IT Education, Girls, and Game Modding

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Researchers have argued that video games have great utility for learning. Games promote experiential learning and can be used to facilitate active learning. This paper examines the potential of video games in education. In particular, it examines the benefits of game modding compared to playing and/or creating games. However, video game classes have been primarily attended by male students. This paper looks further into the gender issue regarding the use of video game modding in education. This is demonstrated through a course developed by the authors on game design. The main goal of the course was to introduce middle school and high school female students to IT and assist them in acquiring five basic IT skills. During the course, survey data was collected from participating students. Results from the surveys as well as analysis of student projects and anecdotal evidence suggest that using video game modding is successful in increasing self-efficacy and motivation as well as teaching female students basic IT skills.

Keywords: Video games education, video game modding, gender and education, games and learning, IT education.

1. INTRODUCTION

Many researchers have argued for the use of video games as a useful learning tool (Aldrich, 2003; Jasinski and Thiagarajan, 2000; Gee, 2003; Glifford, 1991; Prensky, 2003; White, 1984). De Aguilera and Mendiz (2003) discuss 20 years of research on games and learning, concluding with the remark that despite a mixed and sometimes negative research history, "for learning, video games are of unquestionable importance" and "in addition to stimulating motivation, video games are considered very useful in acquiring practical skills, as well as increasing perception and stimulation and developing skills in problem-solving, strategy assessment, media and tools organization and obtaining intelligent answers."

Gee (2003) emphasizes the use of games as a medium to promote experiential learning. He argues that games provide a good facility to exercise an active learning approach. Several researchers have presented successful cases in using game playing as a method for teaching (Hansson, 2005; Hoyles, et al, 2002; Winograd, 2001).

In addition, several projects have used game building or game creation for teaching (Kafai, 1996; Lainema and Makkonen, 2003; Robertson and Good, 2004). Overmars (2004, 2005) argues for the effectiveness of creating games as a teaching tool in the specific domain of computer science. In addition, Werner et al. (2005) demonstrated that using game building as a method for learning with middle school girls resulted in *Information Technology Fluency*.

This paper focuses on the use of video game modding as a technique for learning IT-based skills. *Video game modding* is the process of adapting an existing commercial video game product to create a nearly or completely different video game. Modding is often (but not always) achieved using software tools and programming languages that are included with the game product itself.

Seif El-Nasr and Smith (2006) present two case-studies supporting the use of video game modding in two classroom settings: a high school extra-curricular class and a college-level undergraduate class. They outline several advantages to using game modding rather than game creation. Like game creation, modding offers a learning process in which students do not just consume knowledge but produce knowledge. In contrast to game creation where students use a dedicated programming language or tool, modding requires adaptation of an existing (and often complex) system that is not necessarily designed for adaptation. Video games are designed to be purchased and played, and tools included for modding are often added at the end of the game production cycle. Since IT professionals often deal with the adaptation or integration of an existing complex software system, game modding provides a superior approach to learning skills needed in the IT industry.

Modding also offers students the inherent benefits of

working with an actual video game product vs. a specialized language or tool. Modding of existing video games generally allows students to interact with and manipulate software code, art, and other materials that were used in actual commercial games. Students also may experience increased motivation, as they are working with tools that are close to what they would be using if they were working as game professionals.

Additionally, modding offers students the opportunity to work with games with which they have prior experience. Seif El-Nasr and Smith (2006) indicate that students were motivated more when using *Unreal Tournament 2003* (a video game) than when using a 3D graphics library called *WildTangent*. Students self-reported preferring *Unreal Tournament 2003* to *WildTangent*. Seif El-Nasr and Smith (2006) hypothesize that this was due to the fact that many students played *Unreal Tournament 2003* before.

The work discussed above indicates great potential for video games and particularly, video game modding, as a teaching tool. But video game development has the perception of being a male-oriented activity. Even though 39% of active gamers in the U.S. are women (Krotoski, 2004), only 11.5% of game industry jobs belong to women, according to International Game Developers Association (2005). This is an extreme case of a bigger problem in the larger IT industry. U.S. Department of Education (2004) reports that only 26.9% of total Bachelor's degrees in computer and information sciences were awarded to women in 2002-2003, even though 57.5% of all Bachelor's degrees in 2002-2003 were awarded to women.

An interesting question, therefore, is what considerations must be made to use video game modding to teach IT skills to an all-female audience. This question will be explored through an all-female class taught using video game modding. Results from collected surveys, observations, and thorough analysis of student projects suggest that (1) video game modding is an effective motivational teaching tool, (2) video game modding is an effective tool for teaching IT skills, and (3) video game modding is an effective teaching tool for an all-female audience with certain considerations, including gender imbalance in the video game industry, hyper-sexualized character design, and social perceptions of women and games.

2. RELATED WORK

Several researchers studied the use video game technologies in education; specifically, three techniques have been studied: game playing, game building, and game modding. The examples provided in this section review some projects that demonstrated significant impact through the use of these three techniques within learning environments.

