

**“Input Modality Evaluation for Concept Building Software”**  
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## Introduction

Past research into how people learn suggests there are individual differences in how people acquire certain concepts (DeLosh et al., 1997; McDaniel et al., 2014), and that these differences can predict one’s success in learning and STEM disciplines (McDaniel et al., 2022; Frey et al. 2017). This past work found one of the best predictors of learning is the concept-building task. The concept-building task is a computer-based task in which an individual is trained on learning a relationship between input and output pairs modelled by an underlying function. There are two main classifications of learners – *abstract learners* (individuals able to abstract the underlying function or rule that associates the input values to the output) and *exemplar learners* (individuals that use rote information as a basis for predicting the relationship between the input and output values). However, in all studies which have used the concept building task, there are individuals dubbed *non-learners*, participants that cannot be identified as either exemplar or abstract learners. We suspect that this is at least in part due to the cognitive demands of the human-computer interaction required of the task as implemented.

## Methodology

Participants included 40 undergraduate students recruited from a small liberal arts college in the Southeast with results included from 34 of those participants. Participants were randomly assigned to use either a mouse or keyboard to complete the concept-building task.

In the keyboard condition, participants made their predictions by using the arrow keys: Up and Down arrow keys enabled participants navigate close to their prediction and the Left and Right arrow keys were used to fine tune the prediction. In the mouse condition, participants made their predictions by using their mouse cursor to click on part of the graph corresponding to their prediction. While using the computer software, participants were shown a bar graph labeled with the stimulus at a predetermined height (left, blue bar) as illustrated in Figure 1. They were also given a bar which they used to predict the response using either the keyboard or the mouse to mark their predicted response (middle, red bar which the participant moves up/down). Once they marked their predicted response on the red bar, they were shown a third bar indicating the height of the correct response (right, green bar). Participants were given four seconds to observe the third bar with the correct result and then the bars reset to their original state and a new trial began with a new stimulus level. This cycle continued for 260 trials. After the training blocks, participants were given a transfer block with 36 trials: 30 extrapolated (outside the training range) input data points and 6 interpolated (within the training range). Participants did not receive feedback (i.e., the green bar) on their predictions in the transfer block.

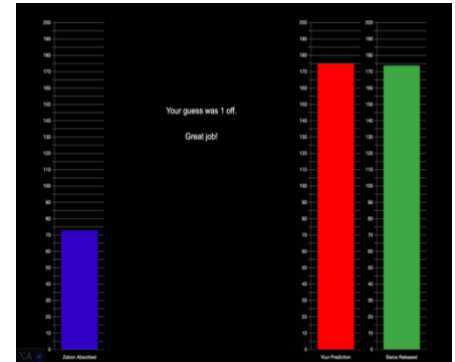


Figure 1

## Results and Discussion

We formulated and tested a set of hypotheses (each with its own distinct focus) to assess the effectiveness of our mouse-based input prototype of the concept-building software and explore the possible advantages of it compared to the currently used keyboard-based version. In this section, we will summarize the findings, offering insights into the implications of our results for implementation of the alternative input modality for the concept-building software.

We found support for the equivalence in the proportion of different types of learners of our keyboard-based input prototype to the published data using a keyboard-based input. We also found support for the equivalence of our keyboard-based and mouse-based input prototypes in the proportion of learners classified as abstract and exemplar. The support for both of these was statistically weak probably due to our small sample

size, impacting the strength of evidence provided by the Bayesian analyses d. Expanding the sample size in future studies may yield more robust and conclusive results.

We also evaluated the superiority of our mouse-based input prototype relative to the keyboard-based prototype on several HCI factors (time and accuracy; English et al., 1967) and its ability to avoid the non-learner classification from the published literature with varied results. The results indicated that there was no significant difference in the time taken to complete the task across both conditions. On the other hand, the results suggested that the mouse-based prototype was ‘better’ than the keyboard-based in terms of reducing the prevalence of individuals classified as non-learners, and the overall error when making predictions. The results also demonstrated that the mouse-based prototype was better in that participants got to learner criteria much faster than those in the keyboard-based prototype.

## Conclusion

Altogether, an analysis of our hypotheses and their corresponding results demonstrates a lean towards the mouse-based prototype being a better task than keyboard-based prototype. This has some implications. Firstly, it addresses the initial problem of the prevalent number of individuals classified as non-learners. Even considering our small sample size, we can make a plausible conclusion that the mouse-based prototype of the task would help reduce the number of non-learners for future use of the concept-building task. Secondly, it opens the door of enquiry for asking more about how input modality can affect one’s performance in the concept building task. Thirdly, an improvement in the task would help in increasing the reliability and internal validity of the task, giving us leeway to explore questions like: do individual differences really exist? Or does learning occur in a continuum as opposed to discrete categorizations of learners?

## Acknowledgements

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# 3D Collision Avoidance Simulation for a UAV Landing at a Non-Towered Airport

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## 1 Introduction

As the operation of unmanned aerial vehicles (UAVs) expands, the day may soon come when unmanned aerial vehicle traffic is integrated with manned air vehicle traffic. While many studies focus on software dedicated to separating UAVs from manned vehicle airspace, little research exists focusing on the integration of UAVs and general aviation traffic. This study creates a Java simulation of a UAV entering the landing traffic pattern of an uncontrolled (non-towered) airport. A collision avoidance system (CAS) and wind correction algorithm is introduced, including maneuvers implementing standard manned traffic collision avoidance methods. Many small airports lack a control tower and therefore rely on "see-and-avoid" anti-collision strategies in Visual Flight Rules (VFR) conditions [1]. Therefore, CAS for UAVs near uncontrolled airports, particularly the landing pattern, is an area of research that requires more attention. Using the standard pattern of a high-traffic, non-towered airport in the southeastern United States with a high volume of student pilot traffic (approximately 300 operations per day [2]), this paper presents a collision avoidance system accounting for wind displacement for a UAV entering a traffic pattern at an uncontrolled airport populated by general aviation traffic.

## 2 Modeling the Flight Pattern

A Cessna 172 was chosen for the UAV model because it is a popular training plane for student pilots and general aviation pilots. Three total planes are initialized. A slow Cessna 150, the Cessna 172 UAV, and a faster Cessna 172. This order ensures a collision without proper avoidance strategies, allowing full testing of the algorithm's effectiveness. A graphical model of the 4 traffic patterns at the non-towered airport was established through vector calculus. A diagram of the runways (headings 36/18 and 29/11) can be seen in Figure 1. Their representation in the simulation, along with the traffic patterns, is shown in Figure 2.

