Transitioning to the Polytechnic: The Game Development Aspect

Dmitri A Gusev
812-348-2029
dgusev@purdue.edu

Dewey A Swanson
812-348-2039
dswanson@purdue.edu

Purdue University College of Technology
4444 Kelly Street
Columbus, IN 47203
Fax (812) 348-2016

Abstract

Facing the need to introduce new approaches to teaching the art of programming to undergraduate Computer and Information Technology (CIT) students as part of the transition of the former Purdue College of Technology to the novel concept and status of Purdue Polytechnic, we came up with the idea of offering a pilot 300-level course entitled "Introduction to Game Development." This course was taught by one of the co-authors in Spring 2015, just before our statewide site was renamed to Purdue Polytechnic Columbus, and then again in the Fall of 2016, this time with a project aimed at creating a virtual reality (VR) application. In addition to the fundamentals of game programming, the pilot course addressed the essential aspects of game design, 3D art, and computer animation for games. In this paper, we will discuss how the two offerings of the course progressed, the course structure, the choice of tools and equipment, team project outcomes, the lessons learned, and our plans for the future work aimed at further development of our capability to reach the goals of the Polytechnic by having students improve their programming and teamwork skills via game development, an educational and fun activity.

Introduction

In Spring 2015 and Fall 2016, immediately before and shortly after the Purdue College of Technology was renamed the Purdue Polytechnic Institute, the Computer and Information Technology Department (CIT) offered a pilot course listed as CNIT 399 and entitled Introduction to Game Development at its statewide location in Columbus, Indiana. In this paper, we are going to give you background on why this course was developed, outline the structure of the course, explain the choice of tools and equipment, describe how the two offerings of the course progressed, discuss the project outcomes and the lessons learned, and, finally, present conclusions and set forth our plans for the future work aimed at continued incorporation of game development into the Polytechnic curriculum in line with its goals.

Background

First, let us briefly explain who we are and illuminate some of the specifics of the Purdue Polytechnic Institute program in Columbus. Purdue University College of Technology (COT) was renamed the Purdue Polytechnic Institute in 2015. Purdue Polytechnic has a statewide system that offers a variety of programs throughout Indiana. Computer and Information Technology (CIT) in Columbus offers a Bachelor of Science (BS) degree with classes in a variety of areas including programming, systems analysis, system administration and databases. Prior and during the experiment with the Introduction to Game Development pilot course that we are reporting on, our students developed mobile games as part of other courses, namely CNIT 355 Software Development for Mobile Computers and CNIT 425 Software Development for Mobile Computers II. The screenshots of some of the student game demos developed in those classes are shown in Figures 1-3.

Figure 1. *FruitSwirl Alpha*: A game demo developed by a team of three undergraduate students for their Fall 2013 project in CNIT 355 Software Development for Mobile Computers.

Figure 2. A screenshot from the *Chess for All* app showing gameplay by *Firenzina*, a chess engine ported to Android for a Spring 2014 CNIT 425 project. Source: Abshire and Gusev (2015).
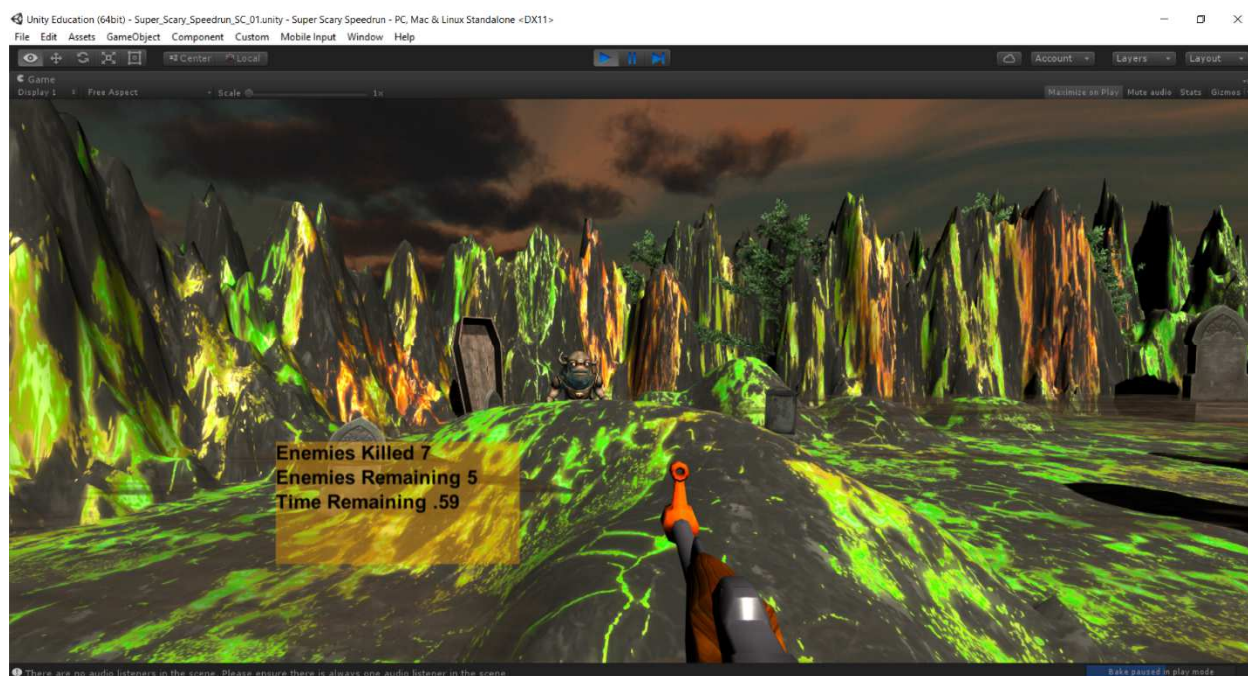

