Designing An Instrument Controller to Enhance Cultural learnings in A Music Blended Video Game

by

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ABSTRACT

This Thesis explores the author's attempts to investigate and design a video game that considers learning about Chinese culture as its primary purpose, while exploring the possibilities of incorporating music and novel and interactive instrument controllers into such a game. The possibility of blending these three elements together to create a special branch of games, and what interesting and thought-provoking ideas might come out of this design process, is what the author wants to explore in this design process. In this paper, we will look at how music and interactive instrument controllers can be integrated into a video game aimed at learning about Chinese culture from the author's attempts to design two prototypes using Unity and Arduino.

Keywords: Chinese culture, music, Arduino, instrument, video game, research, iteration, exploration

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INTRODUCTION

What comes to mind when we are talking about cultural learning? Learning about other countries' cultures helps us understand and respect people from different backgrounds. It reduces misunderstandings and makes it easier to work together globally. In business and diplomacy, knowing about other cultures is crucial for success. Personally, it broadens my horizons and helps us grow. It also promotes sharing and preserving cultural traditions. In simple terms, learning about other cultures makes the world a friendlier and more interesting place.

There are numerous ways for people to learn cultures such as language learning, travel, research, attending events, building relationships with others, media consumption, and formal education. However, sometimes these methods are either time-consuming, difficult to access, or barely interesting. This makes me think about learning culture through one of my favorites: video games. video games have huge potential to achieve the goal of learning because learning about culture through video games could offer an more immersive, interactive experience, unlike traditional methods. Players engage with virtual worlds that simulate cultural settings and narratives, actively participating in diverse scenarios and challenges. This unique approach enhances empathy and understanding by directly involving players in cultural contexts, appealing to a wide audience and different learning styles.

To conduct research and experiment in terms of the potential of learning culture through video games, I decided to use Chinese culture as experimental instance in this project. As a Chinese, I admire Chinese ancient culture and traditions, and I want to make Chinese culture accessible and learnable to as many people as possible, both national and international. In this design process, I will incorporate a part of Chinese culture into the game through visuals and audio so that users

can experience Chinese culture in a relaxing game atmosphere. Although game design in a musical context needs a lot of research in relevant games and creativities, how users will interact with the game could be more vital for users to think and feel if the experience is good, which means that the interaction design needs to be not only creative and playful but also appropriate and comfortable. Therefore, I will incorporate unique player controllers and interactions, and Chinese culture learning into the game design, from early research to instrument controllers, Chinese culture embedded game design in Unity, exploring and discussing its possibilities with the design process and results.

Research questions

Primary question: How to design a video game that allows players to comprehend and learn about some specific China's unique culture?

Secondary research question 1: How can I incorporate some Chinese music elements into games to enhance its cultural atmosphere?

Secondary research question 2: How can I use Arduino to design non-traditional interactions for the players?

LITERATURE & CONTEXTUAL REVIEW

In the era of frequent human-computer interaction, although people are used to the traditional ways of communicating with computers, such as touching the screen and using the mouse and keyboard, new interaction techniques such as tangible, collaborative, sensor-based, and gesture-based interaction are gradually being applied in various fields, and impact people's engagement with music and video games. According to Lupone, following research on a physical model for the bow-and-string system in 1992, the development of virtual musical instruments began (Lupone, 2020). Other areas of research have included the application of interactivity and adaptivity to musical genres, the development of specific technologies for sound art installations and sculptural-musical works, and augmented instruments such as the Feed-Drum, SkinAct, WindBack, and ResoFlute since 1999 (Lupone, 2020). Additionally, Rizzo points out that it is no longer a stretch to consider that interactive digital game systems will soon become routine hardware in the "digital homestead" (Rizzo, 2011, p.261). Newly developed software and devices are making music production and listening easier and more accessible and freeing people from the traditional dominance in video games (Crisdiana, 2021). For example, digital technology and new electronic devices have allowed the fusion of classical and electronic music and the creation of new musical instruments, such as gloves and boxes that can manipulate music. Similarly, fitness rings like Nintendo's have made gaming freer while emphasizing the user's physical involvement. Enjoying music in games, experiencing the game in an auditory feast, and combining the two through enchanting interaction could give users a completely different immersive experience.

At the same time, people often perceive specific, deep-rooted cultural meanings in music and games, such as lyrics and melodies, game costumes, and scenes. Well-designed cultural elements can fascinate those interested, while unfamiliar people can learn about new cultures, such as Japanese street dance, American hip-hop, or ancient Chinese court culture. The researcher Crisdiana developed a digital learning game as a medium to enrich students' insight about their local culture embedded in descriptive text material, and the empirical validation revealed that students responded positively to the produced learning game, with "very good" and "good" ratings for the parameters (Crisdiana, 2021).

Culture blended in video games

Embedding culture in the development and design of games is an important strategy, especially when the indigenous people of the culture are personally involved in the design, which makes the cultural context more convincing and accurate. At the same time, we should also consider the relationship and harmonization between the culture and the elements in the game.

Both Meershoek's and Eduardo's studies emphasize the unique importance of culture in games, and Meershoek and colleagues propose a "culture-driven game design approach" that allows games to adapt to different cultural contexts and respond to cultural embeddedness through player preferences, cultural nuances, and corresponding effective strategies (Meershoek et al., 2014). Creating the gaming experience and culture are the starting points, and then the cultural context is carefully designed to promote understanding and appreciation of the culture. Similarly, Eduardo points out that games can be used as a medium for cultural approaches in both digital and non-digital representations, portraying games as tools for conveying cultural meaning based

on their design (Eduardo et al., 2018). By examining the historical context and technological evolution of game design, the authors emphasize the influence of cultural factors on game design practices, as well as cultural themes and the representation of different cultural elements in games (Eduardo et al., 2018). When it comes to the connections and influences between culture and different elements, Loban emphasizes the importance of indigenous participation in game design. Misleading and inaccurate depictions of Indigenous cultures in culturally engaged video games need to be addressed by being produced primarily or exclusively by Indigenous communities (Loban, 2022). Also, games need a cultural focus that is more than just a visual object, but a response to a deeper cultural understanding of the world (Loban, 2022). I believe that this culturally centered approach can lead to a more streamlined game design, which, coupled with an Indigenous-led design that can allow the user-player to have a more purely cultural experience in the game.