Strategy-based games, such as *Sim City* and *Civilization*, have influenced many game-based teaching methods. In particular, teachers have used strategy-based games to teach several concepts, including management (Murphy, 1978), economics (Gremmen and Potters, 1997), and history (Squire, 2005). Strategy-based games allow the user to operate on several constraints at once while evaluating their effects on the environment as a whole. An example is *The Administration Decision Game*, an educational game described in Murphy (1978), which was designed to expose the constraints that school managers operate under, such as teacher characteristics, pupil characteristics, and salary schedules. The game allows players to act as school principles with the goal of keeping the school running efficiently, which allows students to acquire several skills, including decision making and constraint satisfaction. Beyond management, Squire (2005) presented a case-study of using *Civilization 3* to motivate students to learn about civilizations and history. Also, educators in the field of economics found that computer games can be effectively used to teach economics. Gremmen and Potters (1997) describe results comparing the use of Simulating International Economic Relations (SIER) and standard lectures. They found that students in the class that used SIER showed a significantly higher average test scores than students in the lecture class. This data was collected from four tests that were performed over the length of the course.

Video game creation has also been a successful technique in education. Kafai (1996, 2003) describes the benefits of allowing children to design educational video games for other children. In this example, learning occurred at two levels. Younger students learned a variety of subjects from playing the video games, while older students, who built the games, learned programming and other IT skills. Another example of the use of game creation methods includes the work on Alice at Carnegie Mellon University (Conway et al., 2000). Alice is a visual programming environment that makes 3D graphics accessible to novices. Further evidence of game creation tools as a positive learning environment is presented by Järvinen's (1998) experiment with the Lego/Logo tools. Järvinen's results show that students were able to learn mathematical concepts through building games.

The work of Seif El-Nasr and Smith (2006) showed that game modding offers the benefits of game creation, but has several unique advantages. While the scripting languages presented in game modding are comparable to mainstream programming languages, such as java, they are self documented and are easier to learn, which promotes

creativity as well as allows students to focus on the problem rather than spend much time in infrastructure building.

For these reasons, the work presented in this paper details a class using video game modding. The contribution of this work compared to previous work is in its use of game modding and its specific tailoring methods developed to appeal to an all-female audience.

3. VIDEO GAME MODDING

The specifics of video game modding can vary greatly depending on the video game engine used. Educators need to evaluate the game engine very carefully before using it in their classes. In this section, three video game engines will be reviewed. The focus of this review will be on: (1) the flexibility of the engine, (2) its storytelling ability, (3) the learning curve required of a middle-to-high school age student, and (4) the included art content.

3.1 THE SIMS 2

The Sims 2 can be described as a *digital life simulation*. Players are given control over a group of Sims, which can be described as a rudimentary virtual life form. Players can also create homes for their Sims, and can customize the environment down to the type and location of basic facilities (bathroom and kitchen), the number of floors, entrances, wallpaper, carpeting, and even the location of phones and garbage cans. *The Sims 2* has no definite win or loss conditions. Players never see an explicit "Game Over" message. Certain actions produce more or less favourable results, and complete neglect of a Sim (i.e. not letting a Sim use the bathroom) can result in the Sim's death.

When considering an all-female audience, *The Sims 2* has certain inherent benefits. *The Sims 2* is arguably the most effective video game available for exploring social relationships (by manipulating and exploring the social lives of the Sims) – an activity that Gorriz and Medina (2000) indicate is very appealing to a female audience. *The Sims 2* also fits a number of other criteria enumerated in Gorriz and Medina (2000), including a de-emphasis on competition and action-oriented game play, through the lack of explicit win/loss conditions and low hand-eye reflex requirements.

Unfortunately, *The Sims 2* does not include a very extensive toolset for modding. The game internally allows for the limited visual customization of the Sims (i.e. hair colour, hair style, and facial features) and the construction of houses and other buildings, such as stores. *The Sims* 2 also includes *The Sims 2 Body Shop* (see Fig. 1) – an external tool that adds additional visual customization features, such as the ability to create custom facial hair, clothing, and makeup for the Sims. However, the overall flexibility of the customization options included with *The Sims 2* is ultimately limited. The animations and fundamental body structure of the Sims cannot be changed, and there are no options for changing sound effects, game play mechanics, or adding new objects (such as a new style of chair or telephone).

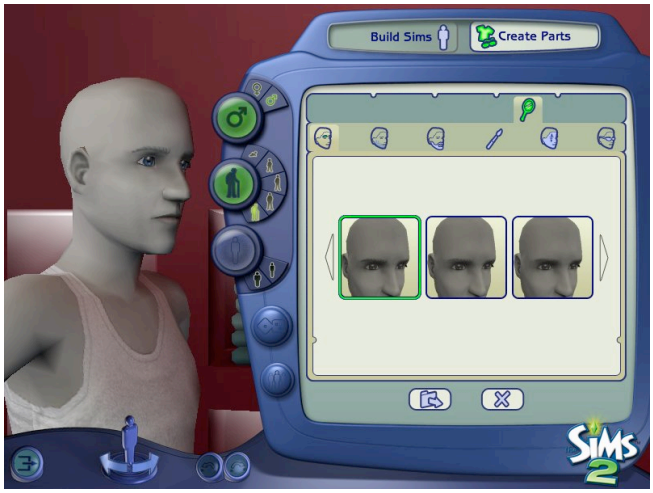

Figure 1 *The Sims 2 "Body Shop"*.

The Sims 2 will become significantly more viable as a video game modding tool if an external editing tool is used. An example of such a tool is *SimPE*, available at: http://www.sims.ambertation.de/. *SimPE* allows users to change Sim behaviours, customize Sim visuals (almost completely), and manipulate many game play related elements, such as "Neighbourhoods" and "Objects". Unfortunately, the legality of tools like *SimPE* is uncertain, and educators who wish to pursue this option will first need to clarify legal issues, such as whether or not using *SimPE* qualifies as copyright infringement.