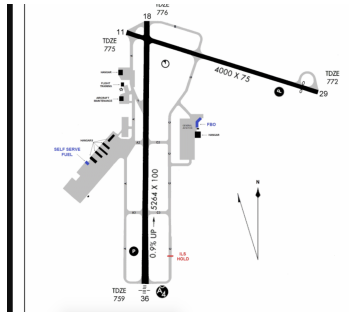


Figure 1: The High-traffic, Untowered Airport [2]

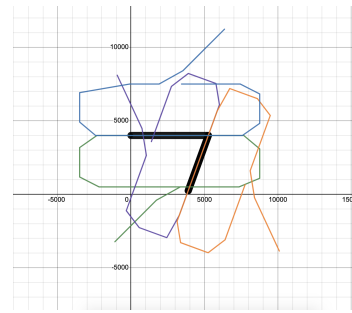


Figure 2: Graph of Traffic Patterns

After checking if collision avoidance is necessary, the program calculates the distance to turn, updates the plane heading, dequeues the leg, and increases the position if turning is required. If the leg is not changed, collision avoidance maneuvers are performed if deemed necessary. The program then updates the plane's velocity based on its acceleration, finds the new point to move to, and corrects for wind displacement. The new point is then used to calculate the new heading of the UAV. If wind is present, a change in the  $x$  and  $y$  position is also adjusted, to simulate the UAV blowing off course. The acceleration needed (throttle setting) is calculated based on current position of the plane, the end of current leg position, and the velocity desired at end of leg based on the plane's  $V$  speeds specified in the plane class. With this algorithm, the program successfully simulates flying a standard traffic pattern with the correct dimensions, speeds, and acceleration.

## 2.1 Wind Correction and Collision Avoidance

This study takes a geometric approach to wind correction, meaning the UAV determines the wind magnitude based on its displacement from the projected path, correcting its trajectory accordingly. This is most realistic to how pilots typically fly in windy conditions by "crabbing," or turning into the wind, based on looking at their position over the ground. As the UAV has GPS capabilities through ADSB, this is a reasonable approach that does not require any additional sensors or information about the wind.

While there are numerous studies that examine UAV collision avoidance, most either find the best path around an object or seek to avoid said object. However, these strategies do not apply in CA along an FAA-prescribed path under VFR. First, a plane should never cut in front of another aircraft in the landing traffic pattern. Second, the UAV is seeking landing and would not aim to simply desert the pattern when at risk of colliding with another aircraft. Thus, this paper proposes three anti-collision strategies for the UAV to perform that align with typical pilot maneuvers: accelerate, make a  $360^\circ$  turn, or ascend to avoid immediate impact. As multiple anti-collision measures may be necessary, a class attribute keeps track of the measures needed and their order to execute. Before advancing to the next point, the program checks this string to verify the collision avoidance path intent of the UAV.

## 2.2 Results

Figures 3 and 4 show the flight path with correction for wind displacement for runway 36 where the winds are 270 at 15 knots. It is important to note that the path is still not perfectly straight, and this is due to heading adjustments in flight on each leg. Each heading adjustment thus results in wobbling and curvature in the path. This can be seen in the Cessna 150 path, which slightly over-corrects on the upwind leg. This

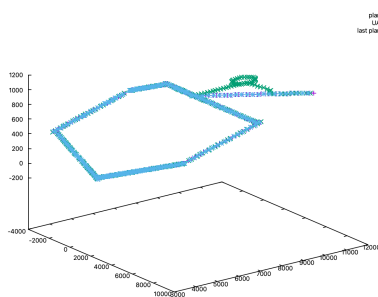


Figure 3: Runway 36, Side View

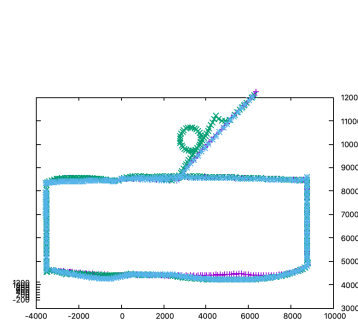


Figure 4: Runway 36, Top View

paper proposes a successful Collision Avoidance System for UAVs landing at an uncontrolled airport. Four traffic patterns according to standard general aviation practice are correctly flown by this simulation. Two other planes of varying speeds are implemented to test the collision avoidance system. The simulation also handles collision avoidance when multiple runways are in use at once. The UAV performs typical avoidance maneuvers such as accelerating to create distance between aircraft, performing a  $360^\circ$  turn, and ascending to avoid immediate impact. The UAV safely circles the pattern, lands, avoids other aircraft, and corrects for wind displacement.



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## Design and Implementation of a Light Database

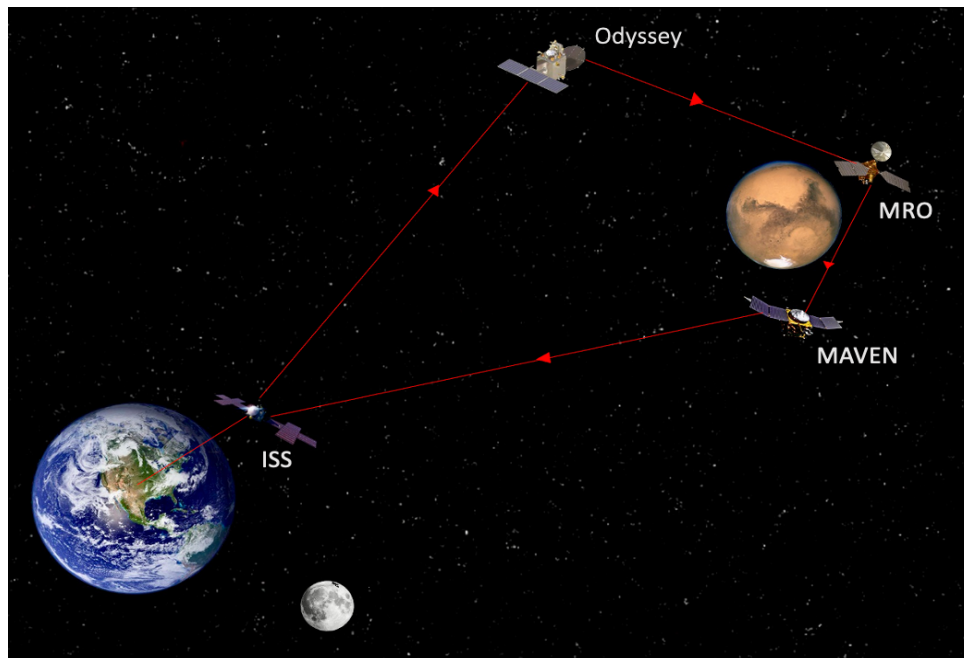
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Databases are organized collections of data typically stored in a computer system. They can hold large amounts of data for long periods. We are building a completely new database that will use light to store data instead of a computer system or memory. Satellites communicate and send data in the form of radio waves or infrared lasers; these are called optical links and are typically initiated from a ground station on Earth to a targeted satellite. For this project, we will simulate optical links traveling between satellites orbiting Earth and Mars. Links will be traveling continuously, which means that our data (stored in the form of light) will always be traveling and never stored in a static location. Furthermore, if the database is optimum, a shift for storing data from computer system to light will reduce the production of traditional storage devices (like Solid state drives or Hard drives) which will help the environment as well.