Video games exert a profound influence on societal perceptions and attitudes, especially regarding representations of race and gender. Gray and Leonard (2012) delve into the intricate ethical dimensions surrounding the portrayal of race in games, elucidating how these representations often perpetuate harmful stereotypes and entrench discriminatory attitudes among players. They assert that game developers bear a moral obligation to actively confront and dismantle prevailing racial narratives within gaming, advocating for a paradigm shift towards more diverse and inclusive representations in game design. Building on this discourse, Kafai, Heeter, and Denner (2008) interrogate the prevalent underrepresentation and caricaturization of minority and female characters in video games, highlighting the pervasive prevalence of clichéd and sexualized depictions pervasive within mainstream gaming culture. Their analysis

underscores the pressing need for greater diversity and authenticity in character portrayals to foster broader societal understanding and acceptance of diversity among players. Both articles cogently underscore the formidable influence of video games in shaping cultural norms and values, thus underscoring the critical imperative of undertaking a rigorous examination and critique of problematic representations within game design (Gray & Leonard, 2012; Kafai, Heeter, & Denner, 2008). Recognizing the importance of fair and respectful portrayals, I aim to make a game that celebrates Chinese culture with authenticity and diversity. By avoiding stereotypes and working with cultural experts, I can ensure that the game promotes understanding and inclusivity. I want to show characters from Chinese culture as real people, not just stereotypes. This way, I hope to help make games more respectful and representative of different cultures.

Case studies of cultural games

The first game I examined is The Assassin's Creed series. The Assassin's Greed is a series of role-playing action games about the society and culture of ancient Egypt, providing players with an immersive experience as they explore authentic historical landmarks and participate in cultural activities (in-game quests related to real events). The game's historical accuracy authentically recreates the architecture, landscapes, and customs of ancient Egypt.

Figure 1. Akropolis of Athens (Source: Martyn, 2022).

Studies have shown that playing the game increases the player's cultural awareness and appreciation of ancient Egyptian civilization and promotes empathy for historical figures as well as an understanding of social structures and cultural practices. However, the game is also controversial in that some of the dialog and personality of the characters are not well designed, and the fact that it is an action game makes cultural education overlooked by the player.

Another cultural learning related game is "Never Alone". This game allows players to travel through the Arctic wilderness and portray Inupiaq culture by controlling a young Inupiaq girl and her Arctic fox companion, incorporating traditional stories and artwork inspired by Native folklore and traditions.

Figure 2. Never Alone. (Source: Vadim, 2021).

As players immerse themselves in the world of the Inupiaq people, they can get a sense of Alaska Native culture and the empathy, appreciation, and respect for such a culture that they learn from it.

Learning through games

Crisdiana explores how digital games can be utilized as a medium for cultural education, particularly with regard to descriptive texts, and how interactive digital platforms can be used to teach cultural nuances and enrich students' understanding of descriptive language in various cultural contexts (Crisdiana, 2021). This game called Describing Objects (D.O.) serves as a medium for enriching descriptive text culture for middle school students by presenting a wide range of cultural content that involves most of the local culture and a small amount of Western culture. And this product is expected to help Indonesian teachers and students in learning English,

especially in learning descriptive text materials without neglecting the value of local culture and ethnic heritage (Crisdiana, 2021). This inspired me to use the right amount of descriptive text to provide some explanations for the cultural elements and help users learn about the culture more easily in the atmosphere of the game. Meanwhile, in helping students overcome the stress of language learning, Keehl's team developed a musical game for learning to write Japanese kanji. The game uses a unique musical melody to help memorize the stroke order. It combines kanji writing practice with musical memorization by assigning a melody to each element of the kanji. They chose to use music because it is a powerful tool that can enhance learning and memorization (Keehl et al., 2021). While learning the cultural elements in the game, the player will be immersed in the game and the learning environment because of the melody, which is also the main purpose of my thesis project. Now next challenge is - how can I create an immersive music experience for the game users?

Music and new musical technology

Before getting into the correlation between music and video games, I think it's important to mention that electronic technology has changed and evolved the way musical instruments are perceived, and that Lupone's team, as well as Frid, have conducted in-depth research into digital instruments and new interactive installations. installations incorporate interactive elements that not only engage the audience, but also challenge the traditional boundaries between the audience and the artwork. Similarly, the exploration of augmented musical instruments reflects the evolving nature of musical performance, incorporating digitally enhanced technologies into traditional instruments to expand the possibilities of live music production (Lupone et al., 2020). Improvising music on the spot by interacting with interactive devices is a fun-sounding idea, but

it also means that it takes more time and effort to think about the compatibility between notes or soundtracks. However, I still believe that this seemingly complex thing can be applied in a simple way to games or musical instruments to give users a great interactive musical experience. In terms of inclusiveness, Frid points out that the beneficiaries of musical interactive installations should not only be limited to adults, but should also take into account children, the elderly, the physically challenged, or the hearing impaired (Frid, 2019). By analyzing the role of more than 100 accessible digital musical instruments in inclusive music practices, Frid says that ADMIs should be designed so that everyone can enjoy the relevant areas of music, and that with DIY as the focused new music technologies, this field may become more diverse and reach a wider group of users (Frid, 2019).

Music related video games

Both Studley's and Gower's studies articulate some broad understandings about interactive music video games as well as some useful issues to keep in mind when designing them. Studley points out that while the practice of game-based composition has existed long before the advent of digital computers, it is now thriving in a rich field of music-making applications, sound toys, and playful devices, that provide access to music composition through game-like interactions. These systems are characterized by a general avoidance of competitive game frameworks, and the interplay between competitive play and musical creativity has been little explored (Studley, 2020). By comparing two very different types of music games (one of which is more competitive), the authors conclude from a user study that players prefer deep musical control even at the expense of general usability or clarity of the game framework. At the same time, players have different conceptualizations of 'gameplay', which affects their perceptions of musical creativity,

control, and ownership in the system (Studley, 2020). Both Studley's and Gower's studies articulate some broad understandings about interactive music video games as well as some useful issues to keep in mind when designing them. Studley points out that while the practice of game-based composition has existed long before the advent of digital computers, it is now thriving in a rich field of music-making applications, sound toys, and playful devices, that provide access to music composition through game-like interactions (Studley, 2020). These systems are characterized by a general avoidance of competitive game frameworks, and the interplay between competitive play and musical creativity has been little explored (Studley, 2020). By comparing two very different types of music games (one of which is more competitive), the authors conclude from a user study that players prefer deep musical control even at the expense of general usability or clarity of the game framework. At the same time, players have different conceptualizations of 'gameplay', which affects their perceptions of musical creativity, control, and ownership in the system.

Gower has similarly researched and understood the wider perceptions of music games, but his research has been more geared towards children and adolescents. Through Cower's study, he sheds light on the popular phenomenon of interactive music video games and hopes to help parents and teachers understand the appeal, importance, attributes, and educational potential of these games (Cower et al., 2012). This study suggests that interactive music video games are in fact of great interest and great importance to students and should therefore be taken into account when developing courses and syllabi (Cower et al., 2012). In addition, the study suggests that interactive music video games may actually be beneficial to adolescents' musical skills and musical development, which has important implications for music educators (Cower et al., 2012).