Figure 3. *Super Scary Speed Run*: A game demo developed by a team of three undergraduate students for their Fall 2015 project in CNIT 355 Software Development for Mobile Computers.

The pilot course entitled "Introduction to Game Development" was designed to familiarize the students with the fundamentals of the video game development technology, including the basic programming and design tasks involved in developing video games. It was offered to try a new, game-oriented approach to teaching the art of programming to our CIT undergrads. We will discuss the course structure in more detail in the next section.

Course Structure

The course began with the overview of the main components of the game development field: game design, game programming, art and animation for games, and game production. The course objectives were set to make sure that the students would learn how to:

1. Implement video games using a modern game engine and other tools. (Tools for virtual reality (VR) were added to the set in the second offering of the course.)
2. Create art and animations and import them into video game projects.
3. Apply artificial intelligence (AI) techniques to create autonomous agents.
4. Design and implement graphical user interfaces / head-up displays (GUI/HUD) for video games.
5. Perform various roles within a group development environment.
6. Research, implement and present various game development topics.

The course continued with an overview of game programming, gaming platforms, and game genres. Material on the fundamentals of game design followed, in order to prepare the students for the game design tasks that they had to complete early on in their project. This part of the course was largely based on the material from the textbooks by Gibson (2014) and Adams (2014). The first assignment instructed each team to come up with a 3D video game concept. The second assignment had each team develop a Game Design Document (GDD) for their concept. A small fragment of one of the GDDs is featured in Figure 4.
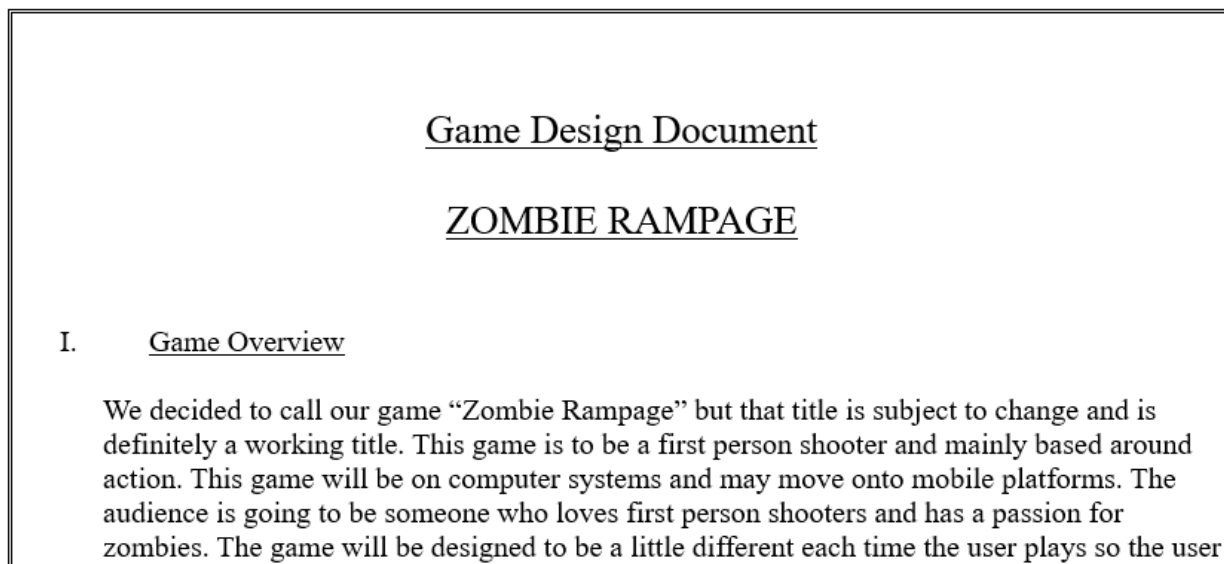

Game Design Document

ZOMBIE RAMPAGE

I.   Game Overview

We decided to call our game "Zombie Rampage" but that title is subject to change and is definitely a working title. This game is to be a first person shooter and mainly based around action. This game will be on computer systems and may move onto mobile platforms. The audience is going to be someone who loves first person shooters and has a passion for zombies. The game will be designed to be a little different each time the user plays so the user

Figure 4. *Zombie Rampage*: A fragment of a GDD developed for a Spring 2015 project in CNIT 399 Introduction to Game Development.

