INSPIRING STUDENTS THROUGH PROGRAMMING GAMES

A Stem Outreach Award
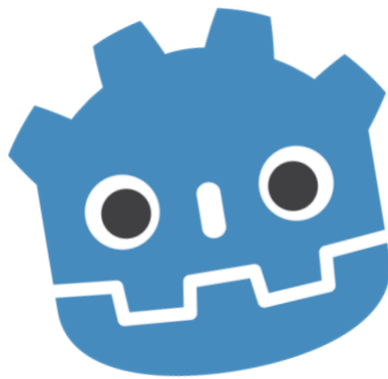
Andrew Bernhardt
Supervised by: Dr. Yan Tong
University of South Carolina

Project Abstract

Studies have shown that video games can have a huge impact on student's interest in programming [3]. Most high schoolers are playing video games on their own time, in fact 90% of children ages 2 to 17 play video games, with an average play time at over an hour per day [4]. So, introducing students to game design allows for them to experience the joy of doing something they already enjoy while combining that with structure to learn in a classroom.

My motivation behind this project is to engage students in something that they have never experienced before. Why expose students to something they see every day? If students are going to have a guest speaker, let them learn something that they won't see in the walls of school from 8-3. That is why I decided to go with Godot game engine; it was an obvious answer given these criteria. It is a free, open source, and accessible from any computer, either Mac or Windows.

In Godot, I programmed a 2D game that was a cross breed between Super Mario and Geometry Dash, two games that the students would most likely have been exposed to. This game wasn't finished, and this was intentional. The remaining parts of the game were to be completed by the students, that way they were forced to have hands-on experience. I guided the students through the completion of the game as they each worked on their own copy of the game (accessed through an individual flash drive) at their own pace. This proved to be a successful lesson plan for many reasons.

Some students worked faster than others. That is just a reality we have in the world – and that is evident in education, too. By each student having their individual flash drive, they can work at their own pace. This allowed for the faster students to progress through the lesson plan while not punishing the slower students.

Each student could create something independent from the other students, allowing them to express their creativity. Some students created a Mario-theme, while some students made the theme around sports, while some students modeled their game around Hannah-Montana. They were allowed to create a game individual to them, and it was awesome to see.

Finally, each student was able to bring their flash drive home. The flash drive had a copy of the lesson plans I used and a copy of the software, that way they were able to plug their flash drive in at home and continue to work on the project. I wanted to create a project that wasn't "game over" when they left the classroom but allowed for further expansion. I linked them educational YouTube videos that allowed them to continue the progress they worked on with me.

This lesson plan proved effective – it was both engaging and fruitful to all students in terms of engagement and their progress on the game.

Project Description

My STEM Outreach Award featured two phases: 1) The preparation of the game; and 2) the presentation/workshop of the game. The preparation of the game involved designing the game and the classroom lesson plan that would be invoked during phase 2 of the project. The second part of the project was the execution of teaching the students using the game as the primary tool for education.

Phase 1 – Preparation of the game and lesson plan – 50 Hours

The first part of the project was the research. I knew that I wanted to use a game engine to create the game, since that was how games are developed at most companies and independent developers, I just needed to find out which one. After comparing Unity and Godot and others, Godot was the most straightforward and user friendly.

The next part was to figure out what kind of game to make – as well as how to use the game engine, *as in learning it myself.* I had not used Godot before, so I did what I always did to learn: watch YouTube videos. After finding some educational YouTube videos, I was able to follow along and create a game very similar to what I would later employ in the lessons. The game used to teach me was a simple game that employed simple concepts. Creating a game too complex for the students would not be beneficial since they wouldn't be able to understand it. Put simply: if I, a 4-year computer science student, couldn't follow along easily, how could the high school freshman and sophomores?

So, the game I programmed was simple yet challenging. The concepts were pretty straight forward. Collect coins, destroy enemies, and make it to the finish line. But the game had to be completed by students and customizable. So, I taught the students how to fix simple bugs and make the game personable. I taught the students how to change the name of their game, the background of the game, the player model (player "sprite"), create new levels, and on some rare cases, the settings of the player itself, such as x-velocity, y-velocity, gravity, etc. These challenges for the students got progressively more difficult. The first part was easy, requiring just a button click, then a few button clicks, then hundreds of button clicks – sprinkled with imagination.

The physics behind the game was the most confusing, so I kept that separate from the lesson plan. Similar to how I didn't need to understand (or want to understand!) the code behind using the game engine itself, I kept the physics hidden from the students, so they weren't overwhelmed.