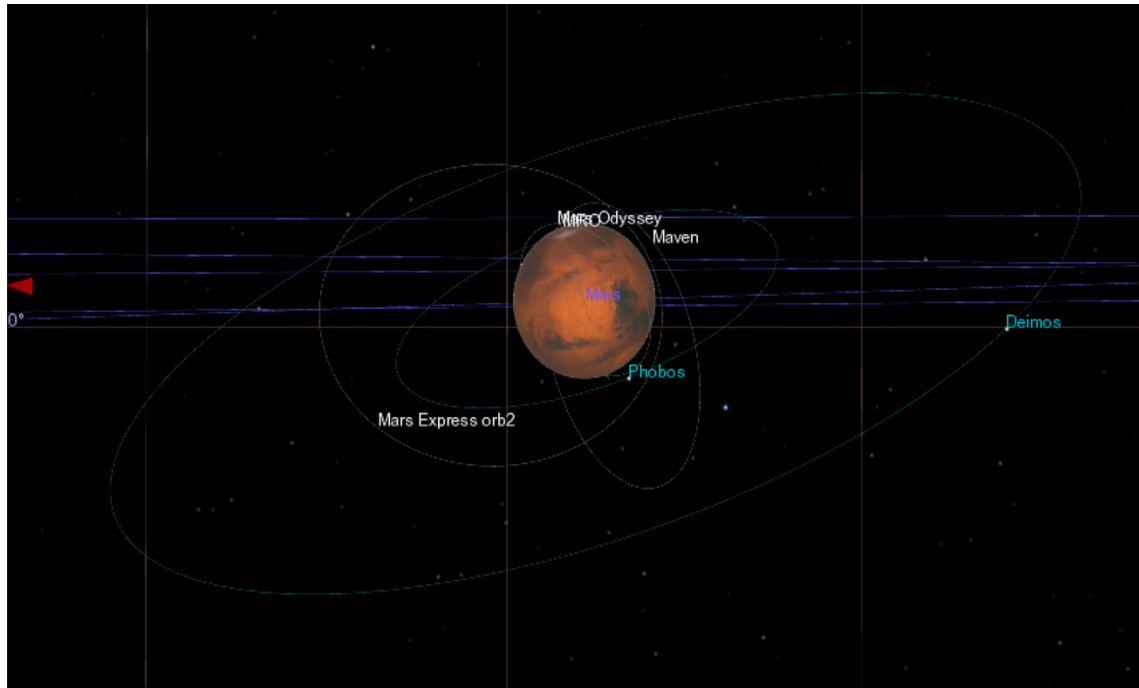


*Figure 1: Visual Representation of Light Database*

The above figure 1 displays the optical link initiated by the satellite ISS orbiting Earth and the data in the form of an optical link is targeted towards satellite Odyssey orbiting Mars. The link then progresses to the MRO, MAVEN, and subsequently returns to the ISS, completing the loop. The cycle data transmission operates continuously until fetched by the end user. For simplicity of this demonstration, the sizes of satellites and their orbits are not exact. I have provided real-time locations and orbit in Figure 2.

Mars orbiters are capable of relay communication, and they are roughly as fast as a home modem, the data rate direct-to-Earth varies from about 500 bits per second to 32,000 bits per second. In comparison, the link with the Mars Reconnaissance Orbiter (MRO) has an adaptive

throughput, allowing for speeds that can escalate to a maximum of 2 million bps. The Odyssey orbiter's communication channel, on the other hand, can operate at either 128,000 bps or 256,000 bps, marking a speed 4 to 8 times, superior to standard home modems. ISS has a data rate of 600 Mbps as well (NASA).



*Figure 2: Mars and its orbiters as seen from Earth using Celestia.*

I will create algorithms and with the help of Celestia (Figure 2), we will be able to simulate data transmission and ensure rate adaptation since every satellite has different uplink and downlink capabilities as mentioned earlier. It will also help find at least two satellites that are in the line of sight to ensure data storage (circulation), help manage data flow, track data, and find efficient optical links. Figure 2 displays the real-time positions of Mars orbiters when the distance for all satellites was noted and it was estimated that for 1 gigabyte to circulate through the path in (Figure 1) and after rate adaptation, it would take 14.22 hours for data to come back to starting point. Thus, with the help of a light database, we will be able to store data in the form of light over long periods. Apart from ensuring secure data storage, it will also benefit the environment by curbing the production of storage devices.

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# Teaching 3D Modeling via an Engaging TinkerCAD Project

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## Introduction

Our project aims to engage all ages to learn more about 3D modeling and 3D printing. Researchers found a positive relationship between frequent exposure to TinkerCAD [1] and computational thinking. For example, Eryilmaz and Deniz [2] published a study that explored the effects of TinkerCAD education on 583 students in Ankara Province. Another study on TinkerCAD [3] used TinkerCAD with middle school students to work on their spatial reasoning skills. This study found a correlation between students that had been exposed to TinkerCAD and improved spatial reasoning ability.

We are developing our project during our Technology Ambassador Program (TAP) course during Fall 2023. The TAP program at Georgia Gwinnett College (GGC) aims to get all ages interested in technology via student projects and outreach. TAP's main goal is to inspire students to explore and be creative with technology. When students join TAP, they not only learn how to use technology but also use what they learn to make interesting projects. These projects are meant to be enjoyed by people of all ages in our community. By showing how useful and fun technology can be, TAP hopes to get everyone excited about the digital world, no matter how old they are.

