators can use these challenges in the serious game context to improve learning.
- *Mystery* – in most adventure and role playing video games, players explore unknown environments, and encounter imaginary situations. This mystery increases their curiosity for playing and drives their learning.
- *Control* – in video games players control, direct, and command their play. This control increases their motivation to play and learn. Thus, control allows educators to design interactive learning activities in the video game context.

These characteristics allow educators to build authentic learning situations and contexts that emphasize concept building and higher level thinking skills into serious games, instead of drill-and-practice activities – found in many Flash-based quizzes and games – for memorization and rote learning. In fact, there are several approaches by which educators could integrate serious (digital video) games into their classrooms:

1. *Collaborating* – Educators work with developers to create new educational games for teaching (i.e., new curriculum and instruction).
2. *Adopting* – Teachers integrate games activities from commercial off-the-shelf (COTS) games into classroom activities (see Squire and CIV). COTS games have been seen to cross multiple disciplines (art, English, mathematics, psychology),
3. *Writing* – Have students create/write new adventures/stories using video game toolsets using a creative story writing "process".
4. *Creating* – Have students learn to write (or program) a new game from scratch as a learning activity

5. *Adapting* – Teachers modify (mod) commercial games for educational purposes (van Eck, 2006).

Adapt and Modify Game for Educational Purposes

Serious game integration can take place within the classroom as in-class learning or instructional activitie; or outside the classroom as extra-curricular projects or student assignments. The modification (or, modding) of COTS games, in particular, has seen a number of variations within the classroom as learning activity, for example:

- for experiential learning (or learning by doing) – NIU-Torcs, a game designed to teach mechanical engineering by Coller and Scott (2009);
- for the teaching of computer programming, logical thinking skills, and script writing (Carr, Bossomaier, & Lodge, 2007, Hanson, 2005); and
- as a technical platform to introduce children to information technology and story-writing skills (Robertson & Good, 2005).

Game Modding

Because creating a digital game (from scratch) is not an easy process for game designers (more so, for educators), adapt an existing COTS game through modification, or modding, this has become a highly attractive means of amateur game creation activity. Modders, or people who engage in game modification, make use of game development kits (GDKs) that are often included in the games to create new game play experiences (like creating new weapons, characters, enemies, models, textures, levels, story lines, music, etc.) for other players. The game modding process not only saves time and cost (as it is included in the game), but also reduces the requirement for programming knowledge for players who are non-programmers. The lack of programming knowledge, especially, has been a huge obstacle that prevents non-programmers from making their own games from scratch. Game modding finally opens up game creation as a plausible educational activity for teachers and school children.

As a game design activity, modding is useful for the teaching and learning of instructional content, thinking skills, and learning strategies. The design process allows the game modders (in this case, teachers and students) to explore concepts, apply skills, and test them

within a virtual environment that mimics the real world. The modding process not only provides a meaningful and engaging context for the modders to learn, but also allows them to create new knowledge structures and mental models. As such, it is a constructivist activity because the modders are engaged in constructing products that are personally meaningful. A modder must: undergo the constructivist process of creating, evaluating, and revising the artifact over time; work independently or as a group to create prototypes, implement them, and test the prototypes with real users; observe the consequences of their game design decisions, receive feedback from game testers; and even express notions of cultural identity within the game (see Seif El-Nasr, & Smith, 2006). Therefore, game modding can also be regarded as a social environment in which learners and mentors interact within a learning context in order to solve a realistic problem through "learning by doing."

Moreover, visual literacy is frequently more important than that for written literacy in today's modern culture (Gros, 2007). Learners who are using serious games have the additional advantage of interaction with virtual (and often, highly graphical) environments filled with diagrams, pictures, symbols, and 3-dimensional objects. Such visual literacy not only affects the student players, but also, the teacher designers.

