

Saint Xavier University

Sax Savior: Designing and Creating a Video Game to Promote Saxophone Education

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Abstract

Learning to play the saxophone can be difficult and costly. One must pay for the instrument, music lessons, as well as additional supplies. Once this financial bridge is crossed, students must learn basic notes, rhythms, and sight reading before they are able to play written music. This often leaves them discouraged and many quit before they have had the opportunity to experience the full potential of playing the instrument.

My research aims to answer the question: How can learning saxophone be more affordable, accessible, and engaging? My proposed solution is *Sax Savior*.

Sax Savior is a rhythm-based video game that teaches you to play saxophone. The game controller resembles a saxophone to teach correct muscle memory. This helps a player transition from playing the game to playing the instrument. *Sax Savior* allows people to learn the saxophone in a fun and affordable way, opening the skill of playing the saxophone to people of all walks of life.

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Introduction

Obstacles to Starting Saxophone

Invented in 1846 by Adolf Sax, the saxophone has become a popular instrument used across many musical genres. In order to learn to play an instrument, prospective musicians must first acquire the instrument. The cost of purchasing the instrument can be a burden, with student saxophones starting around \$300 to purchase (Consordini, 2020). Renting is costly too, typically around \$50 per month (Quinlan, 2020). This price tag can be incredibly hard or even impossible for many to afford; a survey from Bankrate revealed 57% of Americans are unable to cover an unexpected \$500 expense. (Picchi, 2017). This indicates over half of the United States citizens would unlikely be able to provide necessary supplies for their children or themselves to learn saxophone. With the additional expenses of weekly lessons, supplies, repairs, and sheet music, getting involved is typically only open to those of financial privilege.

Learning to play saxophone should be assessible to anyone interested, especially those who would not normally be able to. Data from the Census Bureau shows that 78.9% of musicians, singers, and related workers are white (Data USA, 2017). These statistics display an issue with diversity in the music industry. Saxophone education is a part of this industry, making this a problem in saxophone education as well. It is important that learning saxophone be made inclusive to all walks of life regardless of background.

Getting students engaged enough to overcome the learning curve and build the confidence to play saxophone can be tough. Repertoire has a big impact on students' excitement for saxophone when they begin playing. For beginning musicians, pieces are often selected by their instructors based on difficulty or the concept being learned. These selections are often

classical or jazz, while data from Discogs, Billboard, and Spotify show that these genres are no longer as popular as newer genres such as rock, rap, or techno (Safiullin, 2019). For most students, the saxophone is only an interest when they begin. Playing music they are unaccustomed to discourages students from practicing. In retrospect, they could have engaged and flourished in a different genre.

Sax Savior

Sax Savior is a rhythm-based video game accompanied by a small controller resembling a saxophone. The game teaches you how to use the controller to play along with songs featuring the saxophone. What makes Sax Savior so unique is that everything learned in the game is designed to be transferable to a real saxophone, making a transition to the instrument straightforward. After completing the game, players will have gained a real-world skill: the ability to play the saxophone. The educational aspect of Sax Savior makes it a proposed solution to the problems facing saxophone education.

Beginning saxophone can be a costly hardship as previously detailed. Sax Savior seeks to remedy this problem by being a cost-effective way of exploring interest in the saxophone. Traditionally, an instrument, supplies, and sheet music were needed to test this interest; with Sax Savior, a simple low-risk purchase opens the door to musicianship. To give an idea on the affordability of Sax Savior, the controller parts cost about thirty-five dollars. This price would be lower if Sax Savior were mass produced, as parts would be bought from manufacturers instead of retailers. Not only is Sax Savior significantly less expensive than an actual saxophone, but it also saves money by giving a head start if a player pursues lessons. By giving a solid starting foundation, less time is spent teaching basics when beginning lessons. Concepts that Sax Savior

reinforces include the ability to play a full two octaves and read note pitches. From practicing these skills, money is saved from not having to pay to learn them from an instructor. To be clear, Sax Savior is not a replacement for music educators. It should instead be thought of as a trial or supplement to guided lessons. For example, the game cannot teach embouchure, nor identify and prevent bad musicianship habits. These are things a human instructor will do. What Sax Savior can do is give you a low-cost opportunity to experience playing an instrument in a fun and engaging manner.

Sax Savior's goal is to broaden accessibility to playing saxophone. Giving access to those who could not normally afford it allows those from all walks of life the chance to play music. Additionally, the opportunity to play and create music would be provided to people who lack the confidence to learn an instrument. While people may not feel they are able to play saxophone, they will feel they can play Sax Savior. This can draw in many new players who never realized how much they could enjoy saxophone. Gamers are an excellent group to draw people in from since gaming has become quite popular, especially with younger generations. 66% of tweens aged 8 to 12 play video games for an average of 2 hours per day (CMCH, 2019). The ability to introduce new people to playing saxophone is a magnificent attribute that makes Sax Savior exclusive in growing saxophone education.