## Methods

In our project, we use TinkerCAD, which is a user-friendly, web-based 3D modeling software accessible through a standard web browser. Additionally, we employ 3D printers to bring digital designs to life. TinkerCAD provides an excellent platform for beginners to grasp the fundamentals of 3D modeling because it eliminates some of the common pain points associated with 3D modeling software. It is an ideal tool for our educational objectives because it is free, accessible from any browser, browser-based to avoid downloading software, and allows users to express their creativity in a safe space without the complexity of other modeling software.



Figure 1. Example of a keychain featuring the GGC logo designed with TinkerCAD.

Through TinkerCAD, we empower participants to design personalized keychains featuring the GGC logo (Figure 1), making the 3D modeling and printing process accessible and engaging, even to those without advanced technical knowledge. Our project is a work in progress at the time of this submission.

## Results

We will present our project at three outreach events. First, through the TAP Expo, a school-wide event featuring TAP students' projects and presentations where attending students can try out and play with the provided material. Second, the Super Saturday Series, an event where TAP projects are presented to middle school students to grow and drive interest in STEM and remove some of the initial intimidation associated with the field and its difficulty. Finally, through classroom workshops at our institution, we will present our project before students of varying concentrations to foster the idea that STEM does not necessarily have to be intimidating but can be fun and simple.

We will measure the success of our efforts and the effectiveness of our project through pre and post-surveys which will be given to all participants at these events. By comparing the pre and post-survey results, we can track and measure the success of our efforts and acquire feedback from those who partook in the activity. We will present our project and our findings at the conference.

## Discussion and Conclusion

Our project focuses on introducing individuals of all ages to the world of 3D modeling and printing. Through Tinkercad, a user-friendly web-based 3D modeling software, we empower participants to design personalized keychains featuring the GGC logo, making the 3D modeling and printing process accessible and engaging, even to those without advanced technical knowledge. This project serves as a hands-on, practical introduction to technology, aiming to ignite interest and curiosity across various demographics, including college students, middle and high school students, professionals, and the GGC community. Our mission is to inspire a lasting fascination with technology, bridge the gap between technology and the community, and promote STEM involvement for all. Our poster will introduce the audience to our project and present the results of our outreach workshops.

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## Acknowledgements

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Georgia Gwinnett College - School of Science and Technology

Georgia Gwinnett College – Digital Media Lab

# Teaching Sound Editing with Audacity and Makey Makey

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Instructors: Dr. Anca Doloc Mihiu and Dr. Cindy Robertson

## Introduction

This study is targeted towards young students who wish to learn about audio editing and design. We are conducting this study to engage and teach students the basics of audio editing. Some students may be pressured by the idea of tech and programming, but our project will show them other avenues in the tech side of education.

Our goal is to introduce both tech and non tech students to learn about recording and editing sound files through a fun and interactive horror story Mad Lib activity. We are developing this project as part of the Technology Ambassador Program (TAP) course we are enrolled in during Fall 2023. The TAP program is a program for anyone with an interest in Information Technology. The program lets students learn more about different technologies while creating outreach workshops to promote an interest in STEM in their community. The creation and implementation of these workshops will allow TAP students to develop better communication and leadership skills while also letting students be creative in designing their projects. The TAP program promotes the acquisition of research skills and encourages students to attend conferences to present their projects.

## Methods

Our goal is to introduce both tech and non tech students to learn about recording and editing sound files through a fun and interactive horror story Mad Lib activity. Our project features narrative stories that feature sound effects activated by the reader pushing a button to produce a given sound effect. These buttons use Makey Makey technology to produce certain sounds given certain button input(s) and these inputs are implemented using Scratch. Our demo version includes 6 stories with already edited sounds which will use a Makey Makey to play the sounds, while our workshop will just give each story and let our audience create and edit their sound effects using Audacity. The workshop will also include a couple of examples of the step-by-step process of editing our demo sounds to assist the audience in creating/editing their sound effects.

We will use recording hardware like mics, soundproof booths, and computers to capture sound effects for provided stories for students to fill in. Editing software like Audacity or Garageband will be used to modify our audio, this will give them a chance to learn and get a deeper understanding of how sound waves and modifiers can do to a recording. Once complete, students will be walked through how to code their recordings into Makey Makey and allowed to integrate them into the stories. We wish to teach methods that students can use to record, edit, and export sound, as well as how to code that sound into programs like Scratch and Makey Makey. We will showcase our work at several venues:

- **Tap Expo (Target Audience: GGC college students), Super Saturday Series (Target Audience: Middle and High School Boys/Girls), and CREATE Research Symposium and conference setup (Target Audience: General).** During these events, we will demonstrate how to use a Makey Makey, with the use of a horror story. As the story is being told we will include sounds, activated but the



Makey Makeys to create an immersive experience. We will then give a brief explanation of how the audio clips we implemented were recorded and edited by us.

- **Classroom Workshops (Target Audience: GenEd college classes).** The classroom activity will start with a demonstration of our story and how Makey Makey can be used to insert sound clips. We will then go over how we went about recording and manipulating our audio and what applications we used to make it happen. Then we will turn it over to the students, split into groups, where they will have to edit pre-recorded sounds and apply them to their given story from their own devices.

In the general workshops, we will demonstrate one of our stories using Makey Makey to insert sound clips. We will then go over how we went about recording and manipulating our audio and what applications we used to make it happen. Then we will turn it over to the students who, split into groups, will have to edit pre-recorded sounds from their computers and apply them to their given story. Students who finish early will be allowed to interact with the equipment we used during our project.

Our results will be measured with a pre and post-activity survey. The surveys will have basic technology questions about the technology that is being used in our project along with general questions about age and education level.

## Results

Once we conduct our workshops and demos, we will analyze the results from the previously mentioned surveys. For the Tap Expo, we will evaluate how the concept of sound manipulation is viewed through our presentation of edited sounds controlled by Makey Makeys. For the Super Saturday Series, we will be looking for student engagement, as well as how well middle schoolers can edit and play with sound. For the classroom workshop, we will get the chance to see results from young students and their ability to engage and develop their custom sounds. For the CREATE Research Symposium and Conference Set Up, our results will be tested on student engagement, creativity, and ability to record and edit the sound clips provided.

## Discussion and Conclusion

Our goal is to introduce sound editing to the general public and use the novelty of Makey Makey to increase interest in Information Technology. Using stories as a requirement for certain abstract sound effects, we show the importance of being able to edit easily recorded audio to produce hard-to-record sounds/non-existent sounds. Our workshop uses open-source applications that do not require prior knowledge of IT-related concepts to ensure that our audience can follow along cohesively and explore the concepts taught on their own. Through this workshop, we hope to inspire a wide variety of people- young children to professional adults- to participate in more science/technological activities.