In terms of the more specific design of music games, a number of other designers and researchers have enriched the field by analyzing the gameplay and interactions of existing games. The use of loops and playful interactive experiences are the main points of Cera's article. Cera explores the intersection of music, technology, and playfulness. Focusing first on the concept of loops, the author examines the use of loops in contemporary music composition, particularly in games and playful musical expression (Cera, 2013). He then analyzes a music game that successfully links many different aspects of interaction, including gesture and movement analysis studies, real-time interactive sound synthesis, the composition of interactively generated musical environments, experiments in everyday music listening, and more (Cera, 2013).

In the field of game design, especially where educational games are concerned, many designers use narrative structure to convey information. Narrative structure refers to the way in which a game's story is designed and how that information is conveyed as children interact with the game, and how children integrate the information they receive in the game world into the story (Toh, 2021). Some games, such as Naughty Dog's The Last of Us, allow the game's story to be told through only a single pathway, while others, such as Irrational Games' Bioshock, allow the game's story to be told through multiple pathways. The player's interpretation of the story is an emergent narrative formed in the mental model as they interact with the game by selecting, evaluating, and integrating information (Toh, 2018). When interacting with games such as BioShock, children can choose to attend to (select) the environment and reflect on (evaluate) the state of the game world, or they can learn about the past of the game world and reflect on (evaluate) it by picking up on embedded narratives such as audio logs (select) (Toh, 2018). Each player's story will be unique based on the information they choose to integrate in the game world.

In Lin's work, their team present a framework for creating user preference-aware music dice from a user's music collection (Lin, 2015). Borrowing the idea of a musical dice game, they construct a musical dice graph using musical phrases segmented by song detection (Lin, 2015). Once the graph is constructed, the system can automatically generate various mixtures of music (Lin, 2015). Therefore, they provide a simple feedback mechanism that enables users to specify song segments, modify transition positions and cross-fade durations to better suit their personal preferences (Lin, 2015). This inspired me to thinking through the system design of the music and the users accessibility to these music. Performing music by merely following the instruction or fixed sequence could tedious after a period of time, so it might be great to give users more control on the music they want to play/hear, and difficulties, or the genres they preferred. These are worth to be considered in the game design in terms of users flexibility.

Michalakos designed two electroacoustic games communicated and implemented using the Unity game engine and Max/MSP patches (Michalakos, 2021). The visual information is completely transparent, just as in the realm of live coding, where the audience can see the source code of the music being produced in real time (Michalakos, 2021). Michalakos also points out that, unlike in traditional puzzle games, in the games he has designed, incorrect gestures facilitate the performance of the music rather than delaying the completion of the game, or even leading to its failure (Michalakos, 2021). In fact, players often want to extend a segment without making the correct gesture (Michalakos, 2021). It's a rare experience to let a player continue to play without giving them a hint of an error, and I think this model could work well in my game design, given that this music game isn't competitive and doesn't even need to be designed to accomplish a goal as an end goal. As an experimental and experience-oriented game, perhaps reducing user

frustration (e.g., by not completing the appropriate action correctly) would have been a better design choice.

In contrast to Michalakos's view, Reyher's project focuses on enabling the player to use the remote control to enter the correct rhythmic groups and patterns using either a single key or a two-button combination to enter the appropriate rhythmic groups and patterns (Rether, 2014). If the player makes an inaccurate entry (e.g., rhythm, unstable beat, etc.), the game asks the player to repeat the action until it is correct (Rether, 2014). After completing the "practice", the real game begins. During gameplay, the game will provide feedback, including the character's on-screen reactions, negative auditory cues, and negative visual cues, such as the character moaning, frowning, or scowling (Rether, 2014). Perhaps in-game feedback on player errors is still necessary, but I should also consider how to keep the player playing after receiving the cues.

Taheri and their team presented the design and initial evaluation of FINGER (Finger Individual Grasping Movement Robot). FINGER utilizes a single, single-degree-of-freedom 8-bar mechanism to help patients perform grasping motions using different fingers simultaneously or individually in a natural way (Taheri, 2014). FINGER is unique in that, unlike most exoskeleton designs that aim to align robotic joints with human joints, the joints of FINGER's mechanism remain at the back of the hand and wrist throughout the bending process (Taheri, 2014). It also allows sensory stimuli to be applied to the outer surface of the hand, for example allowing an individual to grasp real objects with the help of their fingers (Taheri, 2014). When considering accessibility into a project, perhaps using only the movements of the back of the hand and the joints of the fingers to manipulate the game is a good option. Since the manipulation requires only minimal finger

movements, there is a greater possibility of interacting with the game even if they are physically challenged.

To summarize, in the relationship between games and cultures, there is a need to consider the harmony of matching cultural and game elements. In order to adapt the game to a wide variety of cultural backgrounds and to provide the user with a more pure cultural experience, I can accomplish this through, for example, in-depth knowledge and research of specific cultural focuses, player preferences, indigenous-orientation, and a focus on both feeling and expressing culture. In turn, the transmission of culture can lead to learning while receiving and understanding, and I need to consider not only how to make the process of learning about culture interesting and unique in my design, but also, in more detail, how to use descriptive text to explain certain difficult cultural elements, or how to use other methods to increase the player's sense of immersion in order to learn about the culture better, such as music. Considerations in compatibility can be reflected in the reduction of learning costs for music controllers, the combination of text and images, and the ease of game design, to name a few. Also, Using interactive devices to interact with music live or to create music requires complex compatibility considerations, but this idea can be simplified by applying it to my design, such as lowering the cost of learning music controllers, combining text and images, and considering ease of use and simple music loops in the design. Finally, the design of the game could be a single linear story or a more free-form approach such as an open world that allows the player to move around relatively freely and control the genre or difficulty of the music they want to hear. At the same time, games that are experimental and experience-oriented, without being competitive or even having to achieve any goals, can reduce user frustration if they don't accomplish the appropriate goals correctly. And for the sack of accessibility, using only the back of the hand and the movements of the finger joints to control the game allows physically challenged users to interact with the game as well.

METHODOLOGIES

As my project primarily involves three domains/phases: music and musical instruments design, interaction design, and game design, the research methods and methodologies will slightly differ in these parts of my research and production. Rather than creating a complete design project/video game, the primary methods that will be used in this project is to explore the possibilities of intersecting games, culture, and music through constant research and iteration. This is being considered out of the fact that a full game design can take years and my limitations on the programming code capabilities involved. Also, the diversity of today's games and the constant iteration of interactions require designers and stakeholders to constantly seek innovative ideas, and it's not realistic to limit oneself to designing a once-and-for-all project. Therefore, in this project, I will use research through design and iterative prototyping as the main research methods to find potential solutions to this problem space. Quick prototyping will be used in the design of musical instruments and interaction so I can see what form and materials are easier to use and preferable. By reviewing the literature and design cases of musical game projects designed by other designers and researchers, the ideation of the game's interaction design and system features would be easier and more rational.