3.2 UNREAL TOURNAMENT 2004

Unreal Tournament 2004 has been commonly described as a *first-person shooter*. The game play involves manoeuvring around an environment in a first-person perspective and killing opponents by shooting them with various weapons. *Unreal Tournament 2004* emphasizes win and loss conditions and an action-oriented game play, where hand-eye reflexes and rapid spatial reasoning skills are important. It is clear when a player wins or loses, reflected with explicit scoring and reporting mechanisms.

Unreal Tournament 2004 has many disadvantages when considering an all-female audience, or in fact any young

audience. It is a violent game with obscene language. The default game play type is focused on hand-eye reflexes, which Gorriz and Medina (2000) indicate may be less appealing to female players. The included artistic materials, behaviours, and game play are focused on the competitive nature of the game, and not much of this material is easily applicable to a fundamentally different experience, for example, interactive storytelling.

The primary appeal of *Unreal Tournament 2004* is its extensive suite of modding tools. The video game includes a map editing tool that facilities complete customization of the game environment (see Fig. 2). It also includes a programming language that allows for nearly complete customization of the game. It is possible, with the addition of a separate 3D modelling tool such as 3DS Max, to completely customize the visual appearance of characters, including their animation. Overall, *Unreal Tournament 2004* is one of the most flexible video games for modding that can be found.

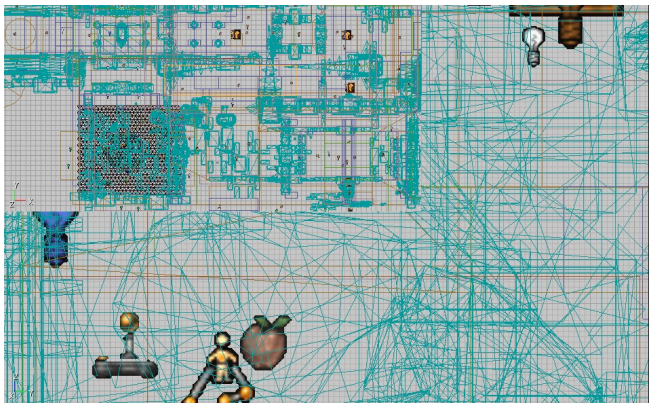

Figure 2 *Unreal Tournament 2004* Level Editor.

This game was used by the authors to teach a 400-level undergraduate class on game design. Example games created in the class include an interactive story of Beowulf, an interactive film noir detective story, an animal wrangling game set in space, and a hack 'n' slash style action-oriented game. Videos of example games created can be found at http://courses.ist.psu.edu/SP05/IST402/projects.html.

Unreal Tournament 2004 is very useful as an educational tool for a higher level undergraduate class with no female audience. If the class is composed of a mixture of female and male students, educators will need to adjust the included art content and deemphasize the default form of game play.

3.3 WARCRAFT 3

Warcraft 3 has been commonly described as a *real-time strategy* game with a fantasy setting similar to *Lord of the Rings*. The game play involves directing a large number of units around a battle field to defeat an opponent. Units may include knights, peons, and soldiers. The player views the world from a birds-eye view. This decision was made to give the player a sense of being a General commanding an army (see fig. 3). Strategic thinking is emphasized, but it must be done quickly. Unlike many board games, players of *Warcraft 3* do not have an unlimited amount of time to consider their strategy.

Figure 3 View of *Warcraft 3*.

Warcraft 3 has advantages and disadvantages with regards to an all-female audience. *Warcraft 3* suffers from a hyper-sexualized depiction of female characters in the included artwork. In the opinion of the authors, however, it is not extreme enough to make the product unusable, but it does require special attention by an educator. The game play type of *Warcraft 3* is also not perfectly suited for a female player. Fortunately, this is very easy to change. Of all the games in this section, *Warcraft 3* is probably the most effective at creating novel interaction models. Finally, *Warcraft 3* lacks a convenient method for visual customization of characters. With consideration of these disadvantages, *Warcraft 3* is useful for teaching classes where the focus is on environments, narrative, storytelling, or game play.

The authors have used *Warcraft 3* in several courses targeted at both high school age male and female students with a great deal of success. Learning goals were achieved and students regularly reported enjoying their work on projects with the game, even those students who reported dislike of the game play style of *Warcraft 3*. Example projects created with *Warcraft 3* include a game of Tetris, a number of interactive stories, puzzle games, and capture the flag style games.

4. MODDING AND IT-BASED SKILLS

Video game modding has a great deal of potential for teaching IT-based skills. National Research Council (1999) lists three main categories of IT skills:

- ***Intellectual capabilities***: "refer to one's ability to apply information technology in complex and sustained situations and to understand the consequences of doing so (National Research Council, 1999)."
- ***Fundamental concepts***: "refer to the foundations on which information technology is built (National Research Council, 1999)."
- ***Contemporary skills***: "refer to the ability to use particular (and contemporary) hardware or software resources to accomplish information processing tasks (National Research Council, 1999)."

It is conceivable that any of these three categories can be taught using video game modding. In this paper, the acquisition of the following five specific skills listed under the *Intellectual capabilities* category will be demonstrated:

a) Engage in sustained reasoning.
b) Manage complexity.
c) Test a solution.
d) Manage problems in faulty solutions.
e) Organize and navigate information structures and evaluate information.