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## Acknowledgments

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Georgia Gwinnett College - School of Science and Technology

# Teaching Algorithms and Growing STEM with Sphero

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## Introduction

The media presents the idea of a programmer as a speed typing super genius who learned how to code when they spoke their first words. In reality, the average coder learns the basic concepts of coding in their late high school to early college years. When people think of IT jobs, they think of monotonous cubicle jobs. However, IT jobs vary in concept, enjoyment, and environment. In order to break this misconception, we will be demonstrating in this workshop how programming doesn't have to necessarily be data analytics and cubicle work.

The Information Technology field offers more fulfilling careers such as: penetration testing, game development, or app development. The Technology Ambassador Program, TAP, strives to break this misconception by providing resources for IT students. TAP students use their programming knowledge and provided resources to create enjoyable, interactive workshops for K-12 or beginning college students [2]. Some TAP workshops include basic game development using Scratch, programming robots like Cosmo, or creating unique 3D models using TinkerCad. In this study, students will have the opportunity to play with a robot while learning the basics of coding which has produced good results in previous workshops as shown by the reactions of those students such as "I am severely allergic to technology, so I was uncomfortable at first. I warmed up a bit during the first activity (playing around with BOLT)....Students could benefit from Sphero Activities... [1]"

## Methods

We will be using the pedagogy of integrative approach to teach the students throughout this workshop. In order to demonstrate this idea, we will be using Sphero to educate students in the concept of algorithms.

Sphero EDU [3] uses block coding, so we will be able to teach both basic and beginner level concepts of coding such as: algorithms, while-loops, if-statements, and methods. Our presentation will consist of a demonstration of the capabilities of Sphero and block coding, and then the workshop will transition to an interactive guided maze route that the students will program Sphero through.

Our goal within this portion of the workshop is to educate students on beginner-level programming concepts. In order to pique their interest in STEM programs and careers, we will conclude our presentation with an interactive demonstration of Sphero paired with Leap Motion and a WiiMote. The participants will be provided the opportunity to operate Sphero using the motion capture capabilities of Leap Motion and the infrared sensors of the WiiMote.

## Results

We are currently in the process of finalizing our project design and implementation. Using this project, we plan to perform outreach at several venues: a TAP Expo event at our college, where the audience will be college students, a Super Saturday Series (S3) event, where the audience will be mostly middle schoolers, and 3 classroom workshops at GGC, where the audience will be students enrolled in General Education courses who are new to technology.

The participants of each of our workshops will take a pre-survey asking the participants questions relating to this misconception and previous IT experiences or knowledge. After the workshop, they will be given a post-survey asking whether they have gained a new viewpoint or interests within the field. The survey will also ask if the workshop was adequate in educating them on various coding concepts. We plan to analyze these pre and post surveys and study the effectiveness of our workshops. We will present our findings on the poster.

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# Using Roblox and VR to Inspire Game Development Skills and STEM Interest

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Instructors: Dr. Cindy Robertson, Dr. Anca Doloc MiHu

## Introduction

This study investigates using Roblox Studio to introduce middle school students to game development and programming concepts in an engaging, interactive manner. We build our project during our Technology Ambassadors Program (TAP) course we are enrolled in Fall 2023.

The Technology Ambassadors Program (TAP) at Georgia Gwinnett College (GGC) provides mentoring and hands-on technology projects for IT students. TAP is a service-learning initiative that empowers IT students to mentor, collaborate on technology projects, host workshops, participate in conferences, and engage in community outreach. TAP teams collaborate with faculty members to develop cutting-edge projects involving emerging technologies. It provides students with invaluable experience, enhances their technical skills, and fosters communication, teamwork, and leadership abilities.

This project aligns with TAP's mission to enhance technical skills and serve the local community. Related works [1,2] have examined using game engines and virtual worlds for educational purposes. In a world increasingly driven by technology, inspiring a new generation of innovative thinkers and creators is paramount. Our study is motivated by the need to provide students with hands-on experiences that combine game development, VR technology, and programming skills. By doing so, we aim to ignite the spark of curiosity and creativity in young minds, fostering their interest in STEM and game development.

## Methods

Previous research [1] has demonstrated the effectiveness of immersive and interactive learning experiences in enhancing student engagement and understanding. Our project builds upon this foundation by uniquely integrating game development and VR technologies into STEM education. We leverage the Roblox Studio game engine and Lua programming language to create educational games that are both entertaining and instructive.

Our project addresses the pressing need for innovative and engaging STEM education by offering two interactive and educational games developed using the Roblox Studio game engine - a VR demo game and an obstacle course with interactive elements. The first game, designed for the Meta Quest 2 VR headset, serves as a captivating demonstration of VR game development. The second game is an obstacle course hosted in Roblox Studio, where players learn basic game development concepts by manipulating the game world and scripting game physics using the Lua programming language—all within the context of an exciting game. The obstacle course aims to teach basic programming and environment manipulation. The project aims to spark interest and increase diversity in STEM and game development careers through an unintimidating and fun introduction.

## Results

We plan to showcase our project at several events to fulfill our outreach target of the TAP course. These events are: TAP Expo where the project will be showcased to GGC college students, Super Saturday

Series (S3) where the project will be showcased to middle school students, and 3 classroom workshops where the project will be showcased to General Education college students.

Workshop participants will learn game design principles and scripting using the Lua scripting language while playing and modifying the games. Assessment of the effectiveness of our outreach effort (engagement, learning, and interest in computer science ) will be measured by analyzing the results of the pre and post surveys that we will administer during the workshop to collect insights from the participants. Results will be measured with the use of pre-event and post-event surveys which will also ask questions regarding the students' knowledge of basic programming concepts and game creation.

This study contributes hands-on game development experience to the TAP service learning curriculum and evaluates Roblox's potential for engaging the youth in programming and game development. Our study caters to young students, specifically those at the middle school level and below, seeking to explore the world of game development and STEM in an accessible and fun manner. Our project aims to demystify programming and technology, making it an unintimidating endeavor for our young participants. Our poster will showcase the project details and the outreach events soon to happen. It will also provide the results of our study.

## Conclusions

Our project aims to make game development and STEM education fun and approachable for young students. We are driven by our passion for games and game development, and we believe that learning should be an interactive and enjoyable experience. TAP, through scholarships, presentations, and affiliations, strives to provide students with real-world experience, contribute to their community, build impressive resumes, and establish networks aligned with GGC's pillars of scholarship, leadership, service, and creativity.