By the end of the project, the player should have learned a small amount of background knowledge about the Chinese culture as well as visually experience some of the cultural elements of the China from the game. While in the music part players can experience the feasibility and fun of using musical instruments to manipulate the game, even though they may have never used any musical instruments before, their experience can be enhanced by the simplicity of the design.

In addition, my personal design skills and expertise in the field will be paramount in considering the design decisions that need to be made in this research and design process, as well as in evaluating the overall and detailed feature results. This also means that thinking through making and self-reflection are also top priorities of research and design methods in this project.

Design Exploration and Process

The design of musical instrument

The first step was to decide on the most basic form of the instrument. Recognizing the importance of cultural authenticity, I chose the Pipa as the instrument controller for my game due to its rich history and cultural significance in Chinese tradition. The Pipa, a traditional Chinese stringed instrument with a history dating back over two millennia, holds a special place in Chinese music and culture. Its unique sound and distinctive playing technique have made it an emblem of Chinese musical heritage. Historically, the Pipa has been associated with storytelling, folk music, and classical compositions, playing a central role in traditional Chinese music ensembles. Its versatile repertoire includes both lively folk tunes and elegant court music, reflecting the diversity and depth of Chinese musical traditions. Beyond its musical significance, the Pipa holds cultural symbolism as well. It is often depicted in Chinese art and literature as a symbol of refinement, grace, and cultural sophistication. Its association with historical figures and legendary tales further enhances its cultural resonance within Chinese society.

By incorporating the Pipa as the instrument controller for my game, I aim to honor and celebrate the rich cultural heritage of China. Players will have the opportunity to engage with this iconic instrument in a digital context, deepening their appreciation for Chinese music and culture while enjoying an immersive gaming experience. Through this innovative approach, I hope to foster cross-cultural understanding and appreciation, bridging the gap between traditional art forms and modern technology.

After the confirmation of the make of instrument controller, I digitally designed the shape of the instrument in illustrator so that it conformed to the basic pipa contours and distinct details on the

surface. Then I laser cut it down and selected 6mm plywood for the front and back of the instrument so that the most basic exterior of the instrument was shaped.
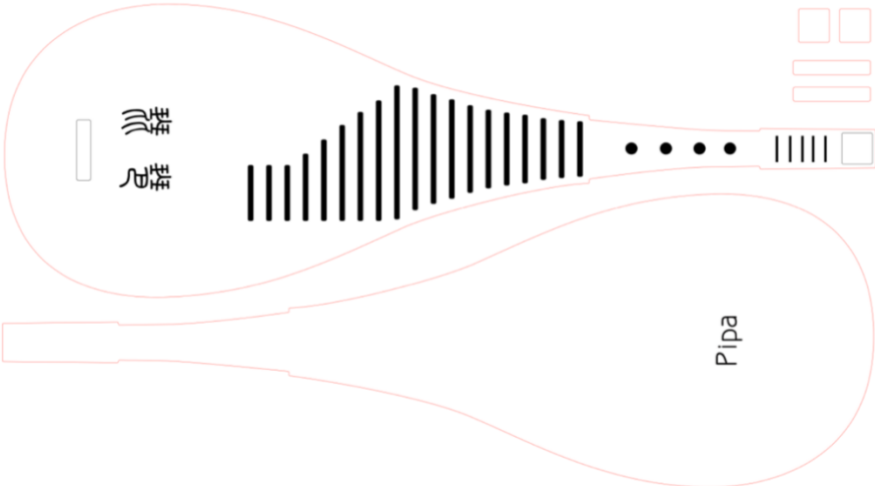

Figure 3. laser cutting design of the instrument on the Illustrator

*Figure 4. laser cutting of instrument controller*

The next step was to find a suitable material and cut it to the same shape as the surface and fill the center part with it to make it thicker to fit the thickness of the original instrument on the one hand, and on the other hand to give me enough space to put Arduino sensors and wires inside the instrument. I considered mounting the Arduino directly on the surface or on the back, which would have been easier, but it would have made the Arduino susceptible to malfunctions due to touch or impact.

*Figure 5. material cutting for the instrument controller*

The center filler material I chose cardboard based on the fact that it's cheap and easy to change form. After cutting out 3 more layers of it, I didn't base it on gluing but started working on the Arduino programming as well as the wiring connections. I programmed a simple device with 3 copper tapes to act as capacitive sensors for the user to interact with the instrument and connected LED lights to them. This way, every time the user touches or slides a different tape, a different color of light will appear, giving the user feedback on what they are interacting with. Traditionally, the interaction feedback of musical instruments is mainly through sound, but since

my prototype is in the early stages, I'm using color instead of sound for now, and the sound and music will be implemented in future productions. The next consideration was how to place the Arduino securely in the instrument. I cut out a notch in one of the layers of cardboard just enough to accommodate the Arduino whiteboard and secured it inside the notch so that it would not come loose from outside influences, and the LED light was secured in the same way and taped with conductive tape to make it more secure. During this process, the placement of the Arduino whiteboard, jumper wires, and sensor inside the instrument were all carefully considered so that the LED light and capacitive tapes would be exposed in the right place.
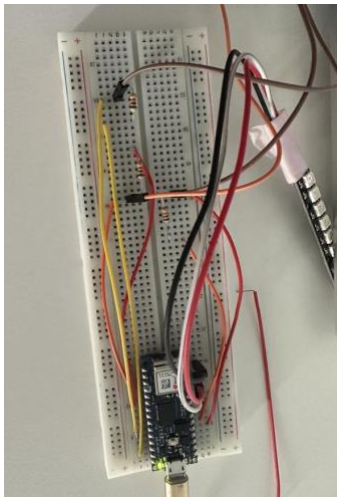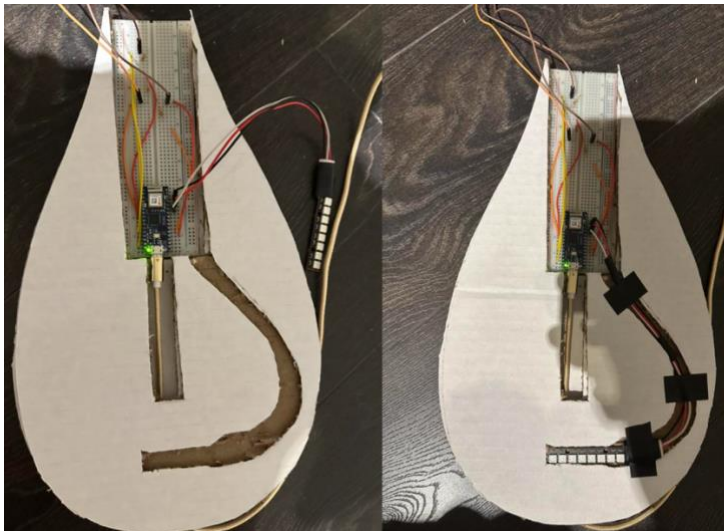