4.1 GAMING FOR GIRLS

The College of Information Sciences and Technology at The Pennsylvania State University offered the *Gaming for Girls* class as an extra-curricular course. The class consisted of five non-consecutive Saturday sessions that ran for four hours in length during the months of September-November 2005. The program was advertised as a way to introduce middle school and high school girls to Information Technology through the use of video game technologies. The program was free to participants. Participants were required to attend all classes and complete three assignments and a class project.

This section will discuss decisions made to tailor the class for an all-female audience. These decisions regarded curriculum structure, selection of the video game for modding, concerns regarding computer programming, and specific considerations unique to the audience, including gender imbalance in the video game industry, hyper-sexualized character design, and social perceptions of women and games.

4.1.1 VIDEO GAME SELECTION

Several guidelines for selecting a video game for the class were established. These guidelines included:

1. The video game should allow narrative and character creation. This decision was based on the notion that "Girls like complex social interaction. They are fascinated by relationships between characters and other game players (Gorriz and Medina, 2000)" and "Girls often identify with characters in video games and mimic the main character (Gorriz and Medina, 2000)." By using a game that allows girls to customize characters, these two considerations can be fulfilled.
2. The video game should permit extensive environment creation to facilitate adventure-based exploration. According to Gorriz and Medina (2000), girls prefer exploring interesting environments, and they prefer adventure or puzzle based games.
3. The video game should not emphasize a "hips and breasts" or hyper-sexualized depiction of women. The term *hyper-sexualized* heavily relies on personal opinion. Nonetheless, video games that depict women in an arguably exploitative or otherwise arguably derogatory manner should be avoided.
4. The video game should include modding tools that are flexible and stable with a short learning curve. This is a major challenge with the use of video game modding as a teaching tool. Tools included with video games are often prone to incompleteness and instability that can completely circumvent the benefits of using modding as a teaching tool.
5. The video game should not have the word "war", "battle", or other terms of competition in the title. This was based on the notion that female students would not display interest in competition; as stated in Gorriz and Medina (2000), "Girls prefer collaboration to competition. Girls prefer working together to accomplish a task than trying to outdo someone else."

Warcraft 3 was initially rejected based on these criteria. Numerous other video games were evaluated as potential candidates, including: *Neverwinter Nights*, *The Sims 2*, *Dungeon Siege*, *Second Life*, *Freedom Force VS. The Third Reich*, and *Half-Life*. Unfortunately, none of these titles fit the established guidelines. *Second Life* and *The Sims 2* were the best fit, but *Second Life* was impractical due to concerns with its Internet-dependent nature (an entire class might be wasted if the Internet connection became unavailable) and *The Sims 2* did not contain sufficient modding tools.

Ultimately, the decision was made to once again use

Warcraft 3 due to several reasons. It fit guideline #4 and #2 perfectly. Although its default game play is *real-time strategy*, it can be easily customized to accommodate other game play types, such as interactive storytelling, adventure, or puzzle-solving. Additionally, *Warcraft 3* provided what was determined as sufficient features for guideline #1, although it lacked a convenient method for visual customization of characters. This was compensated for by placing emphasis on the narrative customization of characters through their actions and interactions.

Warcraft 3 required several considerations. First, the game was determined to have a "hips and breasts" depiction of women, although not so extreme as to be unusable. To address this, discussions of gender imbalance issues and hyper-sexualization in the video game industry were included as part of the course curriculum. Care was also taken in wording assignments to eliminate obvious gender bias. For example, students were required to create protagonist and antagonist characters as part of their project with the explicit stipulation that these characters could be male, female, or a gender neutral entity.

The title of *Warcraft 3* also indicates conflict, suggesting game play that involves combat between two opposing sides (which is true in the case of *Warcraft 3*). To compensate for this, conflict oriented game play was deemphasized in course instruction and project requirements. Students were not explicitly encouraged or discouraged towards or away from this game play.

4.2 CLASS CURRICULUM

The class curriculum was divided into three video game development topics. The first class focused on map design, where emphasis was placed on visual construction of an environment in which game play could take place. For example, students were asked to design two towns, one for a protagonist and another for an antagonist. The second class focused on character design and storytelling. Techniques described in Freeman (2004) as *Emotioneering* were used extensively for this part of the course. Students were introduced to the character diamond technique, which is an organizational tool for laying out character traits to create compelling characters. The third class focused on programming. Fundamental concepts of programming presented in the class included statements, conditions (evaluation of true/false statements), and variables (used to represent results of statements). After fundamental concepts were presented, the remainder of the time was spent interactively helping individual students to program their projects using a problem-based learning approach. Problem-based learning refers to presenting students with a problem, giving them sufficient basic concepts to begin solving that problem, and then coaching them in solving the problem as they encounter difficulties. The last two classes were used to assist students in debugging and polishing their projects.