Sax Savior is designed to appeal to a wide range of musical genres. Keeping interested saxophone players engaged with practicing is an important component of expanding saxophone education. One way to grab players' enthusiasm is allowing them to play music that they admire. Sax Savior provides a vast variety of music and songs, so players are no longer at the mercy of

their instructor in terms of repertoire. Being able to play their desired genre will help students keep engaged while learning the saxophone.

After creating the concept for the game, an intentional title had to be chosen to match the game's ambitions. Sax Savior aims to give everyone the chance to play saxophone, especially those who would not be able to without the game. In this way, the game is trying to “save” people's ability to learn the saxophone. By expanding the saxophone's audience, Sax Savior is also safeguarding the saxophone's relevance. This aspiration to save everyone's chance at one day playing saxophone is what earned the game its title, Sax Savior.

Relation to Existing Technology

Other technologies exist that also try to make music more available, so Sax Savior has competition. These products influenced the design and development to make the best possible version of Sax Savior. One competitor, the Nuvo jSax, is a mini plastic saxophone that follows traditional saxophone fingering patterns to enable kids to develop embouchure and playing skills at an early age (jSax, 2019). It comes with a fingering chart but does not include a video game component. jSax and Sax Savior are both designed to help students learn saxophone in a less expensive manner. They also have the exact same number of keys. jSax retails for \$99.99 which is costly for something only intended to provide an introductory learning experience. That money may be better spent investing in a real saxophone. An advantage the jSax has is the ability to teach embouchure. In contrast, Sax Savior is a cost-effective game that teaches its owner saxophone in an engaging manner. jSax does not do this and is too expensive to solidly claim to make learning saxophone inexpensive. Sax Savior can do both these things.

Rocksmith is Sax Savior's most direct competitor because it is a video game that teaches an instrument. The biggest difference is that Rocksmith teaches guitar and bass, while Sax Savior teaches saxophone. Rocksmith requires you to own the instrument, whereas Sax Savior provides a controller. The "Learning Mode" of Sax Savior was inspired by a feature in Rocksmith that slows the game if the player is missing too many notes. While similar, Sax Savior and Rocksmith teach different instruments and are aimed at different audiences, making them able to co-exist.

The field of using technology for music instruction is atypical, yet an alluring and growing way to teach. There are many different ways learning has been aided, such as keyboards with light up keys to direct which note to press (Bishop, 2015). Another example is SmartMusic, a software that listens to a user play a piece of music then informs them which notes they missed (SmartMusic 2020). There are also websites that offer virtual resources to learn guitar such as *Yousician* or *FenderPlay*. Excluding Rocksmith, Sax Savior is unique in this pool of technology because it is the only one intertwining music education with gaming.

Gaming for Education

Video games have been on the rise and increasing in popularity for years. Even during a recession in 2009, consumer video game expenditures accounted for one-third of monthly entertainment spending and continued rising afterwards (The NPD Group, 2009). With the growth of popularity in gaming, the notion that video games have the capacity to teach skills has also come forth. Research from 2006 suggests compelling evidence that individuals can be deeply engaged in game environments and learn substantive processes and content (Shaffer, 2006). Since this idea's conception, recent research has continued to prove and advance it. In 2014, the American Psychological Association published research indicating that playing video

games boosted children's learning, health, and social skills (Bowen, 2014). Despite this rationale, video games have curiously not become more commonplace in educational environments. Timothy Barko and Troy D. Sadler have outlined the three primary factors they believe to be stalling this merge in their publication *Practicality in Virtuality: Finding Student Meaning in Video Game Education* (Barko, 2013). Barko and Sadler believe the following are three obstructions to education with gaming:

1. Social Issues – Fear of correlation between aggression and gaming. Issues of violence, sexuality, and image.
2. Epistemic Issues – Belief that different types of learning occur between classrooms and gaming.
3. Developmental Issues – Difficulty of balancing the leisure of games with meaningful educational environments.

Sax Savior can be related to each of these issues to better understand and prepare for the challenges it will face by branding itself as an educational video game. Social issues refer to the belief that video games are inherently violent and are therefore unfit for learning purposes. There is no obscenity or violence in learning the saxophone; by presenting itself as a tool for playing saxophone, Sax Savior seems to be unthreatened by this obstacle of social issues. Regarding epistemic issues, Sax Savior is made to teach players real saxophone as effectively as possible. It teaches a skill also taught in classrooms, so Sax Savior is not threatened by epistemic issues. Sax Savior is most threatened by developmental issues that come with merging video games and education to create an overall experience that not only teaches but is enjoyable to play. An example of this issue is putting homework problems in the form of a video game. Many of the

educational games do exactly this; they insert commonplace learning techniques, such as math problems, into a video game format. This has only changed the interface where the student completes assignments, it has not changed how they are learning. To truly take advantage in fusing education with gaming, the key points of what draws players in and makes games appealing must not be tarnished. Jesse Schell's lenses are a game design methodology to more consciously create a gaming experience that immerses a player (Schell, 2020). By holding true to these game design principles, Sax Savior will create a learning experience that teaches while retaining the engrossing factor that video games give. By sustaining what draws players to games while including the ability to teach a skill, Sax Savior will create an experience that overcomes developmental issues from previous technology attempts to merge these two fields.

