

Utilizing Multiplayer Video Game Design Principles to Enhance the Educational Experience in 3D Virtual Computer Supported Collaborative Learning Environments

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Abstract— The goal of this paper is to determine how the effective design principles of popular video game franchises can be adopted and adapted in order to enhance the students' educational experience in 3D virtual Computer Supported Collaborative Learning (CSCL) environments. This paper also analyzes how combining the fundamental characteristics of video games and gamer personalities may allow instructional developers and teachers to explore exciting new opportunities for collaborative learning on the Web and within 3D CSCL environments.

Keywords- *game design; collaborative learning; game-based education; 3D virtual environments;*

I. INTRODUCTION

Serious games are being described by some analysts as the next wave of technology-mediated learning [2], by offering a powerful, effective approach to learning and skills development. When game design focuses on learning outcomes, then, while preserving playfulness, serious learning is possible. The goal of this paper is to determine how the effective design principles of popular video game franchises can be adopted and adapted in order to enhance the students' educational experience in 3D virtual Computer Supported Collaborative Learning (CSCL) environments. More specifically, this paper proposes the approaches of game based collaborative learning and computer supported collaboration as suited to exploit the characteristics and competences of contemporary students. In order to complete the goal stated above, the paper examines the fundamental characteristics of video games and gamer personalities and how these can influence the design principles of 3D virtual CSCL environments and augment the pedagogic advantages of game based learning. This paper is structured as follows: the next section examines contemporary pedagogical approaches and introduces the concepts of collaborative learning and computer supported collaboration as an alternative. Following that, the paper presents fundamental elements of game design, as well as the characteristics and attributes of avid gamers. Next, the paper describes how the properties of both games and gamers could be adapted to an educational setting. Conclusions and future work are discussed in the final section.

II. CONTEMPORARY STUDENTS, PEDAGOGIES AND COLLABORATIVE LEARNING

Traditional pedagogies have a bureaucratic nature, which is expensive to run and doesn't scale well [4]. Furthermore, they are

inflexible and organized around annual examination 'diets'. A bibliographical study reveals a common set of characteristics for the contemporary student with respect to their learning styles and their educational habits [4]. These are:

- Skilled use of tools - Students are already using Web 2.0 services and ICT tools as part of their everyday lives. Modern pedagogy should exploit these abilities, by altering the context, medium and evaluation criteria of educational material.
- Active learning rather than passive receiving of knowledge - A major theme in the theoretical framework of constructivism is that learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge [11]. In other words, active learning through interaction with the environment causes qualitative and quantitative changes in the already existing cognitive structures.
- Authentic learning experiences rather than contrived tasks – Authentic learning experience can include real/ fictional work scenarios which have been documented and solved, or real work issues which remain problematic. Allowing students to tackle authentic unsolved issues can convey to them a real sense of purpose; can enhance their critical thinking abilities and can help them hone their communication and collaboration skills.
- Search, not memorize - Forcing students to memorize facts can numb the brain with seemingly trivial knowledge. Contemporary students should be assessed based on their ability to recover the necessary factual information, and to utilize combinatory logic and analytical cognitive capabilities in order to solve real life tasks or participate in realistic simulations.
- Collaboration not competition - Collaboration allows students to share knowledge, tackle problems that are beyond their individual cognitive capabilities and allows participation in relevant communities of practice.

A. Collaborative Learning

The typical features and preferences of contemporary students, mentioned in the previous section, can be supported by utilizing the collaborative learning didactical approach within a game-based educational environment. Collaborative or group learning refers to instructional methods whereby students are encouraged or required to work together on learning tasks [8].

From a pedagogical and constructivist perspective, collaborative learning methods tend to encourage construction of

knowledge, deeper understanding and greater skill development through their ability to engage students dynamically in the learning process [5]. Depending on the set objective, collaborative techniques can be used independently of, or in combination with each other.