The next topic introduced students to 3D art and animation for games. In absence of a major art department to collaborate with locally, we had to rely upon some of the students' personal interest in graphic arts and animation. The material was based upon the early chapters of Roy (2014) and Palomar (2014) in the first offering of the course, Derakhshani (2015) in the second offering.

An overview of game production and marketing was given next, in order to help the students organize their work on the project using the modern project management tools. The primary source of material for this part was a monograph by Hight and Novak (2007). The third assignment told each team to develop a project management plan for the team's game. The plan was to be represented by a Gantt chart in the Microsoft Project format.

The students were formally introduced to their tools for game programming and version control during Week 3 of the course. The subsequent four lectures were primarily based on Geig (2014) in the first offering of the course, its next edition (Tristem & Geig, 2016) in the second offering. In those lectures, the following topics were covered:

- Terrain and Level Design (and also Virtual Reality in the second offering)

- Import of Artwork and Animations

- Tree and Grass Modeling

- Fundamentals of Game Programming

The fourth assignment required each team to develop a terrain for its game project and demonstrate the resulting level to the instructor in class. This approach allowed the students to gear up for the project quickly and have a solid foundation for it in place by the mid-semester mark.

The lecture topics of the second half of the semester included
- Gameplay, Core Mechanics, and Game Balancing – a critically important part of the course, based mainly on Gibson (2014) and Adams (2014)

- Basics of Artificial Intelligence for Games – a review of (Millington & Funge, 2009)

- GUI/HUD Development for Games

- Game Testing, Debugging, and Integration

- Sound and Special Effects

- Game Physics and Collision Detection

- Networking and Online Games (this topic was covered late in the semester, given that it was unrealistic to expect that the students would be able to develop an online game in this introductory one-semester course)

- Storytelling for Games – based largely, but not exclusively upon Sheldon (2014)

In addition to the aforementioned assignments and project, the midterm and final exams were administered to assess the students' performance. In the first offering of the course, the number of students enrolled allowed us to make the project presentations peer-assessed.

The course structure described above was developed with certain tools and equipment in mind. Their choice is discussed in the next section of the paper.

Tools and Equipment

The undergraduate students of Purdue Polytechnic Columbus used Unity 5 Pro and Autodesk Maya software, along with Microsoft Project, to do their coursework for CNIT 399 Introduction to Game Development.

Unity is a game engine developed by Unity Technologies, initially for mobile platforms. In the recent years, it emerged as the primary choice of VR developers. Purdue University acquired 25 perpetual Unity Pro 4.x licenses at the cost of $14,975 ($599 per license) in March of 2014, with the free upgrade to Unity 5. These licenses have also been used to teach Purdue Polytechnic Columbus summer camps for high-school students. Unity 5 was released on March 3, 2015 and used in both offerings of the pilot course. C# was picked as the scripting language of choice (Unity supports JavaScript as well), and the prerequisite for the pilot course was set to require students to have two semesters of C# programming under their belts. This amount of preparation proved appropriate and sufficient.

Autodesk Maya is a widely used tool for 3D modeling and animation. It provides a seamless workflow transition to Unity. Purdue University has owned up-to-date enterprise licenses of Autodesk Maya.

Microsoft Project is a ubiquitous project management tool that allowed our students to develop the project plan and follow it using Gantt charts, a common means of scheduling project tasks.

Given the small class sizes, running the software on 12 Dell OptiPlex 7020 quad workstations under auspices of Windows 7 in the lab proved a sufficient solution. In the second offering, an Oculus Rift SDK 2, a Samsung Gear VR, and a commercial Oculus Rift unit were available for VR game development.

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Course Progress

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Lecture sessions alternated with lab sessions to give students ample opportunities to interact within teams and across the team boundaries in the instructor-supervised lab environment. This approach is common at Purdue Polytechnic.

The first offering of the pilot course attracted 7 CIT undergrads that formed two teams named Team Black (4 students) and Team Gold (3 students), according to Purdue's revered core colors. The course proceeded according to the plan, and both teams completed their respective PC game demos using Unity and Maya. Students delivered peer-assessed presentations on the game development topics related to their team responsibilities.

Unfortunately, the second offering of the course did not go equally smoothly, primarily because only one student had registered for it. As a result, the student's teamwork opportunity was severely limited to interaction with the instructor. It proved difficult for the student to excel in all components necessary for completing a game demo, despite all efforts to keep the project scope down without turning it into a trivial exercise.

The next section of our paper is devoted to discussion of the student project results and the lessons learned.

Project Outcomes and Lessons Learned

Spring 2015, Team Black: *Zombie Rampage*

Team Black delivered a demo of *Zombie Rampage*, a survival game where the player character (PC) walked or ran in the rain through the wet streets and abandoned but lit buildings of a fairly complex post-apocalyptic city environment, trying to evade a horde of aggressive zombie non-player characters (NPCs) spawned and controlled by the game's artificial intelligence (AI). The zombies traveled successfully along the extensive navmesh (navigation mesh) to find the PC, attack him and inflict damage that caused lowering of the PC's health bar and, ultimately, his death. At an intermediate stage of the project, the PC had a gun capable of shooting projectiles at the zombies. However, the team failed to resolve the collisions issue and decided to take the useless gun away from the unfortunate PC in the last minute. This was in line with the textbook advice to remove a feature, rather than let it glitch. Unfortunately, we no longer possess a working version of the *Zombie Rampage* demo. The structure of the program's Unity assets is shown in Figure 5. It should give the reader an idea of the effort that it took the team of four students to take their project to its final, advanced stage.