Designing the Controller

Saxophonists rely on the development of muscle memory in their fingers to play. Therefore, the first ingredient necessary to a video game that teaches saxophone is a controller to strengthen dexterity. If Sax Savior does not begin to develop its players' muscle memory, then it would not be teaching anything of transferable value. To address this problem, the first solution was to use a USB computer keyboard as the saxophone. The player would plug it in and hold it like a saxophone with their fingers on keys in a pattern most resembling authentic saxophone technique. This idea seemed appealing as it would be easy to implement, and many people have or can easily gain access to a keyboard. During early testing of this approach, it became apparent that standard keyboards can only sense two buttons at any given moment, excluding special characters. Given the large number of buttons saxophones have and the need to press simultaneously, it became clear that this keyboard idea was unsuited to meet the needs for Sax

Savior. Another idea was a device that could attach onto a saxophone to sense what note was being played. At this point, remembering intent and target audience became important. A device for your saxophone would not be ideal for newly interested players as they might not own one. It became clear that to have a controller to teach correct muscle memory and finger patterns on saxophone would require it to be built and created for the sole purpose of this project.

Prototype #1

After determining it was necessary to build a controller to replicate an authentic saxophone, a prototype had to be designed. The end result would be similar to ones used in most video games such as the one in Figure 1 but designed to be held and played like a saxophone.

Figure 1: Common Video Game Controller

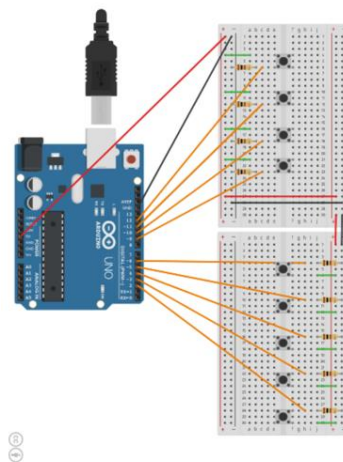


To successfully complete this task, concepts must be drawn and successfully used from the fields of electrical engineering, computer science, and software engineering. It is good practice to make a proof of concept circuit resembling the desired product on a breadboard. This will confirm that the prototype will work before putting resources into a broken end result. A breadboard is ideal for this because you can reuse resources such as wires, buttons, and resistors

to establish a working circuit with no soldering required. Soldering is fusing two parts of a circuit together with heated metal. Once soldered, the parts cannot be re-used, making testing on the breadboard a necessary step in development.

Typically, a modern saxophone has 23 buttons. Creating a controller with 23 buttons would be problematic from a conceptual standpoint, as Sax Savior is targeting new players. To refrain from intimidating these players, Sax Savior has a total of nine buttons. Fourteen buttons could be omitted because six of the keys are specifically made for higher notes, four of the keys are made for lower notes, and four more are used for alternative fingerings or trills. Knowing the trill fingerings is only necessary in specific situations, and most of these absent notes typically are not used by beginner students. The nine remaining keys are used in planning our controller, enabling a full two octaves to be played. This range is fully sufficient, giving a solid foundation to a starting player. Having decided on the nine buttons, a blueprint design emerged as seen in Figure 2.

Figure 2: Prototype 1 Blueprint Design



This blueprint was constructed using AutoDesk TinkerCAD, a software that aids in creation of 3D models and circuits. Key elements in this prototype include an Arduino Uno, small push buttons, and resistors. The Arduino Uno is a microcontroller that sends electrical current from a voltage pin through the circuit and back to connected input pins. It can then take these signals and read them into a computer, allowing the button presses to be recognized as high or low inputs, depending on how the circuit is built. Resistors are necessary to reduce current to prevent damage to the Arduino or other circuit components. Code must be written and uploaded to Arduino for it to understand which pins to read in. The code will also tell it what information to send to the computer and when. An example of Arduino's code can be seen in Figure 3. Once the blueprint was finalized, the physical version was built. It is referred to as *Prototype 1* and can be seen in Figure 4.

