AC 2011-2036: WORK-IN-PROGRESS: EDUCATIONAL EFFECTIVENESS OF IMPLICIT COURSE CONTENT EMBEDDED WITHIN COMMERCIAL VIDEO GAMES

Bruce Eric Davis, Purdue University

Bruce Davis is currently a computer graphics technology masters student with a focus in software development, and gaming.

David M Whittinghill, Purdue University, West Lafayette

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Abstract

As video games have become a mainstay in society, educators and software developers have taken the opportunity to create what are known as "serious games". One definition of serious games is defined as a game that is used for purposes other than mere entertainment[1]. As of today there has been much attention to research on the topic of serious games.

The difference between serious games and commercial games is that in educational games and software, presentation is indiscreet; the learning material is front and center to the player experience, whereas in a commercial game, content the player learns may not always be explicitly presented. "The challenge of creating serious games is to adapt game features for instructional purposes without squeezing out what is enjoyable about games in the first place"[2]. The content in serious gaming at times breaks the flow of the player's interaction in order to teach the material and evaluate the player's knowledge.

This study proposes to place assessment activities within a game context in a fashion akin to the approach used in commercial game – what the player learns is implied rather than explicit. Learning will still be required in order to master the game. This learning can be substituted for an educational topic, which can be assessed throughout the game to test the player. The player can then be tested afterwards with traditional testing media to see if the information learned in the game has been retained.

The primary goal of this study is to examine how effective a "commercial" game can be when it is discreetly filled with educational content. In this project, topics relating to introductory computer science will be used as the educational subject matter.

Introduction

We have been developing a modification of an existing commercial video game to investigate the feasibility of adapting them toward educational objectives. The game we are using is a "first-person shooter", meaning that the player inhabits a digital avatar character and sees the virtual world through the eyes of the avatar. We are creating a gauntlet-style series of game levels that scale up and down in difficulty based on the player's understanding of basic computer programming principles. The player's goal is to survive the level while also maximizing the difficulty of game play. The player is awarded a score for her or his performance. This score is then posted on a "leaderboard" thus compelling the player to play again and again to beat previous scores or to best the scores of other players.

Related Work

Commercial games have become a favorite pastime of today's consumer. According to the Entertainment Software Association sixty-seven percent of American households play computer or video games[3]. The popularity of games has caught the attention of many researchers and government departments and has investigated using games for educational or training purposes. This has lead to the development of serious games. Serious games can be defined as a game that is used for training, education, and other topics instead of solely entertainment purposes[1]. Serious games can be used to help students understand difficult, abstract, or theoretical concepts of various academic subjects. Serious games usually contain assessment activities in order to give the player feedback on what they have learned. Serious games have to address not only teaching educational material to the player, but allowing the player to develop the mindset to mentally think about the problems[4].

Some researchers have taken the idea of using serious games for computer science subjects in order to see how it improves student understanding of difficult concepts. ToonTalk was developed to teach programming to students by transforming source code into animations. The results were that nearly all the pairs of children solved the first 25 puzzles without assistance[5]. Games have also been modified by programming in class as a method to teach computer science programming topics[6]. Computer Science is just one of the many topics serious gaming can focus on to help improve resources available for students to study. Overall serious games have been proven to be effective. One example of this is that classes that used a game had significantly scored higher on the material than classes that did not use a game regardless of gender or gameplay[7].

The challenge of creating serious games is finding the balance between focusing on the instructional objectives while maintaining an enjoyable entertainment experience[2]. This can be because serious games do not use the same techniques that make commercial games fun[8]. Another challenge is the attitudes of the general audience who play games. Teenagers are more likely to pick up popular commercial games such as "Call of Duty" game instead of a "Basic Math" game, which can be observed by the number of sales of both games. These issues have made some researchers focus their attention on using commercial game techniques to develop games with an educational outcome.

Good commercial games can provide good examples of how educational games should be due to a number of important factors. Games contain meaningful interaction for the player, because they are able to relate to the material they learn in the game[8]. Games can provide learning opportunities for the player although it may not be educational[9]. Also games contain motivational factors such as challenges and skills that keep players interested in playing games[10]. These factors are ideal for educational game development as it allows a person to learn, while maintaining the entertainment value. Various developmental techniques have been analyzed in order to find the best solution to integrate educational content and games effectively. Modifying games ("modding"), building games from the ground up, and using commercial games as is, are all just some examples of how the integration of educational content and gaming can be implemented[11]. These processes each have their strengths and weakness, but overall have the potential to improve student learning in many academic subjects through the use of video games.