Name	Date modified	Type
Antique Pack	5/24/2015 9:16 PM	File folder
assets_bathroomprops	5/24/2015 9:16 PM	File folder
Assets_Beds	5/24/2015 9:16 PM	File folder
cartoon building	5/24/2015 9:16 PM	File folder
Cartoon SMG	5/24/2015 9:16 PM	File folder
clouds	5/24/2015 9:16 PM	File folder
Editor	5/24/2015 9:16 PM	File folder
enchantedanvil	5/24/2015 9:16 PM	File folder
furniture pack 1 free	5/24/2015 9:16 PM	File folder
fx_kandol_pack	5/24/2015 9:16 PM	File folder
game sound solutions - 8 bits elements	5/24/2015 9:16 PM	File folder
Graffiti Pack	5/24/2015 9:16 PM	File folder
Grunge pack	5/2/2015 9:06 PM	File folder
london street asset	5/24/2015 9:16 PM	File folder
malecharacterpack	5/24/2015 9:16 PM	File folder
Materials	5/2/2015 9:06 PM	File folder
meshes	5/24/2015 9:16 PM	File folder
mobile_citizen_human&zombie_free	5/24/2015 9:16 PM	File folder
project for game	5/2/2015 9:06 PM	File folder
rainassets	5/24/2015 9:16 PM	File folder
scifi decals pack	5/24/2015 9:16 PM	File folder
skyscrapers	5/24/2015 9:16 PM	File folder
square pack	5/24/2015 9:16 PM	File folder
standard assets	5/24/2015 9:16 PM	File folder
streets	5/24/2015 9:16 PM	File folder
Working Assets	5/24/2015 9:16 PM	File folder

Figure 5. *Zombie Rampage*: The program assets

Spring 2015, Team Gold: *Showdown at The Fair*

Team Gold was fortunate to consist of a talented game designer, a very strong programmer, and a third team member with special interest in 3D art and animation. Working together in harmony, they completed *Showdown at The Fair*, a 6-level game demo, which we have been proud to show at our recruitment events since. This first-person shooter (FPS) is remarkably non-aggressive and fun! The levels consist of five amusement park pavilions and the final boss level, all with different graphic art and music solutions.

The first level involves shooting at barrels of various shapes and sizes. The barrels move horizontally on three shelves in two different directions. The rate of target generation gradually increases. Once ten barrels get away, the game stops. The ammo supply is unlimited. The player's achievements are reflected at a progress bar that allows the player to reach the bronze, silver, or gold level. Once the bronze level of progress is reached for the first game level, the second level is unlocked, and so on. Prior to that, the player can see the next pavilions, but the game's user interface (UI) prevents play. A screenshot of Level 1 is shown in Figure 6.
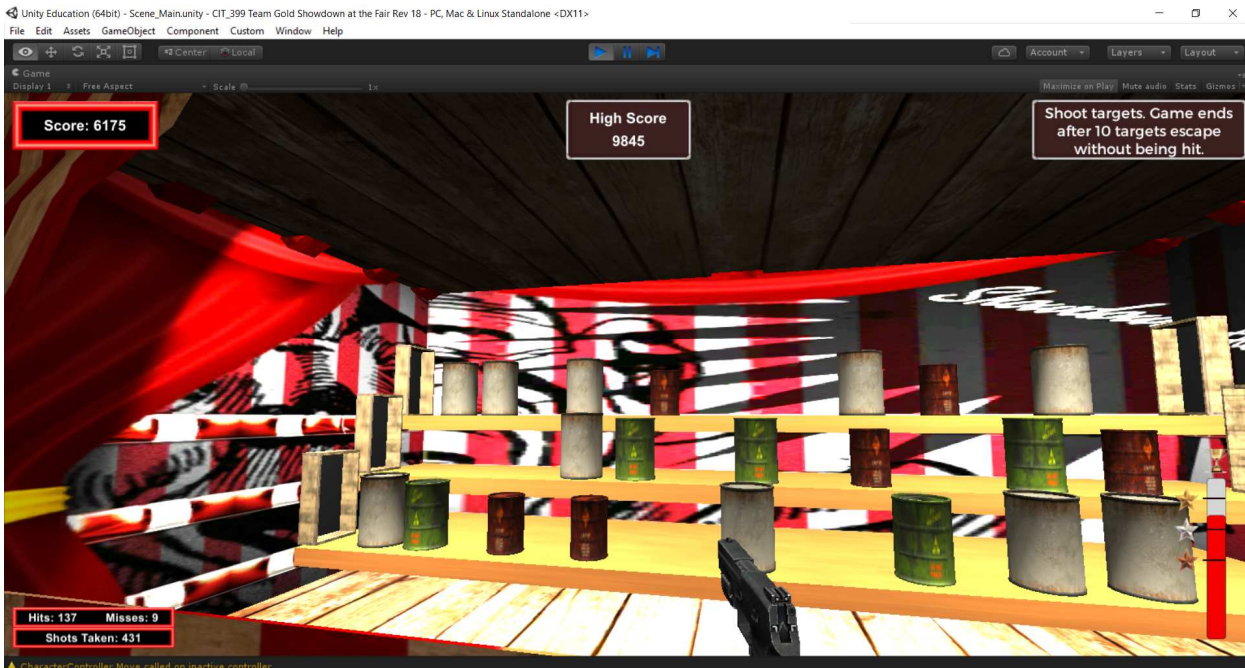
Figure 6. *Showdown at The Fair*: Level 1 (the Classic level).