Phase 2 – The workshop!! – 35 Hours

This was the STEM Outreach part of the grant. This is where that lesson plan and game would be executed in an education manner. This part was more fun for me, as I got to use my natural enthusiasm and teach. The same lesson plan would be executed for all the Outreach activities.

When students first arrived, I handed each of them a flash drive with the game and resources pre-loaded onto it. They would sit down at the pre-logged in computers in our computer lab at the University of South Carolina. Krystal DuBose, the Director of Enrollment Management, helped me organize outreach events. She brought in students from schools around South Carolina to tour the College of Engineering and Computing at USC for the day and included my workshop into their daily curriculum. I would get classes in the range of 8-30 students.

After the students sat down and a brief introduction of myself and USC, I started the workshop. The students would start off by playing the game preloaded. (Picture 1) This let the student get comfortable with the software and to have fun. It was both an icebreaker and an introduction into what they would be working on.

I then walked the students through the customization of the game. We would start off with a "hello world" equivalent of Godot. They simply changed the name of their game and ran it. This demonstrated that the game would change and render based on what we did as programmers!

After this, I taught the students how to change their player icon, enemy icon, and background. This typically took around 40 minutes to get through, but it was the most rewarding feature for the student. By simply changing the background of the game, it allowed for an entirely different feel of the game. The player sprites could then be complementary to the background and add to create a theme of the game.

It was amazing to see the creativity of the students and their themes behind it. Some students created a *Super Mario* theme, some students created a *Hannah Montana* theme, and some hilarious students made their teachers the player icon/enemies.

After the customization of the look of the game, students then were able to customize the functionality of the game itself. I taught them how to create their own levels and connect it into the game. I also taught students how to change the settings of the player's velocity, gravity, and bounce effect.

Over the course of the sessions, I improved of my skills as a teacher for this given lesson plan. I learned quickly what was working and what needed to be changed. (More on this later). The overall lesson plan was very impactful as it was a general lesson plan that could teach everyone while also customizable for each student.
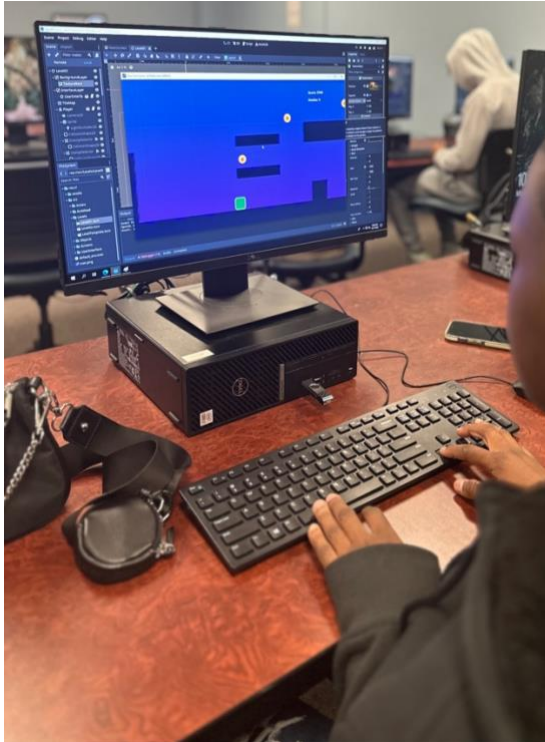
Figure 1 - Student playing the game!
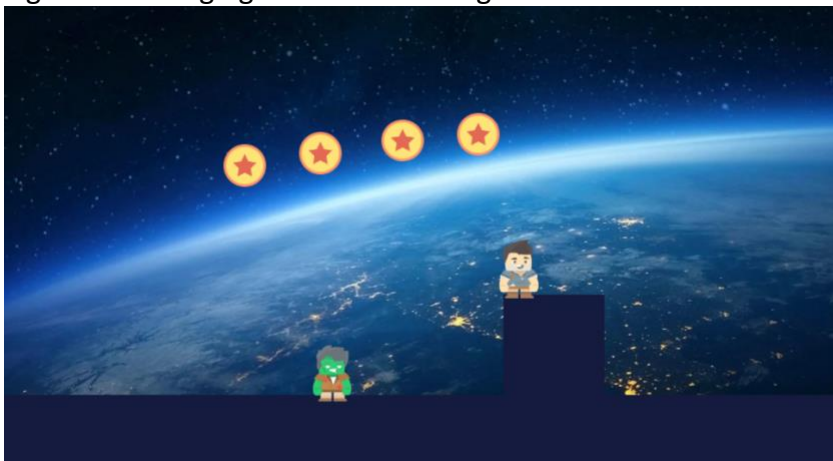

Figure 2 - Changing the name of the game

Figure 3 - A customized background and player icon

Project Results

There were two big takeaways from the STEM Outreach award: what I learned; and what the students learned. My own lessons are probably easier to articulate.