Teacher designers who used GDK to create immersive game environments to facilitate learning need to apply the concept of "engagement" with a game context in order to build engaging activities for the students. As learning is mostly problem-based and driven by meaningful scenarios, teachers must construct problems that will take into consideration, prior game experience, besides presenting knowledge and facts (Squire, 2006). The ability to construct meaningful and engaging problems for learning is an important skill for teachers in the creation of effective learning environments within the classrooms. As more GDKs become increasingly available with today's COTS games, more researchers and educators are learning to create new instructional contents through game modification. Examples of serious games modified by researchers and educators include a game about Einstein's theory of relativity by Carr, Bossomaier, and Lodge (2007), a game about the American civil war by Squire (2004), and a game for teaching High School Health and Science Education by Loh, Byun, Anantachai and Lennox (2008). Other serious games include learning content such as: science, history, languages, health skills, etc.

Adapting COTS Games

Some COTS games, such as Civilization and SimCity, include educational contents that may be adapted for the instruction of life-skills, such as management, languages, economics, etc. For example, SimCity 4 has been successfully adapted to help teachers in the instruction of geometry and civil engineering concepts (Bleah, 2005). Computer Science educators have also reported using the game modding process to teach information technology (Werner, Campe, & Denner, 2005). Seif El-Nasr and Smith (2006) reported two studies in which game modding was used successfully for instruction at high school and college levels. Instead of passively learning about modding, El-Nasr and Smith found these students actively applied what they learned to create new knowledge, and to adapt an existing complex system to fit their needs. Robertson and Good (2005) also reported that secondary school students gained more self-esteem and worked better in teams after attending a course in narrative writing through digital game modification.

Teachers' Perception in Using Digital Games

Teachers will respond differently to the term, "serious games," depending on their exposure to and experience with digital game playing. Before they could successfully integrate serious games into educational settings, it is necessary for both the teachers and the students to become proficient with playing digital games. After studying about the factors that inhibiting teachers' from using video games effectively in the classrooms settings, Baek (2008) reported the following factors:

(a) experienced (older) teachers and parents often worry about students become addicted to gaming,
(b) lack of supporting materials to help teachers integrate serious games into classrooms,
(c) rigid curriculum and fixed class schedules are major obstacles in the adoption of serious games by teachers, and
(d) more experienced (older) teachers are more resistant to the use of serious games in the classrooms than their less experience (younger) colleagues.

Digital Native Teachers

It is clear that those younger teachers – i.e., "digital natives" (Prensky, 2001), who grew up using digital technologies (e.g., computers, videogames, and digital music players) are more likely to accept and respond positively to the use of serious games in the classroom. On the other hand, more experienced teachers (who are "Digital Immigrants") are more conservative and reserved in their willingness to use serious games.

Like teachers in other part of the world, Palestinian teachers may also be separated into digital native and digital immigrants, in terms of their attitudes and comfort levels in using new technologies, including serious games, for instruction within classroom settings. A second factor that might influence Palestinian teachers' perceptions and attitudes is their past experience in playing video games. It is expected that teachers who are familiar with video game playing will be more ready to adopt serious games than the teachers who are not game players.

A third factor that might affect how teachers adopt serious games might be their educational level and the curricular subject area they teach. Teachers who are teaching in information technology and computer science subject areas are likely to be more receptive to serious games than other teachers. In order for new technology to be successfully adopted into the classroom, it is imperative to change teachers' and administrators' attitudes towards the technology and to provide sufficient administrative and technology management supports in helping them facilitate learning for their students.

New Instructional Design Models

The success of new instructional technology is usually accompanied by effective instructional design models. Instructional designers need to refine and enhance their instructional design models to take into account the use of serious games. Good instructional design is rarely easy. Designing serious games (from scratch or by modification) will likely require even higher level skills in "instructional design, game design, high-end production and software programming" (Kirkley, Tomblin, & Kirkley, 2005). Most commercial games designers have few instructional design skills. The reverse is also true, in that most educators and instructional designers have little game design skills. To reduce the complexity of designing a serious game

(from scratch), educators would do well to make use of game modding to create small-scale serious games using GDKs provided by COTS games.