The second level lets the player shoot at sculpture-like lions of different colors that move horizontally or vertically in the stylized jungle. A screenshot of this level is featured in Figure 7. The player just earned 75 points by shooting a lion, which disappeared from view to be replaced with the disk bearing the number 75. The disc lingers for a couple of seconds, while moving up slowly, and then disappears as well. Reward amounts vary depending on a lion's color.
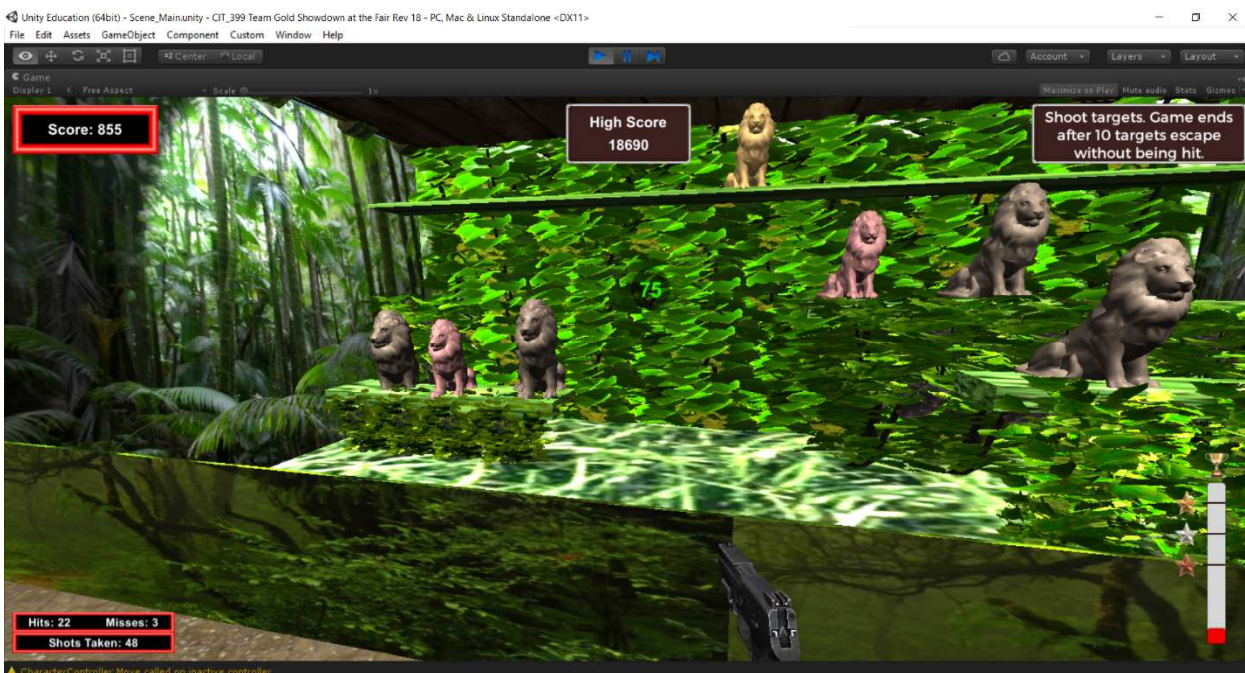
Figure 7. *Showdown at The Fair*: Level 2 (the Jungle level).