Figure 6. Arduino connection for the controller
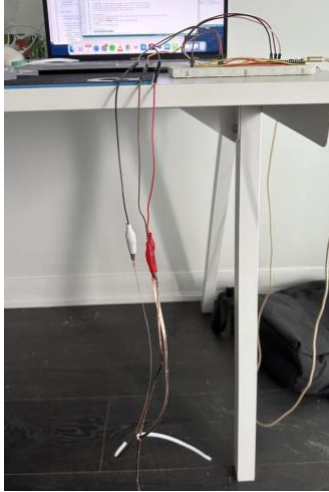
Figure 7. Arduino connection with laptop

Figure 8. Arduino installation inside the controller(in progress)
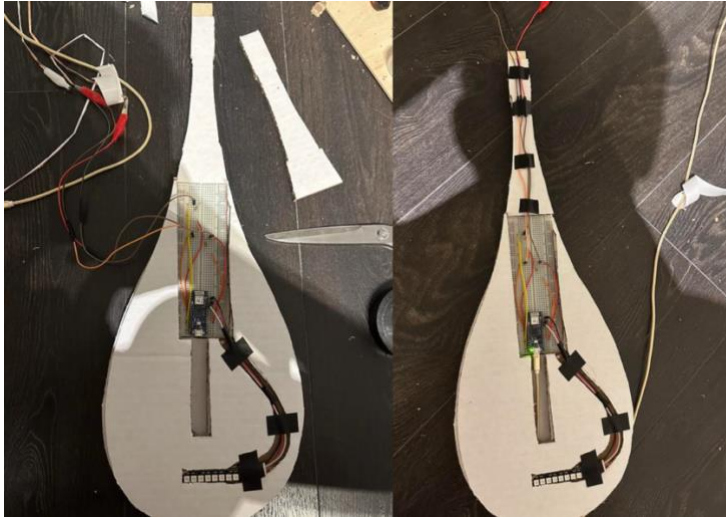
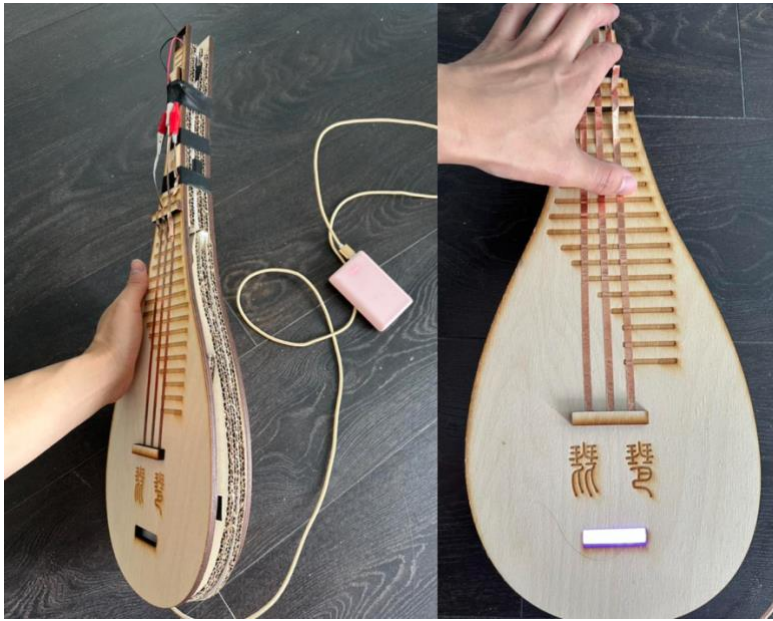*Figure 9. Arduino installation inside the controller(final)*

Figure 10. Final instrument controller display 1

Figure 11. Final instrument controller display 2

One of the problems encountered in the design and manufacture of music controllers is how to make it a medium that embodies a part of Chinese culture. I did a lot of research for this purpose and found that instruments unique to China tend to favor a rustic look, especially if they are made of stone or wood, which emphasizes a sense of elegance and history. Moreover, these instruments and other objects have more symbolic signs or symbols to emphasize uniqueness. These aspects that I took into consideration when designing the look and material of the controller inspired me to use wood as a directly observable surface for the user, and to use ancient Chinese characters in an elegant font and carve them into the surface of the instrument to differentiate it from other instruments with a similar appearance, such as guitars, which are commonly found in Western countries. I reckon that incorporating ancient Chinese characters into the design represents the deep cultural heritage and reverence for history in Chinese society. The use of an elegant font and carving the characters into the surface adds a touch of sophistication and artistry, mirroring the importance placed on aesthetics and craftsmanship in Chinese culture. By differentiating the controller from Western instruments like guitars, it highlights the uniqueness and distinctiveness of Chinese cultural symbols and traditions. On the other hand, I also considered how to transpose

the interaction patterns of Chinese composers playing the pipa in real life to the interaction methods I wanted my users to experience. Playing the pipa requires the player to sit up straight, hold the instrument vertically in their lap, support the instrument with one hand, and pluck the strings with the other, so as to play the music and stabilize the position of the instrument in a comfortable state. This allows the player to play the music and stabilize the position of the instrument in a comfortable state. Therefore, for the player to experience what it is like to play the pipa, the way the player interacts with the game is exactly the way the pipa has been handed down to be played.

The Arduino has been very useful in helping me explore unusual interactions in my projects. Capacitive sensing is not difficult to create and program, but it is more challenging to make it natural for the user to touch the interactive areas. The selection of the copper pieces needed to take into account the size of the player's fingers, the distance between the areas, and the possibility of breakage. The interaction is designed so that the strings are not suspended as in a real instrument, but rather the strings, i.e., the copper pieces, are attached to the surface of the instrument, thus minimizing the chance of the strings breaking and becoming unusable during the user's use of the instrument. Programming the Arduino with sensitivity in mind means that ideally the user would not need to press hard on the strings nor worry about unintentional touches resulting in incorrect commands. In the literature review, we mentioned that the system should provide feedback to the user on whether the operation is correct or incorrect, so here I designed the Arduino with sounds and lights to correspond to the user's actions on the different strings.

Game Design in Unity (Initial version)

As an experiment, my first thought was to use a 3D open-world game to host my research questions. Although it is called an open world, due to time and technical expertise, only a small portion of the game will be shown in this project, covering the most important features of the game, such as music interaction and Chinese cultural history.