In conclusion, our project within the Technology Ambassadors Program (TAP) is designed to inspire the next generation of game developers and STEM enthusiasts by combining game development, virtual reality, and programming in a fun and accessible manner. We aspire to empower young minds to dream, create, and innovate in the world of technology.

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## Acknowledgements

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# **Raising Awareness on Nutrient Pollution-Related Manatee Mortality through a Headset-Based (Quest 2) Virtual Reality Simulation**

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## **Introduction**

Manatees are a large part of the Florida marine ecosystem, but they face many life-threatening issues caused by humans. Since December 2020, an “Unusual Mortality Event caused by starvation due to lack of forage in the Indian River Lagoon (IRL)” has been the leading cause of manatee mortality in the winter months [4]. This “lack of forage” is the result of nutrient pollution largely from humans, creating harmful algae blooms through eutrophication [5]. Our project aims to raise awareness about this event with the goal of lowering nutrient pollution and reducing manatee mortality from malnourishment. To accomplish this goal, we created a Virtual Reality (VR) game for the Quest 2 headset that immerses the player in the manatee’s life, where they can experience the changes nutrient pollution has had on the IRL firsthand. My role in this project was a simulation developer for the Quest simulation, designing robust systems, writing scripts, and assembling scenes in Unity.

## **Background**

In education, VR offers great promise as a valuable tool to assist learning. VR enables students to become visually immersed in concepts that are impossible or impractical to physically explore, such as the marine environment [1]. The presence and immersion of VR, enabled by headsets like the Quest 2 with accurate motion tracking of the player’s head and hands, allows for developers to build player empathy for the avatar and environment [2]. In addition to VR, there has been research into the benefits of gamifying education. “Digital Game-Based Learning” centered on the environment has been shown to build stronger emotional connections to the educational content, leaving a stronger impact on students [3].

Because manatees play an important role in the Florida environment, and humans are the primary cause of their largest threats, raising awareness on how to reduce nutrient pollution is a critical endeavor. The benefits of headset VR and gamification that build strong connections between the player and the educational content suggest that an educational VR game would be especially effective at spreading knowledge and making a difference. Our primary audience is students in middle school and high school, since they are able to make a substantial impact on the environment throughout their life.

## **Our Work**

The primary goal of our project is to increase awareness of everyday pollutants and actions that affect marine ecosystems. Previously we have developed other simulations to address human actions such as high speed boat collisions and garbage dumps in the ocean. This simulation addresses nutrient pollution caused by humans and the sequence of events that ultimately lead to manatee starvation.

In our game, players progress through a series of scenes designed to educate and build empathy. In the first scene, players learn some manatee facts while learning how to use the controllers above water. The immersion of this game is enabled by the Quest’s head tracking and hand tracking, allowing us to turn the player’s hands into manatee flippers and integrate accessible motion controls, like pointing at menu items and looking around, into the user experience.

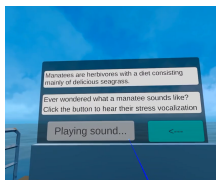


Figure 1a: Listening to manatee vocals in the first scene.

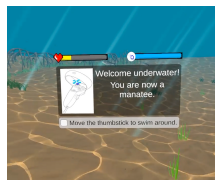


Figure 1b: Learning the controls underwater in the tutorial.



Figure 1c: Watching a manatee named “Eggroll” swim.



The player then transitions to an underwater tutorial area where they are introduced to the game's mechanics as a manatee, which include swimming around with the thumbstick, eating seagrass to increase a health meter, and swimming up to the surface to increase a breath meter. The breath meter decreases over time, prompting the player to occasionally surface to refill their breath.

In the next scene, the player is placed in a larger underwater area with underwater flora, fauna, and landscapes that are reflective of the Florida environment. Here, the user must eat seagrass, keep their breath meter filled, and interact with other manatees. There are two adult manatees, which are named by the player at the beginning of the game, who will act joyful and increase the player's health when pet using motion controls, hopefully also establishing an emotional connection between the player and these manatees.



Figure 2a: Petting a manatee with your manatee flipper.



Figure 2b: The presentation at manatee school.



Figure 2c: A malnourished manatee in a polluted environment.

Once the player has completed the basics of life as a manatee, they are transported to manatee school, where they watch a self-paced presentation explaining nutrient pollution and the effects it creates. The player then leaves manatee school, returning to the previous area with the same objective of surviving as a manatee, only now the environment has been impacted by algae blooms. Visually, the environment looks less healthy and the manatee friends show signs of malnourishment. There are fewer edible seagrass objects, making it harder for the player to complete their tasks to survive. When the player has eaten all of the available seagrass, they are informed that there is not enough food, and that they can send a letter to humans for help. The player then reads this letter, which contains actionable steps individuals can take, and sends it to the humans. The game ends above water again, where the player is debriefed about the simulation and its takeaways.

### **Future Work**

In the future, we plan on running user studies to evaluate the educational impact of the simulation, the immersion and presence, and the usability of the controls, and we intend to gather this information using surveys before and after players go through the game. We will use this feedback to iterate and improve the simulation and to study the effectiveness of VR in environmental education.

### **Limitations**

The greatest limitation to our research is the cost of access. The Oculus Quest 2 headset is \$300 and requires a room with open space to comfortably explore the virtual world. As mentioned in [1], VR in education has many pitfalls with accessibility that could lower the viability of VR use in classrooms.

In regards to development and user experience, standalone VR like the Quest 2 has limited rendering power, so 3D environments and assets must be lower fidelity, which could reduce immersion for some users.

For our user study, since multiple participants will have to use the same Quest 2 headsets, we must take extra care to sanitize the headsets between participants to ensure that germs do not spread and no participants are put at health risks.

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# Tangible Fruits and a Reconfigurable Game Engine for Technology Outreach

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## Introduction

Georgia Gwinnett College (GGC), an open-access public institution established in 2006, ranks as the most ethnically diverse Southern regional college, with a large percentage of underrepresented minorities in computing, ~59% Black and Hispanic students and ~59% female students. Technology Ambassador Program (TAP) is a service-learning course offered by the Department of Information Technology (IT). Its main goal is to break down the stigmas surrounding technology and increase the participation in IT among traditionally underrepresented groups for both students taking the course and those in the college and the surrounding community. The TAP course gives students opportunities to build real-world-like projects and provide authentic teamwork, leadership, and various public speaking and outreach opportunities. Each team consists of three to four students, with varying levels of computer knowledge and skills. They collaborate to develop project ideas, divide tasks, and meet project deadlines. Students demonstrate to themselves and others that technology is not as intimidating as it appears. Most teams choose to develop computer games. They demonstrate their games at various outreach events. They also conduct workshops where participants either learn programming concepts through playing the games, modify the games, or develop mini versions of the games by following step-by-step instructions [1]. Due to the effectiveness of the workshop approach, it was adapted to improve student motivation and learning in an introductory programming course [2].