On the third level of *Showdown at The Fair*, the player is invited to shoot at skulls, some of which appear and disappear in the central slots, while others move horizontally along the shelves placed on the sides of the pavilion. A screenshot of the third level is shown in Figure 8.
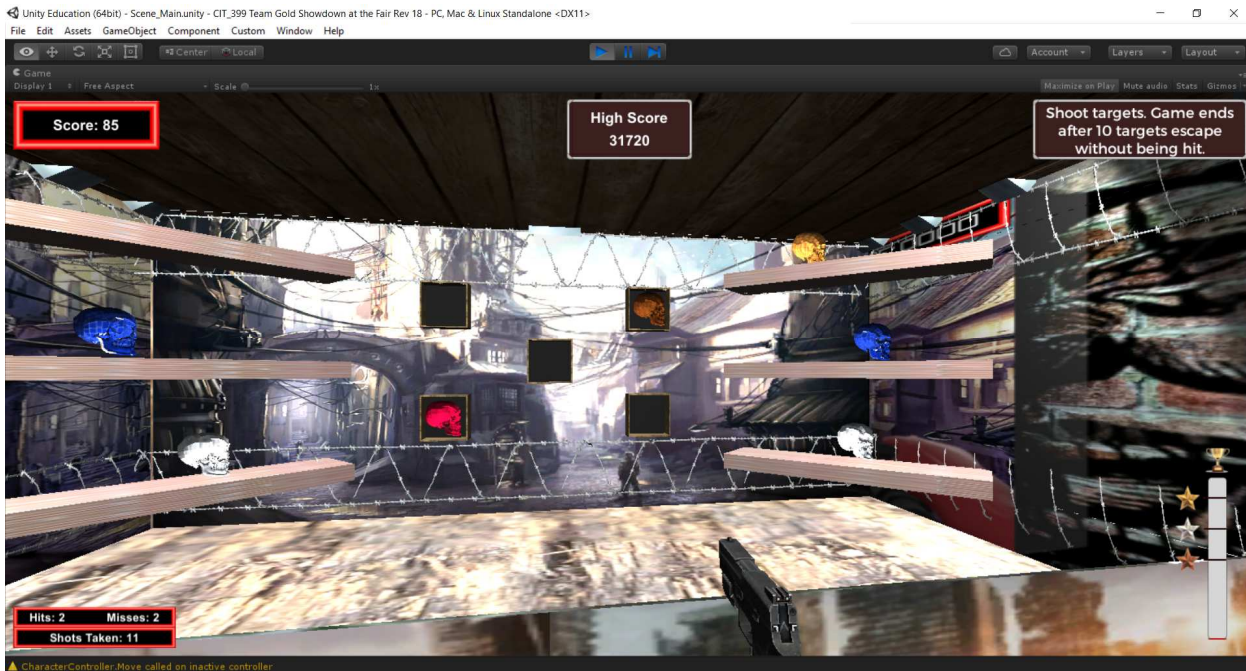

Figure 8. *Showdown at The Fair*: Level 3 (the Urban level).

On the fourth level, the player's targets are psychedelic cows that move as if they were in weightlessness. A screenshot of the level is provided in Figure 9 below.
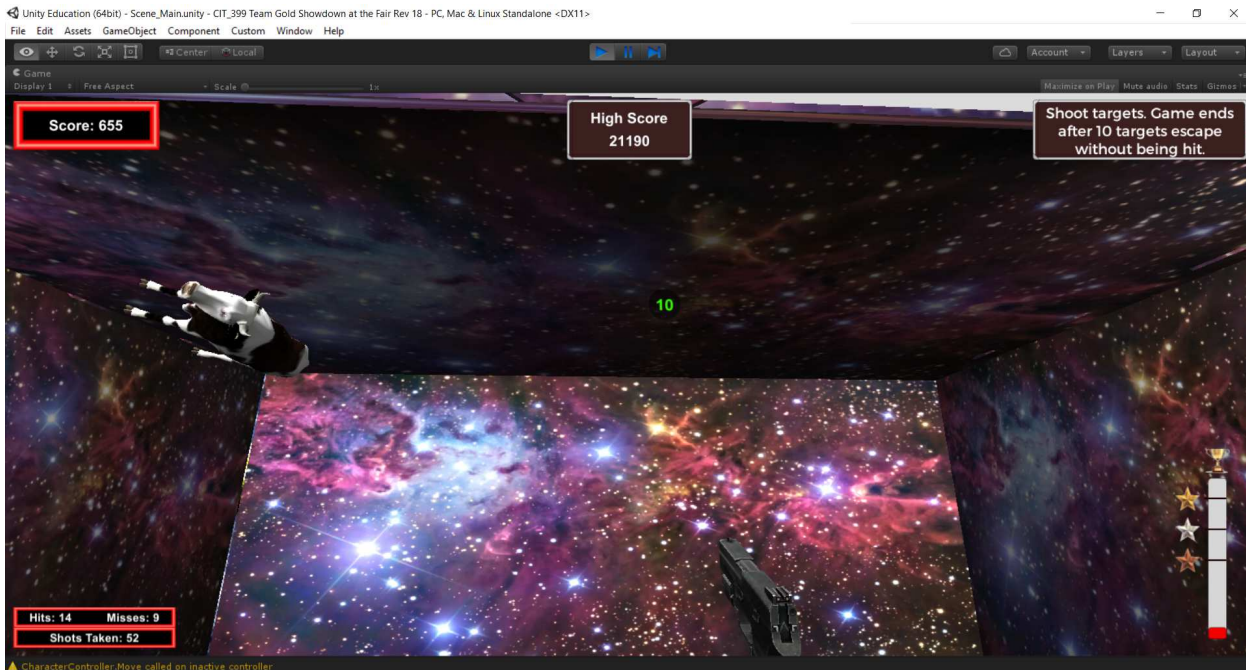
Figure 9. *Showdown at The Fair*: Level 4 (the Space level).