Integrating learning into a game can help players identify how educational content can be applied to what they do in the game. Commercial games provide a learning-by-doing environment, which can be beneficial because students learn what the developers want to teach them, while not disturbing the students' fun[9].

It is important for educational games to teach effectively as well as create a fun experience at the same time. A person having fun can lead to motivation for doing an activity. Motivation is an important factor needed to get the most out of learning a topic[12]. Commercial games naturally emphasize having fun, which motivate players to spend hours playing a game. Studies have shown that introducing educational video games promoting learning had positive effects on student motivation within the classroom[13].

Using the effectiveness of commercial games can be a key concept to unlocking the potential of learning an academic subject. The idea is that people love to learn, which is why they can spend hours learning an activity, but do not like to learn when it is forced upon them[12]. Playing video games allow players to learn a variety of information and make decisions quickly[12]. Another appeal for using commercial games with educational content is its use of Csikszentmihalyi's concept of flow, which can keep players focused on the learning in the game. Flow can be described as when a person is highly focused on an activity[14]. Since flow is the optimal state of enjoyment where people are completely absorbed in the activity, it keeps the player playing the game[15]. As skill increases, so must the challenge, but this relationship must do so uniformly in an increasing positive slope.

Since it is common research to develop educational games to teach introductory computer science topics it is important that the correct assessment is developed in order to rate how well the student it learning. Of all the factors of assessment in introductory computer science topics, problem solving has increasingly become more important[16]. Even if students have a mastery of the syntax of a programming language, if they do not have the attributes of good problem solving methods they will have difficulty in courses such as algorithms[17]. Solving problems using loops particularly is important, because it is a fundamental concept that gives students the most problems when learning introductory computer science concepts[18]. Using pseudocode addresses this issue by allowing the reader to focus on the problem at hand instead of the syntax. Teaching and quizzing students using pseudocode can test problem solving skills directly to see if students have learned or retained any knowledge in computer science topics[19].

Implementation

For our study, we are customizing the game Half Life 2™ which uses the Source ™ Engine and was developed by Valve Software™. The player plays the role of a heavily armed human character in a science fiction world under assault by human-sized invading aliens.

The player is not told what the rules of the level are, but rather will have to experiment with the room in order to discover them. She or he will be able to shoot trigger pads placed around the level that correspond to various parameters of loop structures seen in computer programming. The first example we are implementing is the "for" loop lesson. In this lesson there are five trigger pads with which the students can interact: 1) initializer, 2) stop condition, 3) incrementer,

4) run loop, 5) reset. The first three pads display a number between 0 and 9 and will increment by one each time they are shot by the player. These establish the parameters of the "for" loop. The body of the loop contains a single call to a function called "spawnMonster()". Shooting pad 4 will execute the loop. Therefore if the initializer is set to 3, stop is set to 5, and the initializer is set to 1, three aliens will immediately spawn into existence when trigger pad 4 is shot, with two more aliens spawned over the next two seconds (one alien per second). Shooting 5 resets all the parameters back to zero.

Scoring involves an index of the total amount of damage inflicted on aliens versus the damage taken from aliens versus the time it took to destroy all aliens. The goal is to have as many aliens as possible so that the highest amount of damage possible can be inflicted but to also do so in as short a time as possible while also evading damage.

We believe this particular form of gameplay will be sufficiently engaging – fast-paced action – that students will not think of the game as a "serious" game at all but will likely have quite a lot of fun. However, in order to master the game, the student must think tactically when setting up the loop in order to arrive at the most robust loop structure their individual gaming skills will allow. Maximizing their score will demand an understanding of the parameters that compose the "for" loop structure.

An additional student motivator is the "leaderboard" where individual scores are posted on the web for all to see. Our goal is that this public dimension to the game will induce students to compete with themselves and one another in order to outdo one another's scores.

Assessment

An important goal of this study is to teach students such that they do not feel they are being "forced" to learn. Thus the goals and educational output of the game are never made known to the player. In order to assess learning then, we are going to quiz students who have completed the game on the underlying lesson (in this case, "for" loops) using a traditional paper-based exam. We are interested in studying whether or not students who scored higher on the leaderboards, have higher scores on the paper-based exam and vice versa.

Conclusion

Today, video games have become part and parcel of the modern student's cultural background. Students, by and large, are familiar and comfortable with the idioms and assumptions of digital entertainment and spend a great deal of time with their attention focused on this medium. It would be of enormous value to society at large and the students themselves if educators could understand how to weave into these large blocks of time useful educational content that does not dilute what makes this form of entertainment so appealing in the first place. We believe this study will provide a significant contribution toward this end.

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