## Description of Game and Its Reconfigurability

We enrolled in the course in spring 2023 and were motivated by the creative and collaborative nature of the course. We designed and built a fun educational quiz game, Fruit Rain, that allows others to try out technology in an approachable and enjoyable way. The game first presents a player with a question and then has the answer choices embedded in fruit images “raining” down on the screen. Figure 1 shows the game interface. To make the game more engaging, we used Makey Makey, a toolkit that can make anything conductive a key, to make a “keyboard” composed of real fruits. The player must physically touch the fruit to select their answer. If they answer the question right, the game presents the user with another question. If they answer it wrong, they lose a life and must try again. By using physical fruit, we were able to gain more attention and provide a better learning experience for the participants. As stated in [3], “alternative approaches such as collaborative play and physically embodied designs may also provide important benefits to learners”. Our demos were well-liked by kids and adults.

In the middle of the development process, we added a reconfigurable feature to the game, which proved to be a good decision. The quiz questions are stored in a .CSV file, which the game loads upon selecting a level. This feature gives us a high degree of flexibility and allowed us to reconfigure the game, often on the spot, for different audiences. For example, during the Atlanta Science Festival, we had initially planned to have our game focus on variables and Boolean expressions. However, based on our observation, we quickly changed the questions to simple arithmetic questions so that young kids can enjoy the game with questions they understand, while interacting with technology. Figure 2 is a snapshot of a kid playing our game at the Atlanta Science Festival.

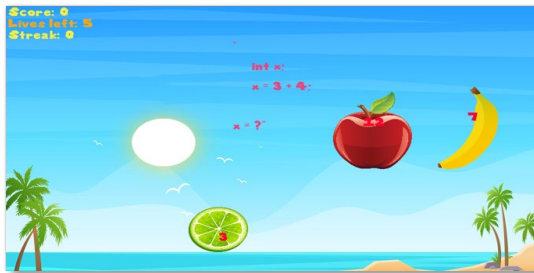


Figure 1: User Interface of the Fruit Rain Game



Figure 2: A Kid Playing Fruit Rain at Atlanta Science Festival

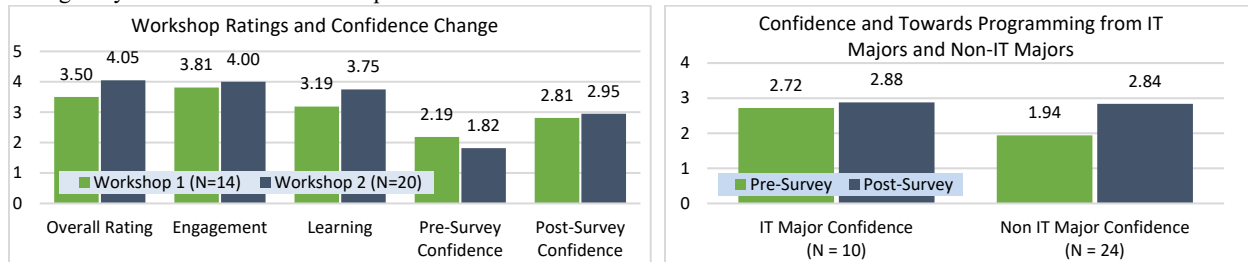
## Evaluation of Outreach Workshops for Early-College Students

During the spring 2023 semester, the Fruit Rain team attended several IT outreach events. This abstract focuses on the two workshops we conducted in freshman-level general education IT classes. For these workshops, we decided to focus on arithmetic operators such as modulus (%), the numeric variable types, and simple and compound assignment operators, such as += or -=. We first taught students these basics and then had them use our game to practice their newly acquired knowledge. It is worth noting there were differences in the ways the two workshops were conducted. The initial plan was to have students download the game from GitHub onto their computers and play on their own. However, we underestimated how long the setup process would take, and with roughly 20 minutes remaining, we decided to switch to a collaborative approach, where students would shout out the answers to the questions, and one of our team members would input their guesses accordingly to the game. This created an atmosphere of fun, collaboration, and learning. This process of trial and error allowed us to observe how workshop experience could be improved by on-the-spot adaptations.

For the second workshop, we kept the collaborative approach. After explaining the basics of the topics, we showed students the code for controlling the size and speed of the fruits and the number of points earned from a correct guess. Students gave their inputs on what to set these variables to, and we would run the game to examine the effects. Afterwards, we had students taking turns to come to the front of the room to control the game, interacting with real fruits, while the rest of their classmates would shout out the answers.

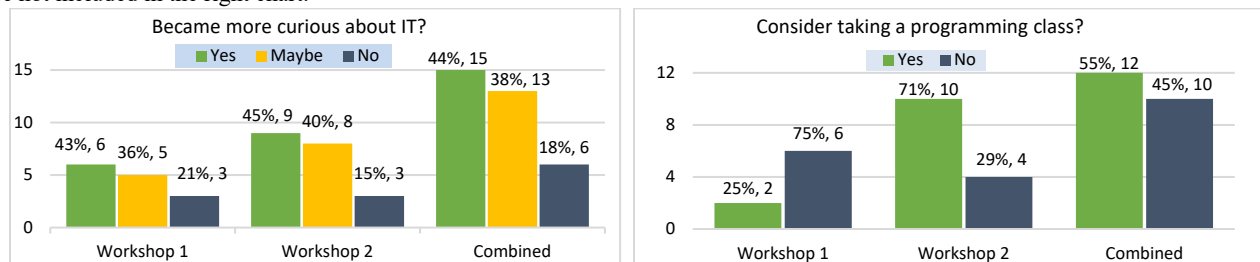
Students were given a pre/post survey asking how confident they were towards programming. Additionally, the post-survey asked students to rate the workshop, their engagement, and their learning, as well as whether the workshop made them more curious about IT, and if they would consider taking a programming class in the future. All questions have a Likert scale from 1 to 5.