Level 5 is the hardest level of *Showdown at The Fair*. It was passed on the third try by a hardcore player with excellent Counter-Strike skills. The player has to shoot at colored bombs, some of which pop up in windows and other static locations, while others move slowly down. A screenshot of this level can be seen in Figure 10. The current high scores displayed in the screenshots give a good impression of relative difficulty of the game levels.
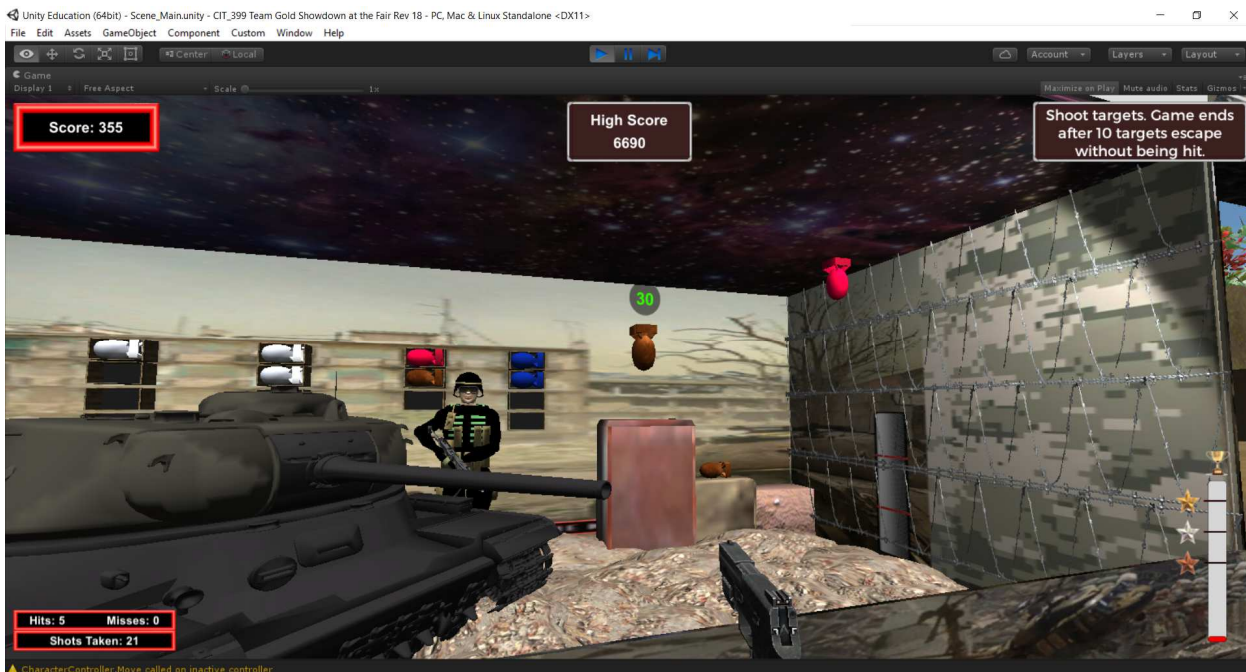

Figure 10. *Showdown at The Fair*: Level 5 (the Military level).
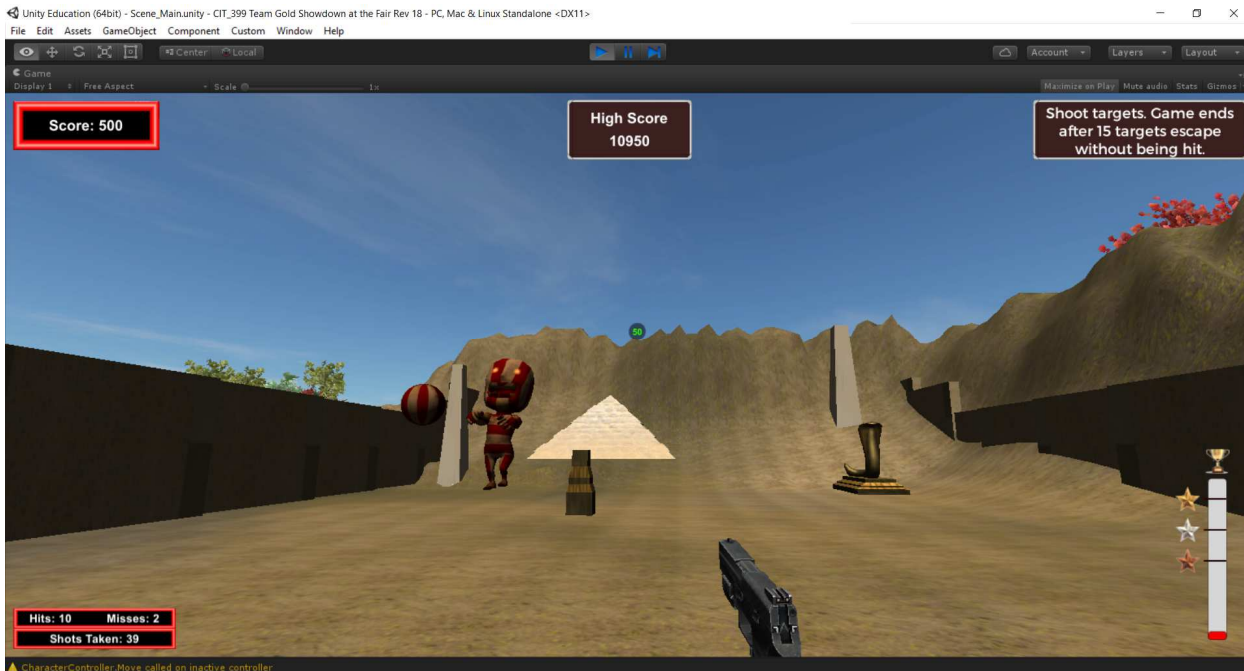
Figure 11. *Showdown at The Fair*: Level 6 (the Boss level).