Figure 3: Arduino Code

```
#define button10 10
#define button11 11
#define button12 12

int incomingByte = 0; // for incoming serial data

void setup()
{
  pinMode(button2, INPUT_PULLUP); //Octave
  pinMode(button3, INPUT_PULLUP); //B
  pinMode(button4, INPUT_PULLUP); //A
  pinMode(button5, INPUT_PULLUP); //G
  pinMode(button6, INPUT_PULLUP); //G#
  pinMode(button9, INPUT_PULLUP); //F
  pinMode(button10, INPUT_PULLUP); //E
  pinMode(button11, INPUT_PULLUP); //D
  pinMode(button12, INPUT_PULLUP); //D#

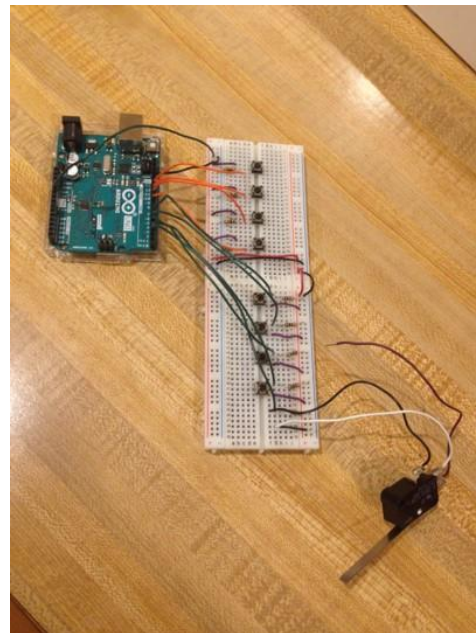
  Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
}

void loop() {
  // send data only when you receive data:
  if (Serial.available() > 0) {
    // read the incoming byte:
    incomingByte = Serial.read();

    // say what you got:
    returnButtonsPressed();
    Serial.println("");
  }
}

void returnButtonsPressed() {
  if (digitalRead(button3) == LOW){//B
    Serial.print("1");
  }
  else{
    Serial.print("0");
  }
  if (digitalRead(button4) == LOW){//A
    Serial.print("1");
  }
}
```

Figure 4: Prototype 1

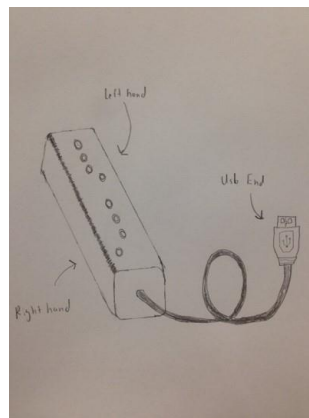


A switch was originally planned to be used for the octave key but would later be replaced by a normal button on the back of the controller for simplicity. After building the circuit, writing the Arduino code, and running tests, this prototype proved to be a solid foundation to becoming the controller for Sax Savior. It was time to move on to designing and building the actual controller, named *Prototype 2*. This version would have several differences from *Prototype 1* as that was only a proof of concept to building *Prototype 2*.

Prototype #2

Prototype 2 would be a controller that resembles a saxophone thanks to its design and three-dimensional printed casing. Its design drawing can be seen in Figure 5.

Figure 5: Prototype 2 Design Drawing



The fourth and eighth buttons down were intentionally placed off center, to more closely resemble the G# and Eb keys on a saxophone. The edges along the length are also smooth for comfort. The sides of the controller are made of LEGO bricks to enable the controller to be opened without damage. Below is a list of the items needed to create *Prototype 2*:

- Arduino Nano - Same use as Arduino Uno, just smaller to fit inside controller

- Micro USB Cord - Connects the controller to the computer
- Buttons
- Wire - Connect the Arduino Nano, buttons, and resistors together
- Resistor
- 3D printed case
- LEGO bricks

*Note that this list only includes parts of the controller, not additional supplies needed to make it such as a soldering iron or electrical tape.

Designing the 3-D Printed Case

To construct the casing of the controller, a virtual model of it had to be designed. Blender is an animation studio that is free and open source, making it an ideal choice for creating the models to be printed. LEGO bricks encompassed the sides, so only the top and bottom of the casing was printed. Both were custom made as they matched the exact dimensions for Sax Savior's controller. Creating and test printing a sample hole for one button ensured the hole's dimensions were correct. Several of these were created to find the perfect fit, which can be seen in Figure 6. Once the buttonhole dimensions were finalized, the top of the controller could be designed. After the calculations and dimensions for it were finalized, the model was created in Blender as seen in Figure 7. It was then exported and sent to FlashPrint, seen in Figure 8. FlashPrint is needed to send models to any Flashforge brand 3D printer. The Flashforge Adventure 3 Lite was chosen for this project because of its minimal setup, competitive price, and reliable reviews. After the model of the controller top was successfully loaded and adjusted, it

was sent to the printer. The Flashforge Adventure 3 Lite with the printed model can be seen in Figure 9.