First of all, in order to be able to incorporate Chinese cultural elements into the game, the game's background and characters are styled after specific dynasties in ancient China. The characters are styled as ancient court ladies, and their hairstyles are the ponytails that were popular in the imperial palace during the Ming Dynasty. Clothing selection is also from the ancient Chinese cheongsam, with white as the main color, with gold stripes, highlighting the royal aristocratic style at that time. The buildings and terrains in the game adopt the most characteristic shapes and styles of ancient China, such as high towers, brick roads, grass houses, tiled houses, city walls, lion statues and so on. The game contains 3 main scenarios, representing the Ming dynasty, Han dynasty, and the great wall, and the buildings in the different scenarios are chosen based on the architectural styles in different periods.
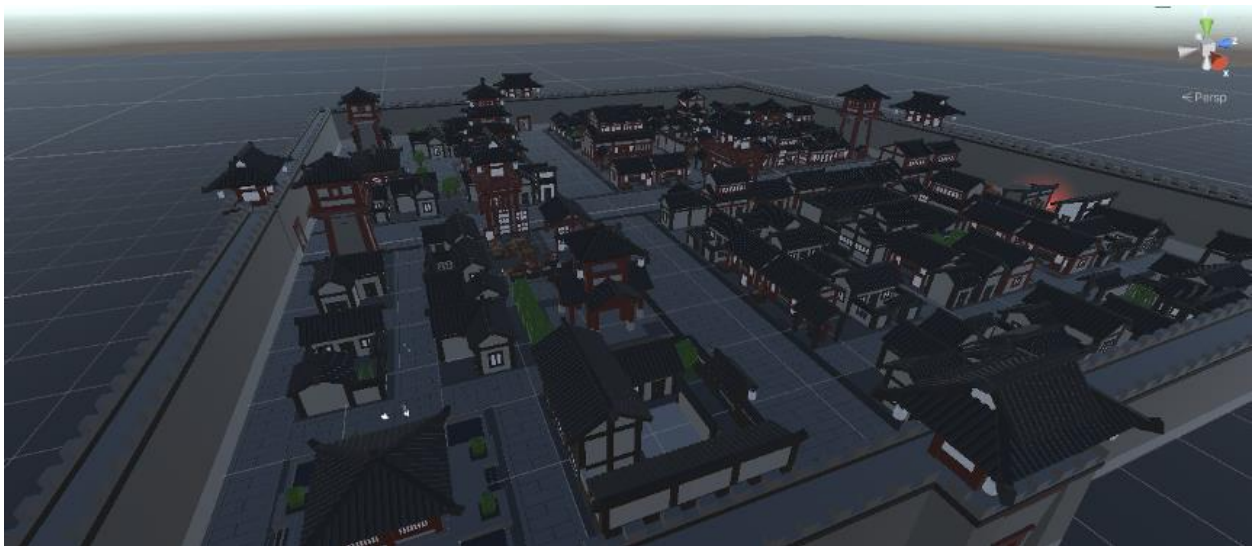
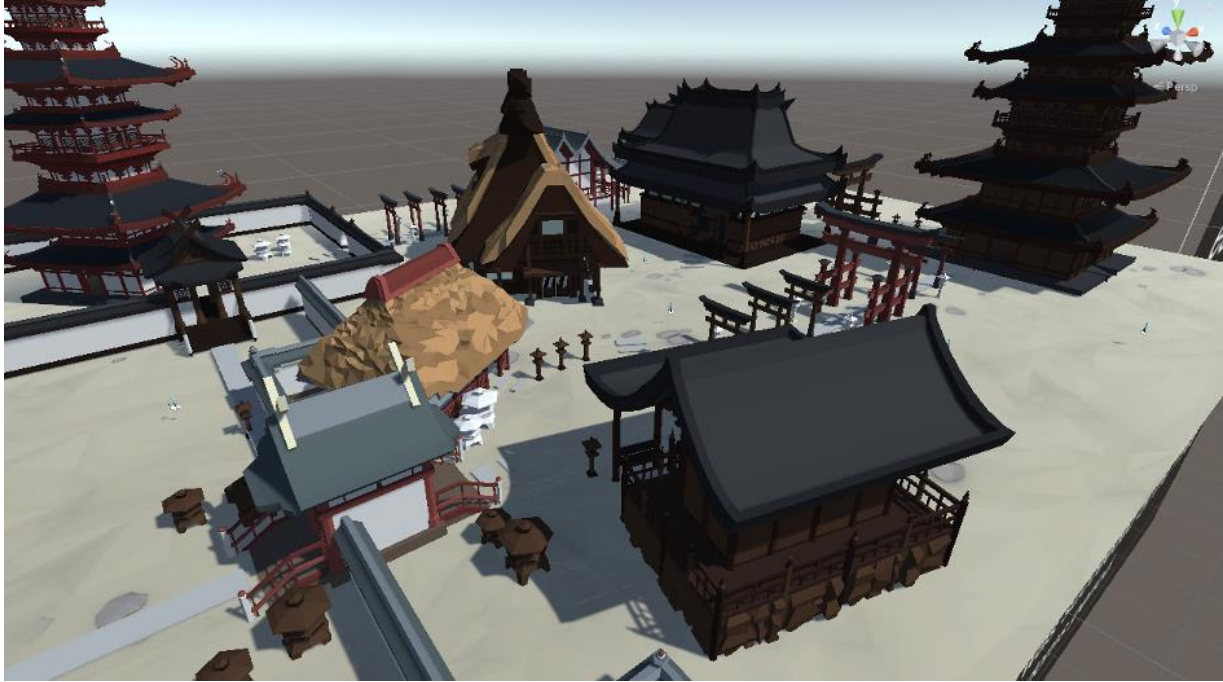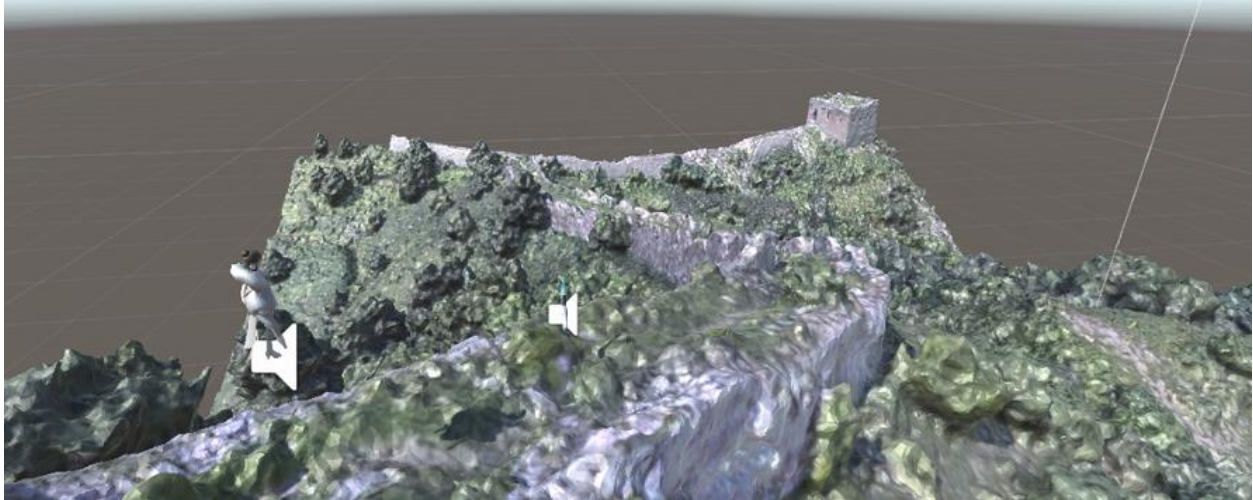*Figure 12. Ming dynasty in game*