4.3 IT-BASED SKILLS

The desired IT skills (sustained reasoning, manage complexity, test a solution, manage problems in faulty solutions and organize and navigate information structures and evaluate information) were targeted across all video game development topics described in section 4.2 in the following ways:

- "Sustained reasoning" was targeted by requiring students to fill-in gaps in their project outlines. For example, one project requirement was to create a protagonist and an antagonist, but exact definitions of these concepts were not given. Students needed to establish exactly what the specifics of their game would be, and decide how the protagonist and antagonist fit into their games' vision. This also required consideration of other stipulated project requirements, such as "your protagonist and antagonist must encounter one another during the course of your game." One example solution given by a student was a panda protagonist who encounters the antagonist (another panda) when the antagonist steals the protagonist's favourite chicken. Students were considered to have engaged in sustained reasoning if their final game project demonstrated deliberate organization of video game elements that fulfilled some or all of the stipulated project requirements. For example, if a student successfully created a town by organizing buildings, trees, roads, and other environmental elements, she was considered to have engaged in sustained reasoning.
- "Managing complexity, testing a solution and managing problems in faulty solutions" were targeted through game programming. For example, students were required to develop a protagonist and an antagonist as part of their projects, and portray an inciting incident between the protagonist and antagonist. To achieve this, students first had to decide how to portray the inciting incident using the two approaches taught: interactive quest and cut-scene. Second, students needed to implement their selected approach (testing a solution). Finally, students needed to adjust any flaws in their implementation (managing problems in faulty solutions). Students were considered to have managed complexity if they had successfully

selected a solution for one project requirement. Students tested a solution if they had attempted to implement their selected solution. Finally, students were considered to have managed problems in faulty solutions if they had demonstrated efforts to fix a problem, or had successfully fixed a problem in their implementations.

- "Organize and navigate information structures and evaluate information" was targeted through the documentation available to students within the *Warcraft 3* programming environment. This environment provides documentation for programming constructs, but this documentation can be difficult to locate and disseminate if a student's concept of how to achieve a goal is different from the concept of the programming environment's designers. Students were required to find a way to organize and structure this information in order to apply it. Students were considered to have successfully organized, navigated information structures, and evaluated information if they demonstrated application of a programming construct not explicitly demonstrated in the class.

5. FINDINGS

METHODOLOGY

The authors used multiple quantitative and qualitative methods for collecting data. The use of multiple methods allowed for research triangulation, which provided a clear picture of the participant's learning experience. In particular, three methods were used: (1) three surveys conducted at different time periods during the course, (2) noted observations of student performance and questions during class periods, and (3) thorough analysis of projects and assignments completed by the students, where analysis was done to measure learning and skill acquisition in areas discussed in section 4.

The use of multiple methods, quantitative and qualitative, has been used by many researchers in information science and technology. Sawyer's essay in *Qualitative Research in IS* (2001) states "Multi-method research is based on the premise that analysis of separate and dissimilar data sets drawn on the same phenomena will provide a richer picture of the events and/or issues than will any single method."

In this study, the authors used three surveys that consisted of both quantitative and qualitative questions. Qualitative responses were tied to specific quantitative questions to give more explanation to numerical responses. The survey was distributed to all students except those who declined to participate.

The authors acknowledge that survey methods are often subjective, rely on perception, and to a large extent rely on the participant's judgement, which is often biased by many factors, such as their experiences and expectations. However, the authors believe that surveys can be effective in measuring certain qualities, such as motivation and self-efficacy. For this reason, surveys were used in the current study to assess these two main qualities, namely motivation and self-efficacy.

Observational data was collected by instructors during the class periods. Although such observational data are subjective and are largely subject to interpretation, they still can be helpful in interpreting the qualitative responses of the surveys.

In addition to these methods, the authors also extensively analyzed students' projects to assess students' learning. The authors set several analysis methods based on the learning objectives discussed in section 4.3. They then assessed each project using the analysis methods established. Analysis of projects presents a good approach to the assessment of IT-based skills. This is due to the fact that IT-based skills rely on application and understanding rather than iteration of knowledge as tested using conventional tests. This evaluation method was also triangulated with survey results and observational data.

5.2 SURVEYS

Fourteen participants completed survey #1, and seventeen participants completed surveys #2 and #3. Of the five class sessions, these surveys were conducted during class sessions on programming, peer review, and wrap-up classes (the final three classes). The timing of these surveys had significance. The first survey gauged the students before they received any instruction on programming, the second survey while they were working on their projects, and the final one after they completed their projects.

Survey #1 was composed of five main questions that were mostly concerned with a student's experience with computers, technology, and her perception of her skills compared to skills required for the class. The intention of this survey was to gauge a student's prior experience with computers, her self-efficacy with computers, and her motivation for participating in the course. Each question consisted of a four-point Likert scale and a space for a written response. A response of 1 or 2 is considered negative, while a response of 3 or 4 is considered positive. A sample question from the survey is shown in fig. 4.

Survey #2 was composed of seventeen questions. It was mainly intended to gauge how students spend their time

outside class. A sample question from survey #2 is shown in fig. 5.

I feel like I am a computer expert:
□ 1 not at all
□ 2 a little
□ 3 mostly
□ 4 absolutely

Why?

_____

_____

Figure 4 Sample question from survey #1.

Survey #3 consisted of twenty-two questions on a four-point Likert scale, followed by three short answer questions. This survey was intended to gauge students' motivation, confidence, and learning after the course. It was also used to evaluate the course in general. Two sample questions from survey #3 are shown in fig. 6.

In the table below mark how many hours per day you engage in these activities. Please fill in ones that we missed. Then please rate them in order of the most important.

Activity	No. of hours/day	Prioritize, 1= most important
In-School		
Homework		
Family responsibilities (chores, meals)		
Organized Sports		
Employment		
Entertainment (TV)		
Entertainment (Games)		
Socializing (with friends)		
Internet (general surfing)		
Internet (socializing)		
Other:		
Other:		

Figure 5 Sample question from survey #2.