Figure 6: Buttonholes



Figure 7: Blender Model

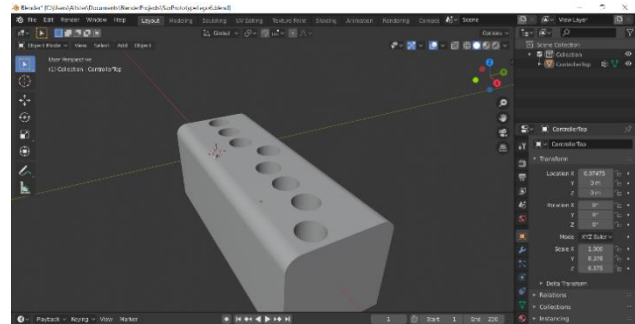


Figure 8: FlashPrint Model

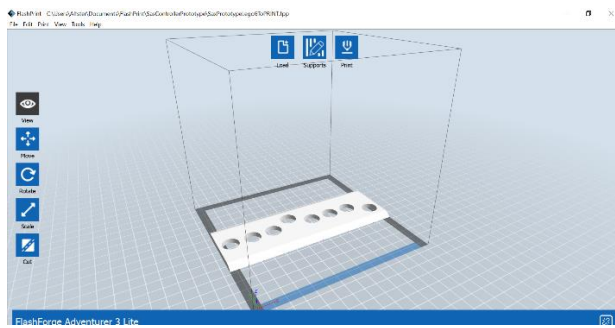
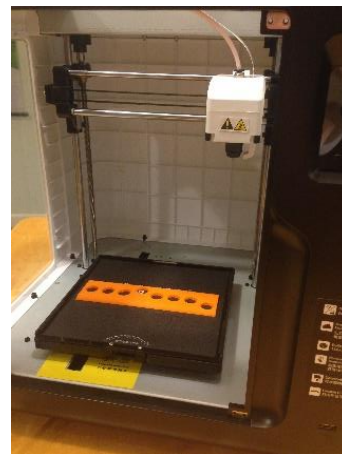


Figure 9: Flashforge Adventure 3 Lite



These steps are repeated to create the back of the controller. After both sides were printed, the first level of LEGO bricks were glued onto the top and bottom of the model. Next, the wires, buttons, resistors, and Arduino Nano were soldered together. Once everything was soldered (Figure 10) and tested to verify it worked correctly (Figure 11), the LEGO bricks were added to the sides and *Prototype 2* was officially complete (Figure 12).

Figure 10: Soldering the Controller

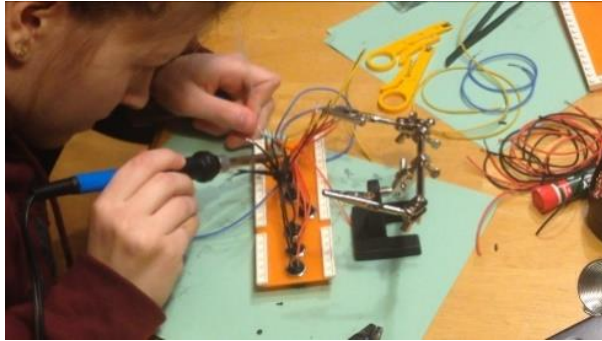


Figure 11: Inside of Controller

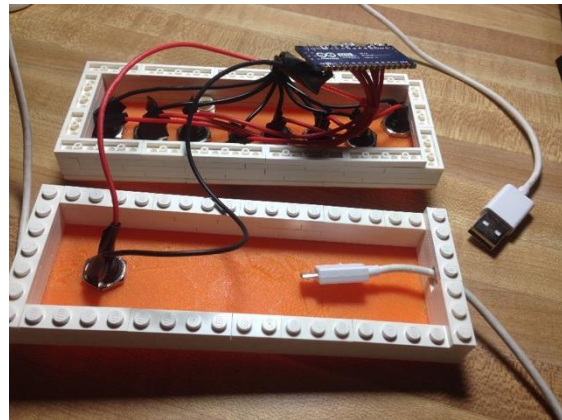


Figure 12: Prototype 2



Future Improvements

If a third prototype were designed, a few improvements could be implemented that were not used in *Prototype 2* either because of a lack of knowledge or time. The first would be to improve the buttons. The final buttons used in *Prototype 2* were a bit too hard to press, putting