B. Computer Supported Collaborative Learning

As one of the most promising innovations to improve teaching and learning, CSCL utilizes the help of modern information and communication technology [8]. Bruckman and Bandlow [1] summarize the most important benefits of using CSCL in education. Among others they mention that, using CSCL, teacher-student interactions become more balanced and gender differences are reduced. They also point out that the exploitation of a virtual environment: a) lowers inhibitions; b) provides strong anchors from which classroom discussions can emerge; c) can be enjoyed by multiple different personality types; and d) aids students in discovering aspects of their own identity.

A Collaborative Virtual Environment (CVE) is a computer-based, distributed, virtual space or set of places. In such places, people can meet and interact with others, with agents, or with virtual objects. CVEs might vary in their representational richness from 3D graphical spaces, 2.5D and 2D environments, to text-based environments [7]. Access to CVEs is by no means limited to desktop devices, but might well include mobile or wearable devices, public kiosks, etc. When CVEs are used for education, they are referred to as Collaborative Educational Virtual Environments (CEVEs). CEVEs are powerful and engaging collaborative environments for eLearning, capable of supporting several important learning objectives and pedagogical scenarios.

III. VIDEO GAME DESIGN AND GAMER CHARACTERISTICS

Every computer game is designed around the same central element: the player. While the hardware and software for games may change, the psychology underlying how players learn and react to the game remains a constant [12]. Behavioral psychologists look for general "rules" for learning and for how minds respond to their environment. Because of the species - and context - free nature of these rules, they can easily be applied to novel domains such as computer game design. Therefore, by exploiting basic rules of behavioral psychology, game designers can achieve outcomes such as increasing the length and intensity of play. To intensify play, a designer could implement a variable ratio schedule, one where each response has a chance of producing a reward. Furthermore, to prolong the duration of play, designers have to make sure that there is always a reason for the player to be playing. This involves sustaining "behavioral momentum", a tendency to keep players doing what they're doing even during the parts where there isn't an immediate reward.

Moreover, two types of immersion in video games can be distinguished: a) visual immersion, and b) emotional immersion. In visual immersion, there is a chain of events in the best games that goes from camera (i.e., the view of the game world) to character (i.e., the vicarious experience of instilling your own persona into the game) to controller (i.e., pressing a button and seeing an appropriate action) and back to the camera (i.e., what you see in the game). In addition to this, there is also an emotional response, a trigger that makes us care about a plot change or a new character development (i.e., emotional immersion).

Research [10] identifies four ways that videogames produce narrative: evoking a pre-existing narrative association, providing a staging ground upon which narratives may be created, imbedding narrative elements, and providing resources for emergent narratives. Moreover, games are structured in very literal stages, like missions, levels, or worlds. This structure, in combination with power of

story, curiosity of exploration and diverse challenges can further engross the player.

For the ideal in game play, the goal every developer aims for is an experience that keeps players in a "flow" state, constantly surfing the edges of their abilities without getting stuck and frustrated [6]. According to Bogost et al. [10], the best content understands exactly how the player likes to play, and makes it slightly harder. It seems custom procedural variations in a limited environment can be more fun than big environments and open worlds.

Gamers have been identified as "super empowered hopeful individuals" [13]. According to GamesRadar UK [9], other gamer characteristics, brought on as after-effects of multiple years of gaming experience, can include:

- Heightened concentration – being completely absorbed and immersed in the gaming experience, gamers can block off the world around them and focus entirely on the task at hand, increasing productivity and efficiency.
- Increased intelligence – games can teach the importance of tactics, prioritizing and economics. However, according to Owen et al. [3], although specially designed games such as computerized brain-training programs can provide improvements on trained cognitive tasks, there is no evidence that these effects transfer to untrained tasks, even when those tasks are cognitively closely related.
- Better hand-eye coordination – through playing video games on a regular basis it is possible to train hand and eye to work together in order to execute the most precise and complex procedures. Referred to by Thompson [6], a study in the February 2007 issue of "Archives of Surgery" found that laparoscopic surgeons who excel at videogames make 47 percent fewer errors and work 39 percent faster than their peers.
- Increased stamina and determination – challenging tasks with an incremental level of difficulty teach gamers to push through the tiredness, have one more go and see a game through to the end.
- Better multi-tasking – video games have progressed from single buttons to mouse and keyboard combinations or controllers featuring multiple analog sticks and more than ten pressure sensitive buttons.
- Better awareness – video games teach users to pay attention to their surroundings so that they instantly pick up on all the necessary information to prolong game time as much as possible.