These surveys are used to show evidence of the use of video game modding as a method for increasing self-efficacy and motivation in an all-female course. These results will be presented in the following subsections.

A. Most of the girls I know play video games:
□ 1 Strongly Disagree
□ 2 Somewhat Disagree
□ 3 Somewhat Agree
□ 4 Strongly Agree

B. What did you like best about the course?

Figure 6 Two sample questions from survey #3.

5.3 SUPPORT FOR MOTIVATION

Motivation was gauged through two measurements: time investment and self-reported enjoyment of the class (collected through surveys discussed above).

5.3.1 MOTIVATION AND ENJOYMENT – EVIDENCE FROM SURVEY RESULTS

Questions in survey #3 addressed motivation by asking students to rate their enjoyment in the class (1-4, where 4: strongly Agree and 1: Strongly Disagree). Table 1 lists the questions and the responses. As shown, the results indicate that 100% of the students responded positively (in the 3-4 range) to the question "I enjoyed the *Girl in Games* in-class tutorials." To the question "I enjoyed the Girl in Games Project" the results were 94% positive. And finally to the question "I had fun taking the Girls in Games course," the results were again 100% positive. Students also responded "True" 88% of the time to the question, "I wish I had more time to work on my project. True False (circle one)."

Question	**4**	**3**	**2**	**1**
I enjoyed the Girl in games in class tutorials.	76%	24%	0%	0%
I enjoyed the Girl in Games Project	59%	35%	6%	0%
I had fun taking the Girls in Games course.	88%	12%	0%	0%

Table 1 Percentages of responses**.**

5.3.2 TIME INVESTED

The project was considered a significant investment of time when compared to the student's usual daily schedule. According to the responses shown in Table 2, students spend 7 hours a day in school. All students reported spending several hours a day on other extra-curricular activities and homework for school. Students were not

required to take the course, and were not assessed. Students invested much time just to attend the class (4 hours in class, and some students invested as long as 11/2 hours in transportation time). Based the on the evidence of the time spent outside the classroom, the time spent on the projects indicate that the class was placed as a high priority.

Activity	Hours
Time in School	7.73
Time on homework	1.67
Family time	1.14
Sports	0.66
Employment	0.47
TV	2.03
Games	1.16
Socializing	3.28
Internet(gen)	1.67
Internet(social)	1.08
Total	**20.89**

Table 2 Daily Activities.

5.3.3 ADDITIONAL EVIDENCE

Casual comments from the parents of students indicated high motivation. In fact, a number of parents indicated that their daughters were spending more time working on the project than working on their homework for school, and that they had to tell their daughters to "close the laptop and do your homework."

In summary, time investment combined with self-reported enjoyment, and a self-reported investment of significant hours into the project outside of class indicate a high motivation for the course.

5.4 SKILL ACQUISITION

Skill acquisition was measured through three methods: (1) surveys, (2) anecdotal observations of in-class experiences, and (3) thorough analysis of projects and assignments completed by the students.

5.4.1 INCREASED SELF-EFFICACY – EVIDENCE FROM SURVEY RESULTS

By comparing the self-efficacy reported in the beginning and end of class, results collected showed increased self-efficacy. In the first survey, students were asked the questions shown in table 3.

Question	4	3	2	1
"I feel like I am a computer expert"	14%	22%	50%	14%
"I taught myself most of what I know about computing"	21%	36%	43%	0%

Table 3 Question Percentages #2**.**

To the question "I feel like I am a computer expert", 64% of the student's responded negative, indicating that most students had low self-efficacy with regards to IT skills, which is in accordance with evidence reported in the literature (Ryan, 2000). The question "I taught myself most of what I know about computing" had 58% positive responses. Students indicated in written responses that while they learned about applications such as Microsoft Office in school, they had to teach themselves more general computing skills, such as Internet surfing or HTML creation. One student in particular mentioned "feeling ill" using a computer at school due to a fear of breaking it. The previous work (Gorriz and Medina, 2000) in the area suggests that these results are not unusual.

Question	4	3	2	1
"I feel I understand how a computer/video game is built"	41%	35%	18%	6%
"I believe that I could design and build a computer game in the future"	29%	35%	24%	12%
"I feel like I understand the basics of computer programming."	35%	47%	6%	12%
"I would like to take a computer programming course at my school"	41%	35%	18%	6%
"I plan to take computer programming courses in college"	35%	29%	30%	6%

Table 4 Question Percentages #3**.**

In the final survey, students were asked questions shown in Table 4. While not all of the responses were positive, there

is a general increase in number of positive responses compared to the responses in the first survey. These positive responses indicate an increase in self-efficacy and provide support for video game modding as an effective tool in teaching IT skills. The responses were 66% and 64% positive to "I feel I understand how a computer/video game is built" and "I believe that I could design and build a computer game in the future" indicating high confidence with programming and software tools. The question "I feel like I understand the basics of computer programming" shows an 82% positive response. And finally the last two questions "I would like to take a computer programming course at my school" and "I plan to take computer programming courses in college" indicates the student's readiness to enter future IT courses. The responses to these were 66% and 64% positive respectively. While responses were positive, the significance of these results is not conclusive due to the small sample size.