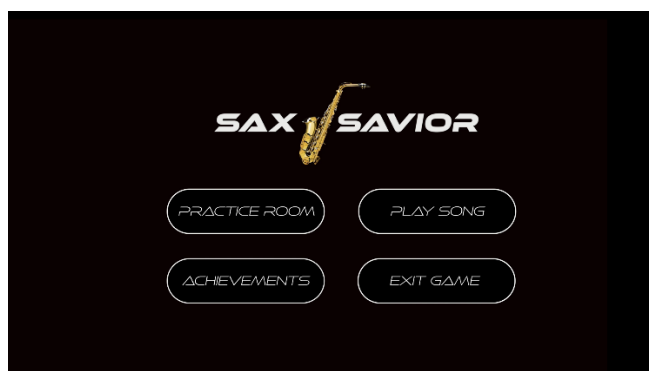
strain on the player's fingers. Additionally, the buttons should all match their in-game note color. *Prototype 2* was limited by the fact that the buttons used only had 6 different colors, so not all buttons matched their colors in the game. The second area for improvement would be controller durability. There should be a feature to prevent the USB cable from putting pressure directly on the Arduino Nano if pulled. Redesigning the 3D printed controller case could achieve this and make the controller more durable. The final suggested improvement is to 3D print the controller sides instead of using LEGO bricks. A new design would have to be implemented to make this possible, such as using screws to hold the controller together to still allow it to be taken apart.

Designing the Game

While the controller is impressive, it is nothing without the game to accompany it. The game is what will teach aspiring musicians, which is the ultimate goal of Sax Savior. It will guide players through learning how to use the controller to play notes and songs. To make the experience enjoyable, Sax Savior has been streamlined to keep it simple to understand, inviting people from all skill levels to play the game. Sax Savior aims to engage players in a way that encourages them to continue playing, practicing, and learning the saxophone. To achieve this, different game theory methods were drawn upon such as creating player incentive and balancing the game. Balance is integral to keep the game from becoming too easy, otherwise the player will grow bored and quit. Likewise, if it is too difficult, the player will become frustrated and leave. If balanced is achieved, players will enter a flow state and become immersed. It is here that the optimal learning will occur. The game's primary objective is to teach saxophone, and it can only do this by being fun and immersive to its players to draw them in.

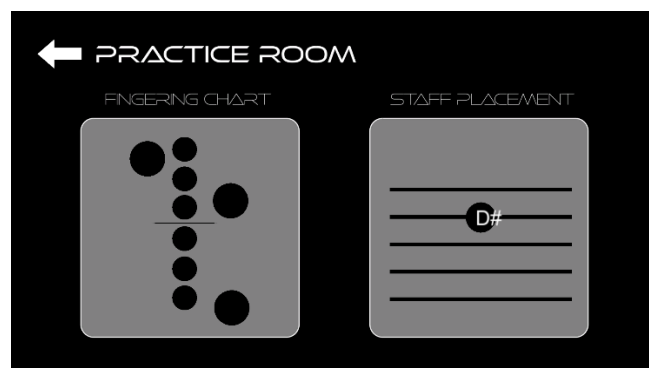
The main menu is loaded when the game begins. It serves as a hub to get to any of the other screens including the Practice Room, Achievements, and Play Mode.

Figure 13: Sax Savior Main Menu



The “Practice Room” is used to check the controller is plugged in and working correctly. It is also used to check note fingerings and play freely without an accompanying song.

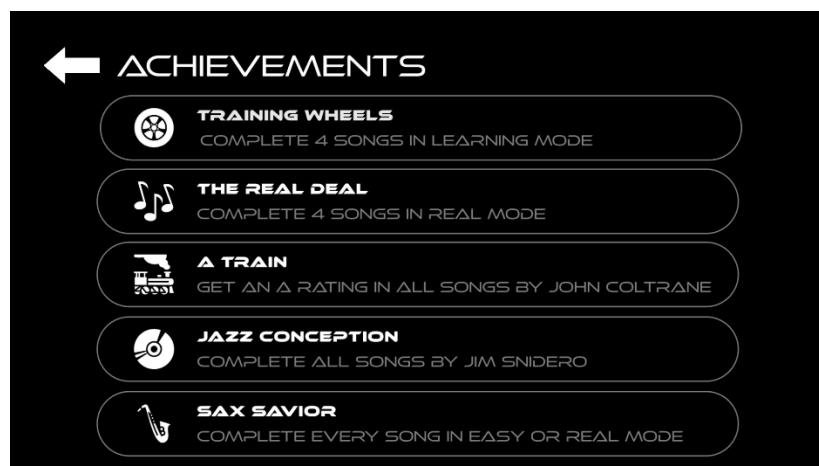
Figure 14: Sax Savior Practice Room



“Achievements” contains a list of goals for the player to work toward. It displays which have been met and which still need to be reached with their progress. Certain goals will unlock different color saxophone bodies or keys for the player to customize. Having achievements is

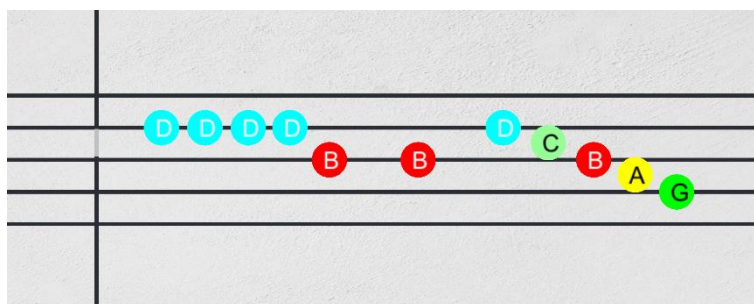
important because it gives players a reward to stay motivated. Having goals will keep players immersed, causing them to spend more time playing and therefore, practicing.