Figure 13. Han dynasty in game

Figure 14. main character

Figure 15. The great wall in game

In this game, I set the camera, or the player's viewpoint, to be the back top of the game character, which allows you to see the character's exclusive ancient attire while being able to give the player a wider range of perspectives. First, the camera can be fixed at a specific angle and can move with the character and rotate with the character. The character has realistic gravity so that it doesn't float in the air or sink into the ground but stays above the ground and fits. The speed of the character's movement is based on the size of the surrounding environment and buildings, so that it matches the speed at which the character moves or runs in the real world. In order to give the game character, the same physical appearance as in the real world, I also added a set of animations for it in its resting and moving states.

To intersperse music throughout the game, I referenced floating musical notes and randomly spawned them at different locations in each scene, then set them up to be collided/collected by the characters. These notes then have their own triggered short musical fragments played by the ancient Chinese instrument, the pipa.

The rules of the game are that the player needs to use a musical instrument controller to maneuver the game character to move around the scene, from which he can feel the architectural style of a certain period of ancient China. The player then picks up notes in the scene and matches them to the music in the game by touching the 3 strings on the controller (in a simple way rather than exactly matching the drumbeat). Once the player has successfully "played" a musical phrase, a note is picked up, and once the player has picked up enough notes of the music, the player moves on to another scene to pick up more notes, but the music will be different. The game also has interactable items to pop up a textual synopsis of the dynasty in the scene, allowing the player to learn something about the dynasties of Chinese history during the game. This game mainly lets players feel the uniqueness and potential charm of Chinese history and culture through the layout of the scene environment and buildings, the dressing of characters, and the style of music. Musicality, on the other hand, is triggered by playing the notes scattered in the scene to give players a fun musical experience, even if they are not professional musicians, composers, or professional pipa players. Ideally these elements, which are unique to the ancient Chinese period, will give the player a sense of immersion, and the immersive atmosphere will be conducive to learning as well as cultural learning.

In the section on instrument building, I mentioned how the Arduino can be used to build and interact with instrument controllers, and at the same time, the Arduino is a bridge between Unity and instrument controllers. However, once I finished connecting the Arduino to Unity, I realized that the actual situation was worse than I had imagined. It was indeed possible to control the movement and steering of the gamer via the interactive controller, but the character would constantly sink vertically into the ground, which prevented the player from picking up music notes

on the ground, thus preventing the cultural music experience I had designed. Finally, due to time constraints and the fact that the basic form and interaction of this prototype was already set in stone, I decided to start researching and designing new prototypes so that I could look for more possible gameplay scenarios. In conclusion, the first game prototype was designed to utilize the historical background and various cultural elements to create an atmosphere of Chinese history for the player. Ideally the player can interact with simple music in a historical setting, sort of barely combining music, culture and gameplay. However, in addition to the technical issues that could not be resolved, the prototyping process also involved many more important issues. First of all, it's my biased understanding of culture that leads to the fact that even though my game has a lot of elements that represent different time periods such as clothes, buildings, and environments, the player can only feel the atmosphere of the ancient Chinese period, but cannot really learn about Chinese culture from it because we are more likely to learn from what happened around us rather than what is there, which we could not even notice their existence. During the design process I tried to use some introductory text to increase the player's understanding of the background of the dynasty, but this proved to be tedious, and the player was often resistant to the long text in the game. Instead of linking culture directly to history and history-related elements, I believe that finding and spreading the customs of the local people that have been passed down from the past should be the right way to understand cultural learning, and this is the point I need to emphasize in the second prototype design. In addition, I need to pay more attention to evaluating the feasibility of the game implementation in advance in my subsequent designs. Programming limitations should not be an excuse for not being able to complete the design. Sometimes designers should evaluate the technical problems that may arise in advance,

and then be ready to adjust the final goal before and during the design process. This way, even if the system fails to achieve the desired complex and profound goals, the core features, interactions, and solutions can be presented to the user in a relatively complete form.

Game Design with Videos (Second iteration)

One of my inspirations was an interactive and narrative game called The Quarry. This game is multithreaded and allows the player to determine the direction of the character's story through their different decisions. Although the interaction in this game is as simple as clicking on different options at different moments, the sense of the unknown and the interesting story that could unfold as a result of each decision leading to potentially very different consequences and story segments makes the game fascinating.

The ultimate goal of this prototype is to allow players/users to actually learn a part of Chinese culture and customs, and in both cases, the culture needs to be pinpointed to specific things or behaviors. The specific behaviors can be contrasted with the first prototype, which tends to introduce the general Chinese historical background and environment, which helps me to analyze the design strategies that are more applicable to users in different situations. Secondly, compared to the ambition of designing an open world game (even if it is only a small area), the second time I needed a more practical project to avoid technical problems and time constraints, so my goal was to deliver a minimal viable product that would allow users to learn a very small portion of the Chinese culture through a much shorter gaming experience. Finally, the game should be significantly more interesting and innovative than the first prototype, which is one of the advantages of using game design to teach culture.

To get inspiration for the game's story, I brainstormed over 50 cultural behaviors unique to China and Chinese and listed the ideas on a piece of paper.

know historical building in China ------Worst one
know special festivals in China
how to make dumplings
street culture
Chinese cooking method
Chinese cooking ingredients
chinese music styles
Chinese lyrics
calligraphy
instrument learning (Pipa)
Chinese customs in new year:
give and receive red pocket to children
evening News and weather forecast
elite education for children
sending gift to others
ancient emperor in different dynasties
princesses outfit, personalities, habits
second "dad". ------- Silliest one
moon cake
Chinese gambling
red pocket in wedding
ppl travel in holidays
boring education: study hard before Uni, and play in Uni
tradition: man earn money, woman do housework
how parents hope children do, and what theyve done for them
parents sacrifice
Chinese knotting
live with Panda or other species
how to fly a kite
Chinese drinking culture

Figure 16. Brainstorming of 50 Chinese cultural behaviors

Then from there, I chose which were the funniest ideas and which were the most boring ideas, which generated five ideas that could be used in the story, or used to make up the storyline of the game:

- Giving and receiving the red pocket in new year/wedding

- Watching daily evening news and weather forecasts

- Second dad

- Mooncake/dumpling

- Drinking hot water

Through research and asking others for their opinions, I have chosen these five cultural practices and traditions that are relatively more interesting and that fit into the daily lives of Chinese people. These iconic cultural examples can be used in the game to effectively highlight the habits and things that Chinese people have to do in their daily lives, and the fact that these ideas are accompanied by some of the Chinese people's own thoughts and emotions which allows me to add some emotional elements to the game to make the cultural communication more emotional rather than just a dull learning experience.