At the final, Boss level of *Showdown at The Fair*, it is pointless to shoot at the mummy-like boss that keeps moving about the level. Instead, the player should be shooting at the balloons that the boss is throwing toward the PC. The level is played until 15 balloons get away. A screenshot of the last level is shown in Figure 11 above.

Fall 2016: *Un Vincitore*

Un Vincitore was designed to be a VR chessboard application. In the screenshot shown in Figure 12, you can see its UI. During the project demo, the chessboard could also be seen, even though it was not fully functional.
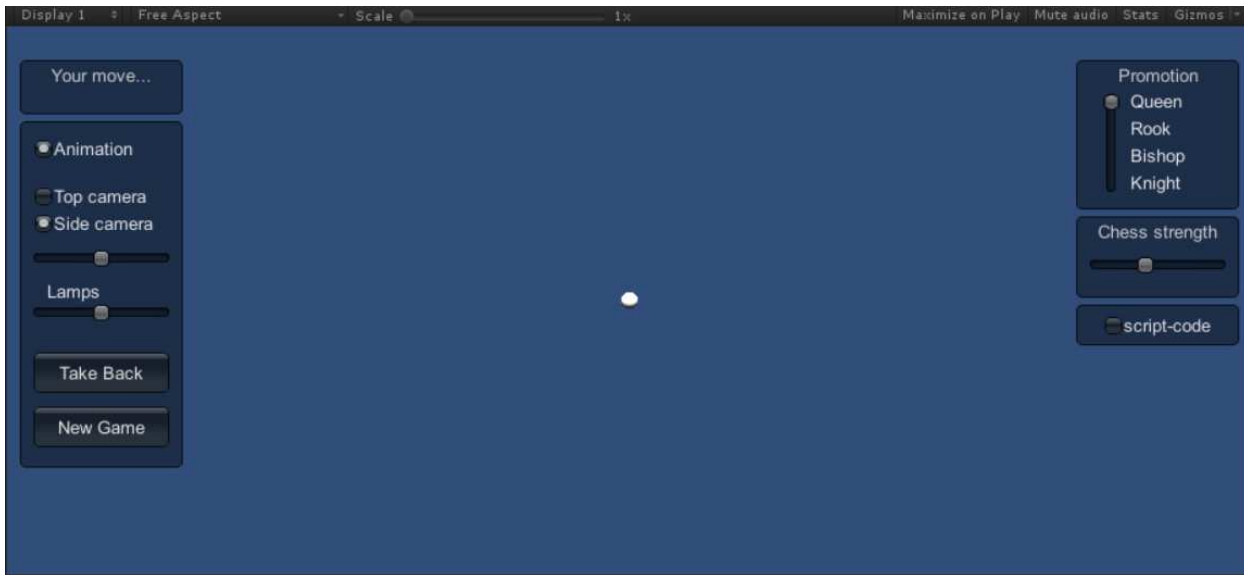
Figure 12. *Un Vincitore*: The VR chessboard UI design.

Lessons Learned

One-semester game development projects using Unity and Maya can be productive (lead to a good game demo) if at least three or four team members are available. Students whose interests complement each other may form a very successful team! Prior to scheduling an "Introduction to Game Development" course, it is important to make sure that the interest in the course is sufficiently high among the current students that have the prerequisite.

 Conclusions

A pilot 300-level course entitled "Introduction to Game Development" was developed and offered twice at Purdue Polytechnic Columbus. The course contributed to improvement of programming skills of the undergraduate CIT students by engaging them in C# scripting for video game demos. One of the game demos proved useful in recruitment of new students, helping generate more interest in the CIT program. The most recent version of the course featured a virtual reality (VR) game development project. The spirit of the new, heavily project-oriented course is in line with the vector of the Purdue Polytechnic transformation aimed at placing increased emphasis on student teamwork. However, for the course to be successful, it is important to make sure that sufficiently many students that meet the prerequisite are interested in taking it.

Future Plans

We intend to offer the pilot course for the third time prior to deciding whether we should ask for a permanent place for the course in the Purdue Polytechnic curriculum. Meanwhile, we are exploring the benefits of switching from Unity to its closest competitor Unreal that has recently transitioned to a more promising business model. In addition to VR development, we would like to investigate development for holographic mobile devices, such as those based upon the Leia 3D technology and scheduled for release near the end of the year.

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