Figure 15: Sax Savior Achievement Screen



Pressing “Play” is where the main game lies. Clicking play from the main menu will allow song selection. Once selected and confirmed, the song will begin and the player will play along, learning the song and becoming more familiar with the saxophone. If playing for the first time, only one song will be present, and during the introduction there will be a quick tutorial to teach the game. If a song introduces a new note, it will teach it to the player before the song begins where it will be used in action.

Figure 16: Sax Savior Play Screen



Sax Savior also teaches how to read notes on traditional sheet music. This is important because it gives the player the chance to transfer their skills to a real saxophone. In sheet music, a staff is five horizontal lines that contain notes. The note's location in relation to the lines determines the note's name and correct fingering. This is also true in Sax Savior, but with a perk. In Sax Savior the notes are assigned a color. This helps players in the following ways:

1. **Controller** – The notes in the game have corresponding colors to the buttons on the physical controller. This will help new players learn what buttons to press on their controller to hit the correct notes on the staff.
2. **Running Lines** – The colors were systematically picked to ensure that no two similar colors were used on notes near each other. When multiple notes come quickly it will be easier to differentiate which notes they are as the bright colors will help players read them.
3. **Octaves** – Octaves in music are a higher or lower version of the same note. For example, there is the note B in the middle of the staff, and the note high B which is above the staff. Having both Bs be the same color is important to assist the player distinguish octaves. This will help them learn the new notes in a different octave faster as they realize it is familiar to the one they already learned.

The only drawback to reading sheet music in Sax Savior is the absence of teaching rhythms. In sheet music, the type of symbol determines how long the note will be. In order to use the symbols in Sax Savior, they would have to be stretched, making it unreadable to the player. To compensate, Sax Savior uses circles lengthened to the duration of the note. This looks cleaner and is easier for the player to understand what is going on.

After finishing a song, the player will receive a score and grade based on the percentage of the notes played correctly. New levels and achievements can be unlocked from successfully completing each song.

Repertoire

Repertoire for Sax Savior was carefully selected to meet several requirements. First, the selected piece needed to contain saxophone throughout. Second, it must be free domain, paid for use, or given permission to be used by its creator. Third, the pieces needed to cover a wide range of difficulty. They were placed in the game in a carefully paced, incremental fashion to avoid boredom or frustration. Following this principle, the first song only contains two notes. Once the player is comfortable with these notes, the next song will add a new note for the player to learn. This will continue until the player has learned two octaves. From here, songs will work to improve the player's dexterity as they continue to advance to more difficult saxophone repertoire. The difficulty balance will result in the player feeling flow, and it is in this state that engagement and learning will be at its peak.

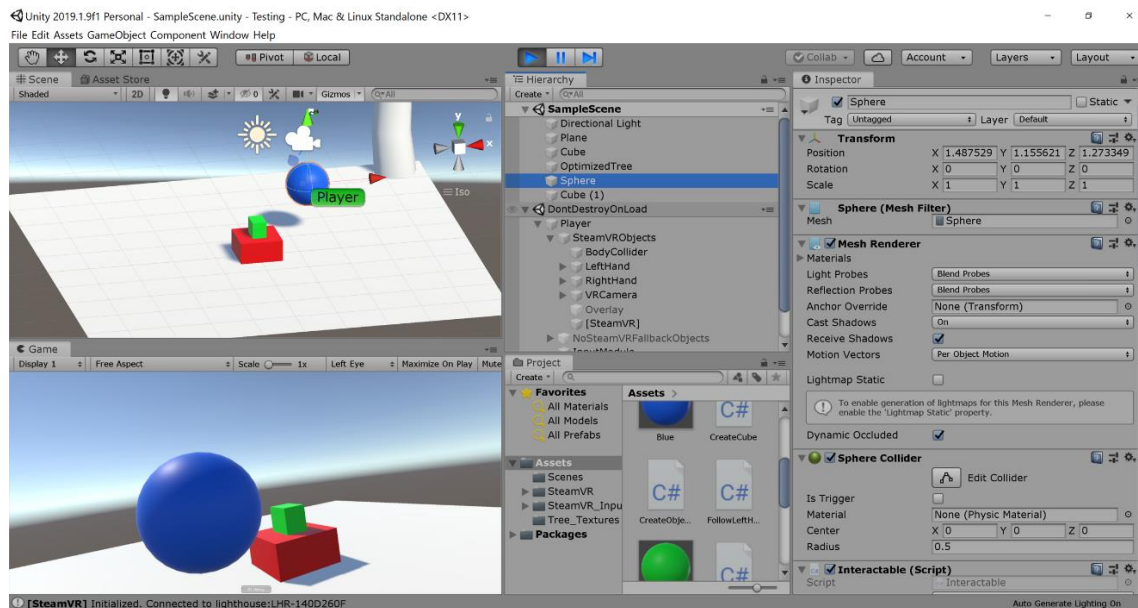
An example of such repertoire that will be included in Sax Savior are *Groove Blues* and *Amen* from Jim Snidero's *Jazz Conception*. Jim Snidero is a professional jazz saxophonist and educator whose *études* have become commonplace tools for teaching jazz at all skill levels. The beauty of these *études* is that they give focus to articulation and phrasing, two of the most pivotal factors in having a jazzy, versatile sound that is not bland. It is for this reason that *Jazz Conception* was selected for Sax Savior. Sax Savior players will have a palette of exemplary articulation in their ears so that they are able to quickly work towards a more refined articulation vocabulary to catch up with their fluid note flexibility from playing with the controller.