IV. 3D CSCL GAME-BASED DESIGN

A report from the NPD Group, a New York-based market research firm, reveals that 72 percent of the U.S. population played video games in 2007, up from 64 percent in 2006 [14]. Furthermore, at present, 24% of Americans over the age of 50 play videogames, compared to just 9% back in 1999. This increasing interest in games indicates the potential for using online computer gaming as a method of implementing traditional and novel learning theories. According to McGonigal [13], like games, novel classroom experiences must be designed in such a way in that there is no fear of failure, with greater sociability and knowledge sharing and feedback which is consistently positive and constructive.

A. How can an educational environment become more engaging, entertaining and addictive?

Educational activities should adapt to the challenge of a task dynamically, finding exactly the mastery level at which the student

succeeds. By tracking this mastery level over time, educators would be able to measure and provoke improvement. As previously mentioned, every developer aims for an experience that keeps players constantly surfing the edges of their abilities without getting stuck and frustrated. One of the most fundamental techniques for engagement in entertainment media is the power of story. Within an educational context this could include a realistic scenario which envelopes the complete course material and enables students to participate through role play. Although educational material is usually organized into levels of complexity, such as basic, intermediate and advanced, this structure is not as literal as in games. This distinction of levels should be further emphasized in education by providing diverse challenges, with gradually increasing difficulty peaking the learner's curiosity and determination, within a meaningful realistic scenario.

Furthermore, students should be able to unlock achievements and enjoy specific rewards which enable them to tackle even harder challenges. The students should not expect the educator to provide all the answers and satisfy their curiosity and interest. Motivated by specific tasks, the students should explore the vast sources of the Internet, learning to mine for valid data and quality information from trusted authorities.

B. Which are gamer traits that can be exploited in an educational context?

Gamers are willing to work hard if they are given meaningful work within the appropriate context. The educational material doesn't have to be static and impersonal. Users should be able to add their personal touches, substituting their role of consumer for the one of creator utilizing their ability to prepare for and handle the surprising results and complexity that occurs at larger scales. In addition, this approach and attitude will provide learners with that epic meaning they long for: participation in helping the education of future generations of students and leaving behind an enduring legacy. Furthermore, the gamers' ability of heightened concentration and better awareness can be utilized for the filtering of meaningful info, patterns, and commonalities from massively-multiple streams of data, such as the Internet. Finally, exploiting the increased intelligence and determination of gamers, educators should provide cognitive challenges indicating that each context and space requires a different persuasive strategy and technique.

V. CONCLUSIONS AND FUTURE WORK

Growing research shows the educational effectiveness of constructivist and collaborative learning in 3D Virtual Learning Environments (VLEs). Several VLE features are considered supportive of knowledge construction, self direction, immersion, interactivity, and education. Such rich multi-media spaces should be fundamentally changing the way we think about learning, social interaction, and self-expression.

Furthermore, an increasing interest in games indicates the potential for using online computer gaming as a method for implementing traditional and novel learning theories. In this paper we examined how by conforming to specific approaches of game design, educational approaches can attempt to attract, engage and immerse students in meaningful learning experiences. However, one should consider that most educators lack the time, skill and technical expertise to set up such an elaborate teaching

environment. Therefore, future work should focus on the development of suitable user friendly platforms, which will enable educators to actualize virtual tools, simulations and metaphors in order to exploit the representational richness of a 3D game based learning and collaboration medium, providing students with novel educational potential and possibilities.

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