There is also a need for a new instructional design model to be crafted to guide teacher-designers and serious game designers to achieve a good balance between entertainment and learning in serious games. Such an effort is already underway, as researchers, educators, and instructional designers become familiar with the game making or modification processes in creating these game-based virtual environments for instruction.

A 10-step model for serious game design was presented by Loh (2009), as follows:

1) *Determining target audience and learning content:* Fully analyzing the characteristics of the target audience and to determine the learning objectives we are going to attain.
2) *Determining the amount of funding and time available:* Designing a serious game from scratch needs a long time period. Modding a game to build a serious game is less time and funds consuming.
3) *Writing game narratives:* Listing all the props and characters needed to stage the game story.
4) *Selecting the GDK/Game Bundle:* Selecting the best development platform that fits effectively with the target audience, content, and story narratives. When modding a game, designers need to pay attention and work with "finite resources provide by the GDK/game bundle."
5) *Video game design and game mechanics:* Early prototyping to test the game design. During this step, the game world is designed as well as the player and non-player characters.
6) *Interactive learning instruction design:* Designing and implementing learning activities with suitable assessment process. It is important to apply clear teaching strategies and sequence the difficulty of the learning activities.
7) *Integrated assessment framework:* Some video game engines allow for collection of data during game play. This performance data can be used as an assessment tool and provide a clear idea about this performance.

8) *The game development cycle:* During this step, programmers will be working on software functions and voice artists and musicians will be recording voiceover for NPCs and background music, etc.
9) *Beta testing and usability testing:* It is necessary to insure product quality by testing the game, players may be used to test-play the game and test the usability of the game.
10) *Public release:* The development project ends with the pressing of the master/gold CD of the finished game. Most companies do not pay attention to improving their commercial video games after sales. However, in serious games it is necessary to receive feedback from customers and to improve the product.

Because serious games are new instructional media, Loh (2009) believes that "efficacy assessment"– collecting empirical data for the evaluation of the cost-benefit ratio of serious games – is an important aspect of serious game design. It is clear that the Loh model originated from the general instructional design model; i.e., Analysis > Design > Development > Implementation > Evaluation (ADDIE).

Kirkley, Tomblin, and Kirkley, (2005) adapted the Systems Approach to Training (SAT) Process, which is a spiral approach to making self-development training decisions, to develop Simulation-Games Instructional Systems Design Model (SG-ISD). This model is suitable for educators modifying commercial video games for educational purposes because it has a modding process. Therefore, this model is useful for designing the entire serious game as well as modding an existing game by changing its scenario, learning objectives, and evaluation.

This model will have the following steps if a small group of educators or a teacher were to adapt it for modding or designing a video game.

Analysis:

- Needs analysis: present a clear justification of why you need to design a video game.
- Target audience analysis: analyze and document target audience characteristics that have an influence on design decisions like: gender, age, experience in playing video games, etc.

- Instructional theory: analyze the learning theories and decide which one to follow in the design process. Are you going to use and implement constructive, cognitive, or behavioral learning theory in your design process and why.
- External data: analyze external constraints that might influence your design decisions like budget, time, technical support, or the number of computers available in the school.

Concept:

- Learning methodology: there are different learning methodologies that have been applied effectively in serious game design like: drill and practice or practice and feedback, learning by doing; learning from mistakes; goal oriented learning; situated learning; discovery learning, etc. Decide which learning methodology to adapt and apply.
- Games features: depending on the data revealed from the analysis phase and the learning methodologies, decide what game features are relevant and suitable for your game. When modding an existing game it is very important to understand the game features or the toolset first before making any decisions.

Design:

- **Storyboard script:** this part is very similar to that of a movie script. The game designer progresses through each scene of the story and details all the necessary information. The storyboard has the following parts:
    1. **Game story:** the game story works as a skeleton that carries all other scripts. The game writer should write a complete story line, from the opening scene of the game through the major steps all the way to the completion of the game. Therefore, the players achieve the goals of the game by moving through this story line to its end. It is important to write a game story that fits with the educational objectives and gamers'/learners' characteristics.
    2. **Describe your game world**: as game writer you should describe your game history and explain what the world is like, and what kind of history it has. These descriptions are guidelines for designing this world and writing other scripts.
    3. **Write sub-quests and pose an overview for each sub-quest:** it is better to write a learning hierarchy map that analyzes the story line of the game interaction to its components or sub-stories (Loh, 2009). In each sub-story we can implement game

sub-quests. Game sub-quests can be simple or complex but each one is a story in itself. The game writer must tell these stories.