First off, I improved my technical skills. I picked up proficiency in a programming engine and language that I've never had before. Godot is now on my resume! I was able to improve my teaching skills as well. Teaching the group got easier as the year went on. My soft skills of speaking legibly improved. I was able to multitask better and delegate better. If a student was understanding the material well, it was easy to ask that student to help his/her classmate next to them. These are all skills that I will take with me moving forward.

The results of the students are best understood through their projects. There were some students who didn't know how to copy and paste until I taught them, some students who didn't know how to save files to their computers, and some students who learned how to design a level properly so that the user could enjoy the experience. There were all kinds of progress from the students.

I made sure to attend to every student so that they would each be able to learn something. Some students needed help on every step, while other students wanted more to do. The workshop was scalable to accommodate everyone's needs. Unfortunately, I do not have the files of the students showcase in this report, since they took their flash drives home with them, but Krystal took some pictures of some of the students' games!

Gallery of some projects by students!

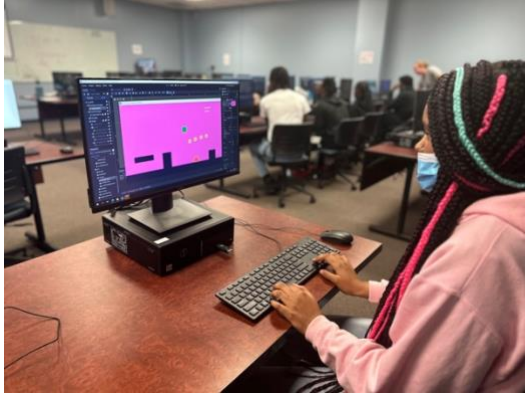Figure 4 – A student customizing their game

Figure 5 – A student playing their customized game

Figure 6 – A student creating their own level

Figure 7 – A student helping another student with the project

Figure 8 – Andrew (me, standing) helping a student with their level

Figure 9 – A student working on their game

Figure 10 – A pair of students talking about their game

Figure 11 – A student helping their neighbor

Participation Table

Name	School	Dept.	M/F	Ethnicity	Disability Y/N	Education Level *Undergraduate Graduate*	Total hours worked on project
Andrew Bernhardt	University of South Carolina	College of Engineering and Computing	M	White	N	Undergraduate	85

Outreach Events Summary

These are the schools that were reached:
10/17/22 - Calhoun County High School – 31 students
2/27/23 -AC Flora High School-31 students
3/2/2023-Calhoun County High School -31 students
3/15/2023- Fountain Inn High School- 25 students
4/5/23- Hilton Head Christian Academy-12 students
4/19/23- Union Career Center- 14 students
4/26/2023- Columbia High School- 12 students

Overall Experience

This Outreach Award was a blessing to be a part of. It was such a joy to be able to teach students what I know about programming and to see students learn in a fun way. Many students blew me out of the water in what they knew and were capable of. I believe that as we get older, our imagination and creativity can be halted by structure and procedure. When you try something for the first time, you can visualize a bigger picture or new way to do something. Revolution comes in the form of change. Change comes from creativity. These students have so much creativity. It was rejuvenating to see, since it's easy to feel like we live in a world where we're defined by confinement.

Impact

Figure 12 – Andrew (me) beginning the game design presentation

Future Efforts for Sustainability

William Hobbs was awarded this grant for the 2021-2022 school year. He did a similar project and worked with Krystal DuBose to perform outreaches. A lot of the ideas behind why the project would be successful came from him. So, I owe a lot of credit to him as he was helpful in the early development and ideas of the project. There is another USC computer science student who has applied for this grant, so if they are to receive the grant, I will be helping the undergraduate with it, just like how Hobbs helped me with my grant.

References

[1] A. Bednarz. Computer science salaries rise with demand for new graduates, 2016.
[2] Code.org. Support k-12 computer science education in South Carolina, 2013.
[3] S. Kurkovsky. Engaging students through mobile game development. ACM SIGCSE Bulletin, 41(1):44–48, 2009.

[4] Granic, I., Lobel, A., & Engels, R. C. (2014). The benefits of playing video games. American psychologist, 69(1), 66.