Software Development

Video game design requires knowledge and talent drawn from many different disciplines to plan and create a masterpiece. Jesse Shell is a leading educator in the field of game design and author of *The Art of Game Design*. In his book, he cites twenty different skills utilized in game design including animation, mathematics, music, sound design, technical writing, and visual arts (Schell, 2020, 4). Even once the necessary skills are acquired, sheer time is required for the appropriate designs to be fleshed out and developed properly. To compensate for this, games are typically created by a team rather than a single person. Having a team ensures that each element of design and development receives the necessary time, focus, and talent required. Sax Savior is an independent research project with one developer, meaning there are limitations to what can be created within the allotted time. Envisioned features cut due to these restrictions are listed in the conclusion.

Unity is a game engine used to make video games across multiple platforms, and the primary software studio used to develop Sax Savior. It was an ideal fit for this project because of its support and wide array of consoles it can be exported to such as Switch, Steam, PS4, Xbox One, and many others. Should the time come to release Sax Savior, Unity promises it will not be barred or restricted to people based on the console they own. Unity has an extraordinary number of features and tools. Listed below are the basic windows with examples of these numerous features. Figure 14 provides a visual reference of the Unity studio.

Figure 17: Unity Screenshot



- Hierarchy – Games in Unity are built up from different objects. The hierarchy shows a list of all the objects a game has in it.
- Game – This is the players point of view, and what is seen when the game is run.
- Project – This window shows all your assets including music, art, or scenes in a game.
- Inspector – Displays an object’s components. Components can add elements such as sound, gravity, or hitboxes to a certain object. When there is not a component to do what is needed, a C# script can program the object to do what is desired.

To create clean, forward thinking code, programmers must practice good programming habits. One such example is that the code should be universal. After Sax Savior is fully developed, if it was decided that an applause track should play after each song is completed, code should only be altered in one spot, when the player wins, for this change to be in effect. It would be bad programming if each song had to be programmed separately to applaud at the end.

This would waste time and unnecessarily complicate the code. Good programming practices make it easier to go back and make changes. That is why Sax Savior uses the same code to run each song and loads in separate music and notes.

Conclusion

Future Improvements

Below is a list of additional features that could be implemented in a future version of Sax Savior and an explanation of their importance:

- A treble clef could be added at the far-left side of the staff to help players familiarize themselves with this symbol.
- Players could have their own saxophone in the game to customize. Different Saxophone overlay and body colors would be unlocked through different achievements. This would serve as an extra incentive to motivate players to play the game.
- When notes are fingered in the practice room their corresponding pitches will play, allowing players to play freely on this screen.
- Currently the game is pitched in Eb for alto and baritone saxophones. A planned feature would allow players to switch between an “alto” and “tenor” mode, changing the pitch of the songs from Eb to Bb. This would let tenor and soprano saxophone parts be playable since they are pitched in Bb.

To make Sax Savior able to teach people of all different capabilities, the difficulty could be set to three different settings, they are listed and detailed below in ascending order:

1. Learning Mode - In this mode, if a note is missed the song stops and the game reminds the player the correct fingering for the missed note until it is corrected. Players cannot lose in this mode. It is intended for players new to both video games and music. Players can also use this mode to work through difficult parts of more challenging pieces before attempting in a harder mode. This mode can be set to either contain or dismiss accidentals.
2. Easy Mode - In this mode, if notes are missed the song continues. The player can lose if they miss enough notes. Accidentals do not exist in this mode.
3. Real Mode - This mode is the same as easy mode except it contains accidentals. This mode is the most default and highly recommended if the player is considering transferring to real saxophone afterwards.

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