4. **Write interactions with non-player characters:** your game will probably involve interaction with non-player characters (NPC's). You should write out the dialogue and flowchart the choices the game player can make. These interactions are often critical to the story and they can take the player on very different paths toward the conclusion of the game. Remember that this interaction is part of the sub-quests you are designing in the game.
5. **Write cut scenes:** cut scenes are short animations or movies that come before or after major plot points in your story. A cut scene should always be written to enhance or describe the story. A cut scene is also a reward given to the player for achieving a major milestone in game play.

- **Lessons Plans/Educational quests:** some game sub-quests include learning contexts in which the player learns an educational objective in the game environment by executing these quests. Writing a hierarchy map will help the writer build clear gaming and learning sub-quests and relate them effectively to the game story line.

Prensky (2001) summarized eleven learning techniques that are used in digital game based learning as follows: (1) Drill and practice or practice and feedback: the video game presents a series of problems and tracks how people answer them. It is better to use this technique when learning requires repetitive practice. For example, Slam Dunk Typing uses this strategy to teach the players typing skills. (2) Learning by doing: the game allows the user to interact with its environment by exploring, discovering, and problem solving. Drill and practice is one form of learning by doing. (3) Learning from mistakes or trial and error: the game motivates the player to continue trying until succeeding in achieving its goal or sub-goal and provides the player with action feedback. In most cases, something happens to the player while trying; he loses or dies. (4) Goal oriented learning: achieving a game goal is what motivates the player to keep trying. This happens by informing the player right at the beginning of each quest, of what he should do to accomplish it. (5) Discovery learning: it is solving a given problem by searching data, structures, or clues. A game can structured this discovery by providing the players with a

clear idea of what the problem is, and what they need to solve it, at any time. (6) Situated learning: This is designing the game environment to be similar to where the learning material will be used and applied in the future. This includes designing the physical, cultural, and social learning environments. (7) Task based learning: in task based learning, the learner goes directly to solve a problem without starting with conceptual explanation and demonstration. The game provides the gamer with required information directly when using it. It is possible to increase the difficulty of these tasks by gradually sequencing them. (8) Questions-based learning: forcing a player to answer a question in a game environment will force him to think about the question and the required information to answer it. (9) Role playing: in role playing games, the gamer plays the role of a given character. The game uses role playing as learning a strategy through designing the interaction of this character with other elements in the game environment. (10) Coaching: the game uses practice missions in the game environment to coach players in their way to complete a complicated task. (11) Multisensory learning: in this case a game has a multisensory game environment that supports the player with multisensory experiences to interact with and learn from.

- **Character:** create character descriptions and bios for all of major characters in the game. Many of the non-player characters you create will pop up time and time again and their story is woven deeply into the fabric of your world. You need to describe this relationship in detail and how it appears in each sub-quest.
- **Assessment:** as designer you should explain what assessment components are included in the game and how to present them.

Technical Design and Prototype Implementation: Once the game designer has finished writing all of the game scripts it is time to construct the media, implement the prototypes, and produce the lessons. Prototype implementation will help the designers test out the look (design) and the feel (mechanics) of the proposed game (Loh, 2009). It is good to do this as early as possible to take time to balance all the game objects. Finally, the designer needs to pilot the game and receive feedback from users before its final use. This testing includes: bug testing, usability testing, play/fun testing, and learning testing.

Conclusion

Serious games are e-learning tools that have unique educational characteristics. These characteristics allow educators to build authentic learning situations and contexts which emphasize concept building and higher level thinking skills. To integrate serious games effectively in classroom activities, teachers need to adopt new roles as game designers and game modders and educators should build new instructional design models that fit with the new technology.

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