Figure 3 (left) shows the ratings from two workshops. We can see that both workshops gathered positive ratings and the second workshop gained higher ratings for all metrics: student confidence improvement, overall workshop, engagement, and learning. It shows that the workshop format adjustment we made was effective. Students interacting directly with the game through real fruits at the second workshop might also be a contributing factor. Figure 3 (right) shows the comparison of workshops' impact on students' confidence between IT majors and non-IT majors. For IT majors, confidence was improved from 2.72 to 2.88. For non-IT majors, the confidence improvement was much more drastic, from 1.94 to 2.84. This shows the effectiveness of this outreach format, especially for students who did not originally choose IT as their career path.



**Figure 3: Confidence Ratings from Workshop Participants**

Figure 4 shows the post-survey ratings on whether the workshops improved students' curiosity for IT and programming and whether students would consider taking a programming class if not already planning to, respectively. Again, we can see that both workshops had positive impacts and the second workshop's impact is substantially higher. It is worth noting that six of the 14 students in workshop 1 and six of the 20 students in workshop 2 were already planning to take a programming class before their respective workshop, therefore they were not included in the right chart.



**Figure 4: Attitude change because of workshops**

## Conclusion

This project was a wonderful opportunity to develop our programming capabilities and our team building, leadership, and communication skills, which will be instrumental in our IT careers. As a result, one of us who was contemplating changing their major to Management Information Systems of the Business School decided to stay in the IT major. We also made an impact on others. Many who had the opportunity to interact with Fruit Rain enjoyed its novelty. Interacting with the game through real fruits gave our product a strong impression among workshop participants, helping improve their curiosity for IT and be open to the idea of learning to program.

The design choice for a reconfigurable game mechanism is one of our project's greatest strengths. It allowed us quickly to adjust to the change of workshop approach and topics during the planning stage of the workshops as well as during community outreach events. One IT professor already expressed interest in using our game in her classes. We also plan to advertise our game as a teaching tool for other disciplines.

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**Industry Connect Initiative (ICI):  
“EnTrack” – A Real World Application of Information Systems**

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### ABSTRACT

Southeastern Louisiana University’s Computer Science Department developed what is known as the Industry Connect Initiative (ICI) in order to give students the opportunity to develop real-world-ready skills. The method behind ICI is to provide students with real-world curriculum opportunities in a sequence of “Project Classes” – the second course in the sequence being Information Systems [1,2]. This paper details the student project “EnTrack” that was developed as part of this class.

**Keywords:** Real-world, Skills, Information Systems, Industry, Database, Frontend

### 1. INTRODUCTION

Information Systems, taught by the software company that is well-known for LA wallet, Envoc, aims to give students experience by simulating a real-world scenario with a client, as well as having the students coordinate in a team of randomly selected peers. The course is broken down into three phases where the student must learn the technologies they will use in the final phase to develop a web and mobile application for their client [1]. This approach allows the students to familiarize themselves with industry standard frameworks, such as React.js and ASP.NET Core, while also teaching the student the importance of professionalism and clarity while communicating and cooperating with clients as well as fellow developers.

### 2. PHASES



*Figure 1*

The first phase covers the basics of making an API using ASP.NET, creating a database, and using entity framework. The second phase covers authentication, authorization, setting up the frontend using react web and react expo, as well as deployment. The final phase uses what is learned from the previous two phases and builds on it. With a clear understanding of the basics, the student is then tasked with creating a web application for a client. Students are separated into groups of four for each phase, and must establish biweekly communications with their client for the final phase.

### 3. DEVELOPING ENTRACK

For the final phase, our client was EnTrack, a railroad passenger corporation whose desire was to expand their passenger rail options, and to provide a better traveling experience than airlines. We began the development process by using the knowledge and tools acquired from the first and second phase to construct our database, the backend, and web application, the frontend.

## Database – Backend

Our first priority was to craft a database that would allow EnTrack’s customers to plan their route and then purchase a boarding pass.

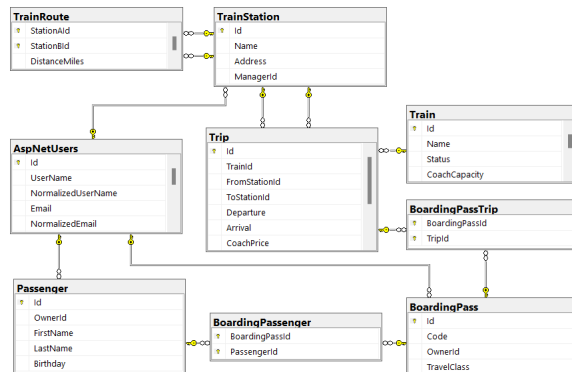


Figure 2

Route planning was very freeform. Admins would schedule many “trips” for each train, each trip dictating when and where the train would depart from and arrive at stations. Customers would simply provide a starting station and an ending station, and the backend system would attempt to find one or more sequences of trips that would eventually bring the customer from the start to the end. A “boarding pass” could be purchased for any sequence of trips and could include any number of “passengers,” as long as it does not exceed the maximum capacity of any trip in the sequence.

## Frontend – Web Application

After setting up our database, we started working on creating a friendly interface for EnTrack’s customers. When entering the website, the user is met with a welcoming home page. For easy navigation between different parts of the site, a navigation bar is always visible at the top of the screen. It features EnTrack’s logo, which allows quick access to the home page, multiple tabs for switching between the different pages, and a way for the user to either log in or sign up. Another major

feature of the web application, shown on the home page, is the route planner.

The screenshot shows a web form for the Route Planner with the following fields:

- Starting From:** A text input field with a placeholder "Enter City" and a clear button (x).
- Going To:** A text input field with a placeholder "Enter City" and a clear button (x).
- Departure:** A date/time input field with a placeholder "mm / dd / yyyy" and a calendar icon.
- Arrival:** A date/time input field with a placeholder "mm / dd / yyyy" and a calendar icon.
- Travel Class:** A dropdown menu with "Coach" selected.
- Book Now!** A prominent button at the bottom.

Figure 3

Figure 3 is a screenshot of the Route Planner component. It allows the user to easily select the route they will be taking, the time in which they wish to depart and arrive, as well as the class they wish to take. After filling out the required fields, they are given the option to “book now” and then they are automatically routed to another page of the application where they may purchase the boarding passes described in Section 3 under *Database – Backend*.

## 4. CONCLUSION

In conclusion, the Information Systems project - “EnTrack” - was an insightful experience on the development process of a web application. It allowed us to gain valuable skills, such as communication, project organization, technology knowledge, and more, that we can expand upon in our future careers.

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