5.4.2 PROGRAMMING

This section discusses a confusing yet important topic called *parallel processing* that students in the class were required to understand in order to successfully program in *Warcraft 3*. A student's ability to manage a problem in a faulty solution was gauged by her demonstrated understanding of *parallel processing* in a specific example case that will be described shortly. As a result, this short overview of *parallel processing* in *Warcraft 3* is given to help the reader understand the example case. Readers who feel comfortable with this topic can skip to the next section.

Code in the *Warcraft 3* programming environment is divided into Triggers. Triggers consist of Events, Conditions, and Actions. A Trigger executes when one or more of its Events occur and when *all* of its listed Conditions are true. When a Trigger executes, each of its Actions are evaluated sequentially in the order they are listed in the Trigger Editor window (see fig. 7).

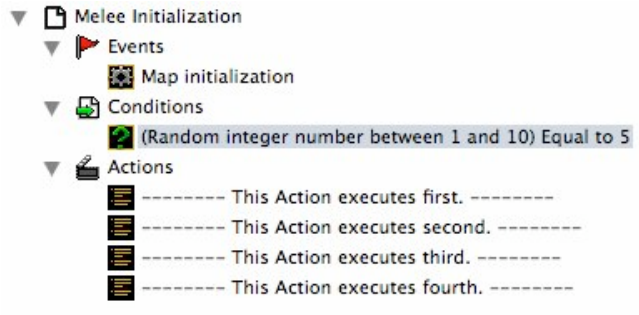

Figure 7 Action list part of the *Warcraft 3* Trigger Editor Window.

Actions in *Warcraft 3* generate *consequences* (this is the terminology of the authors, not of the *Warcraft 3* designers). *Consequences* can have a temporal component; they can take a perceivable amount of time to complete. Actions, on the other hand, have no temporal component. In other words, even though Actions execute sequentially in the order they are listed in the Trigger Editor window, they will all execute *immediately*, in no perceptible time (see fig. 8). This can be described as follows: Actions execute in a *single processing* environment, sequentially, as listed in the Trigger Editor window. The *consequences* that are generated by Actions, however, execute in a *parallel processing* environment, and can execute alongside one another at the same time.

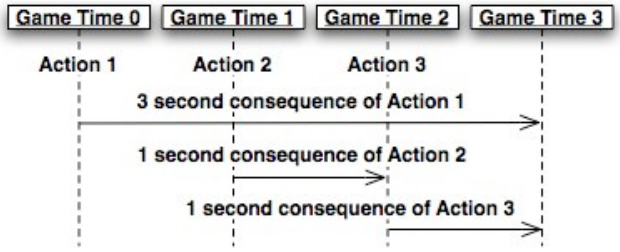

Figure 8 Sequence of Actions and consequences of Actions.

Understanding this concept was important for students, particularly to create dialogue. The method for creating dialogue that was presented in the class consists of four actions that are repeated for each line of dialogue (see fig. 9). As seen in fig. 9, the Action listed in line one creates text above a character's head. The Action generates a *consequence* (make text appear) and this particular *consequence* has no temporal component, so it completes immediately. The Action in line three then specifies that this text should remain visible for two seconds (or in other words, the Action listed in line three generates a *consequence* that takes two seconds to complete, the *consequence* being that the text is no longer visible). The Action in line five is a special Action. This "Wait" Action effectively generates two *consequences*. The first *consequence* is that the current Trigger immediately stops executing Actions. The second *consequence* takes three seconds to complete, and once it completes, the Trigger resumes executing Actions, starting at the Action immediately listed after the "Wait" Action.

This example presents the method used in the next section to evaluate a student's ability to manage problems in a faulty solution. If a student was successfully able to adjust the times of the Actions listed in lines three and five in fig. 9 to create smooth flowing dialogue, she was considered to have sufficiently acquired the skill necessary to manage a problem with a faulty solution.

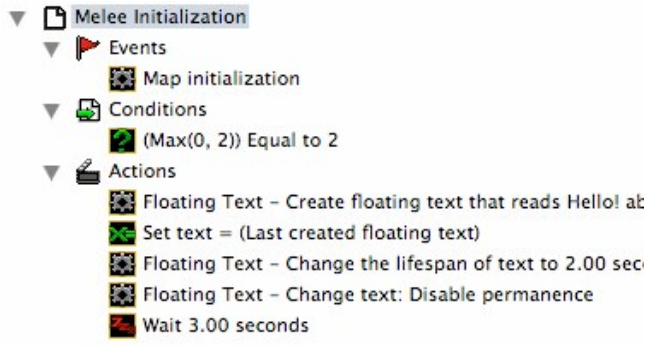

Figure 9 Example Trigger used to display text for creating dialogue.

5.4.3 IT SKILLS ACQUIRED BY STUDENTS

Effective learning of IT skills was demonstrated after careful examination of student projects. Twelve projects were evaluated after the class was completed. The following gauges were used to determine acquisition of each of the five IT skills mentioned previously in this paper:

- Students were considered to have "engaged in sustained reasoning" if they completed the course and their project demonstrated deliberate organization of video game elements. 100% of evaluated projects fit this criterion. All evaluated projects demonstrated either organization of visual elements into structures (for example, buildings and roads arranged to form a town) or organization of programming elements into behaviours (for example, displaying text to create a conversation). All but one project demonstrated both.
- Students were considered to have "managed complexity" if they had successfully selected a solution for a project requirement. 91% of evaluated projects fit this criterion. Some projects contained a dialogue sequence to introduce the game, others contained a "quest" to cause the protagonist and antagonist to meet and still others contained a "race against time", which was a third project requirement.
- Students were considered to have "tested a solution" if they had attempted to implement their selected solution. 66% of evaluated projects fit this criterion. Several projects indicated a choice of a solution (such as a dialogue sequence) through the visual arrangement of characters, but contained no programming to actually create the dialogue.
- Students were considered to have "managed problems in faulty solutions" if they had demonstrated efforts to fix a problem, or had successfully fixed a problem in their implementations. 25% of evaluated projects fit this criterion. This was a difficult skill to gauge due to the lack of tracking in the programming environment. There was no way of knowing if an attempt had been made to fix a problem that remained in a submitted project. As a result, only projects that demonstrated refined implementations were considered to have "managed problems in faulty solutions." For example, if a project adjusted timings for text that created a dialogue sequence, this was considered a refined implementation.
- Students were considered to have successfully "organized and navigated information structures and evaluated information" if they demonstrated application of a novel programming construct not explicitly demonstrated in the class. 25% of evaluated projects fit this criterion. For example, several projects used environmental special effects that were not demonstrated in class.

5.5 EFFECTIVENESS OF GENDER CONSIDERATIONS

Discussions were held in each class session, making a total of five discussion sessions. Discussion sessions during the first three classes involved the examination of contemporary video game products, particularly on their appeal to a female video game player. The last two discussions focused on the perception of women in video games, female characters in video games, and the problem of gender imbalance in the video game industry.

These discussions were designed to bring issues of women and technology to the attention of female students. The students were also encouraged to vocalize any trends they themselves noticed or questions they had about IT careers. These discussions were well received and generated a dialogue between the instructors and the students. Students were asked the two questions on the final survey shown in Table 5.

Question	**4**	**3**	**2**	**1**
"I enjoyed the discussions we had during the Girls in Games class"	59%	35%	6%	0%
"I would like to take another course like the Games and Girls class"	47%	29%	24%	0%

Table 5 Question codes #4**.**

The highly positive response to discussions, as shown by the responses to the two questions in Table 5, compared to the projects indicates that efforts to tailor the course for a female audience were well received. The few negative responses for the first question indicate in their written responses that they wished the discussion to remain focused on video games and not gender. The negative responses to the second question indicate having trouble balancing the time commitment of the class with other activities.

Finally, the overall positive response to taking another course like the "Games and Girls" class supports the notion that efforts to customize the class for a female audience were successful, or at the very least did not create a negative response. A second course following the same theme was offered in the spring. 50% of the students in this second course were from the first class, and all 30 available seats for the class were filled, leaving 16 students on a waiting list.

The results presented earlier in sections 5.1 and 5.2 also support the assertion that the students responded well to the gender considerations. If this goal had failed, the previous two assertions of learning and self-efficacy may have also suffered significantly.

6. FUTURE WORK

Students strongly expressed an interest in visually customizing their characters to fit the personalities they had created through dialogue. According to casual feedback, this was apparently due to a lack of variety in the *Warcraft 3* models and not due to the hyper-sexualized nature of *Warcraft 3* models. The authors plan to teach a future class similar to *Gaming for Girls* using a tool that allows for visual customization of models.

In addition, the authors will attempt new methods to target the last two IT skills, "managing problems in faulty solutions" and "organizing and navigation information structures and evaluating information." The first may be addressed by explicitly presenting a discussion on techniques for debugging faulty programs. The second may be addressed by presenting alternative organizations of information (for example, what was referred to as a "character" in the class, *Warcraft 3* refers to as a "unit", and this fact was only implicitly addressed in the class).

7. CONCLUSION

This paper presented an argument that video game modding is motivating to students, effective for teaching IT skills, and effective for teaching an all-female audience, with certain considerations. This argument was demonstrated through *Gaming for Girls*, a course targeted at middle-to-high school girls. Findings from the *Gaming for Girls* class support this paper's arguments; in particular it demonstrates the utility of game modding for (a) increasing motivation and self-efficacy when working with computers, and (b) teaching IT-based skills to an all-female audience.

There are several benefits and limitations to the methodology used and the results collected. In particular, the use of surveys to assess self-efficacy and motivation was successful as discussed in the findings section. The decision to administrate one survey in the first class and another in the last class presented a good approach for isolating the impact of the course and methods used on students' motivation and self-efficacy. Even though the results presented show success of the approach, the results were not conclusive. This is due to the fact that the subject pool was too small to measure statistical significance. Therefore, the authors aim at increasing the sample size in future studies.

The analysis conducted on students' projects was successful at assessing student learning of the targeted IT-based skills. The method presents a good approach to the assessment of IT-based skills, because IT-based skills rely on application and understanding rather than iteration of knowledge as tested using conventional tests. However, this analysis was made with the underlying assumption that concepts, such as parallel programming, debugging, etc., were not taught to students before the class. In future studies, this assumption will be tested through a simple in-class exercise to identify if such skills were a result of the class or were previously acquired.

Also, the requirements of the projects and assignments were constructed with less emphasis on the research goals, which introduced minor biases in the analysis process. Future plans include the use of empirical goals for minimising the bias in assignments/projects evaluation.

Although there are several limitations to the methodology used and the results discussed, the authors believe that overall, the results present significant contribution that warrants deeper study and follow-up research seeking conclusive results. In future research, the authors plan to extend their methods and subject pool, as well as expand the game engines used for the study to evaluate the utility of other engines with better aesthetic and artistic appeal.

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