Normally game design would present these ideas on screen by way of scenes, but this time I decided to compose the game by shooting live action video. This is because firstly the difficulty of making a game out of these behavioral scenes might even exceed the first prototype, and secondly a game composed of videos would be more vivid and novel. How to present these ideas in a video game format was the biggest challenge. This is because first making a game out of these behavioral scenarios might be even more difficult than the first prototype, and secondly a game composed of videos would be more vivid and novel.

It simultaneously inspired me to think about how to design where the story goes and how the player should access the different videos. Due to the relatively small number of culture ideas, a linear storyline might be too short and not give the player much opportunity to interact with the game. However, if an idea can be split into different videos, each video may have the same scenes and characters, but the content of the story, such as dialog and character behavior, will be different, so that more content can be generated using fewer ideas. The story is presented to the

player in a linear progression, where they can choose different decisions by interacting with the music controller, and these decisions will show them different videos that represent the Chinese culture. The videos are made with cell phones and cameras and are performed by two or three actors who act out the scenes that correspond to each Chinese culture. The scenarios are presented in an entertaining and relaxing way, avoiding a stagnant presentation of Chinese culture. The videos will be augmented with gamification to simulate the game's interface, such as health bars, inventory, mood states, and other special abilities. These UI changes in different videos correspond to different cultural scenarios, providing systematic feedback to the player while also helping them understand the different outcomes of different behaviors in the video, thus providing a fun way to learn about Chinese people's thoughts of and reactions to their own culture.

Figure 17. Game homepage.

The platform for the game will remain Unity but the production and processing of the videos will be done on Adobe Premier Pro. The edited video is made possible by Unity's own features as well

as code that allows the video to be populated by user actions. Each video is accompanied by subtitles to facilitate the player's understanding of the necessary dialog in the scene. In addition to this, I designed a simple Unity interface to guide the user through the actions until the end of the game. To interact with the game, players need to touch the difference strings on the instrument to choose different path in the game, which lead to different video story. For example, when a user is holding a controller and they need to make a choice in a game, they can touch the left string to select an option on the left side of the screen, or touch the right string to select an option on the right side of the screen.

Figure 18. Gameplay Example: the scene of "do not want to go to the wedding"

So, how is the users' journey through the game in an ideal state? First, they would pick up the instrument controller and while sitting in the chair, I would then give them a very brief explanation about how to select the options on the screen by touching the strings on the instrument. Once they have clicked on the options on the main page and entered the game, a video will play showing them that they are now playing as a Chinese person and that they will come across different human objects, and that they can make different choices with the instrument whenever they come across people and objects that they can interact with, and that these choices will then

lead to different outcomes for the protagonist of the game such as a drop in blood, a loss of

mental energy, a loss of energy, and a loss of energy for the protagonist of the game. euphoria,

or obtaining a certain item, etc. This not only allows the player to learn about the specifics of

Chinese culture, but it also allows the player to see how real Chinese people react to these

situations and how they are affected by the culture.

Figure 19. Gameplay Example: the scene of "meeting two kids in the wedding"
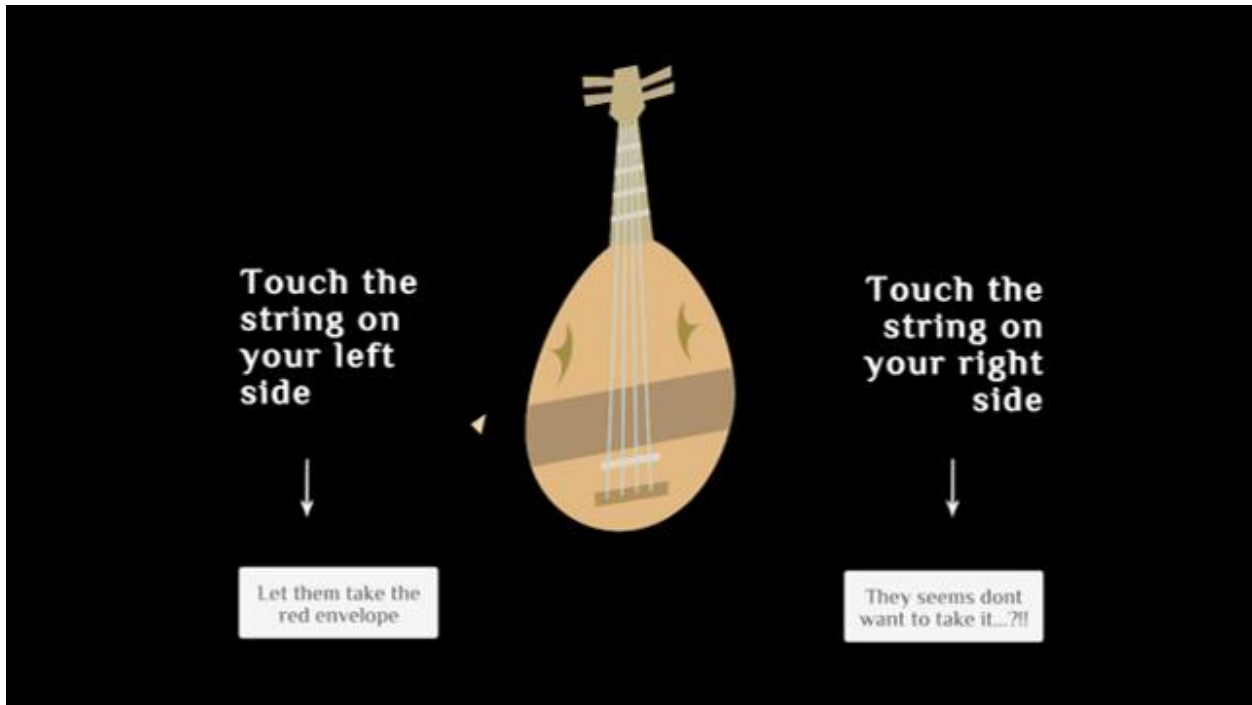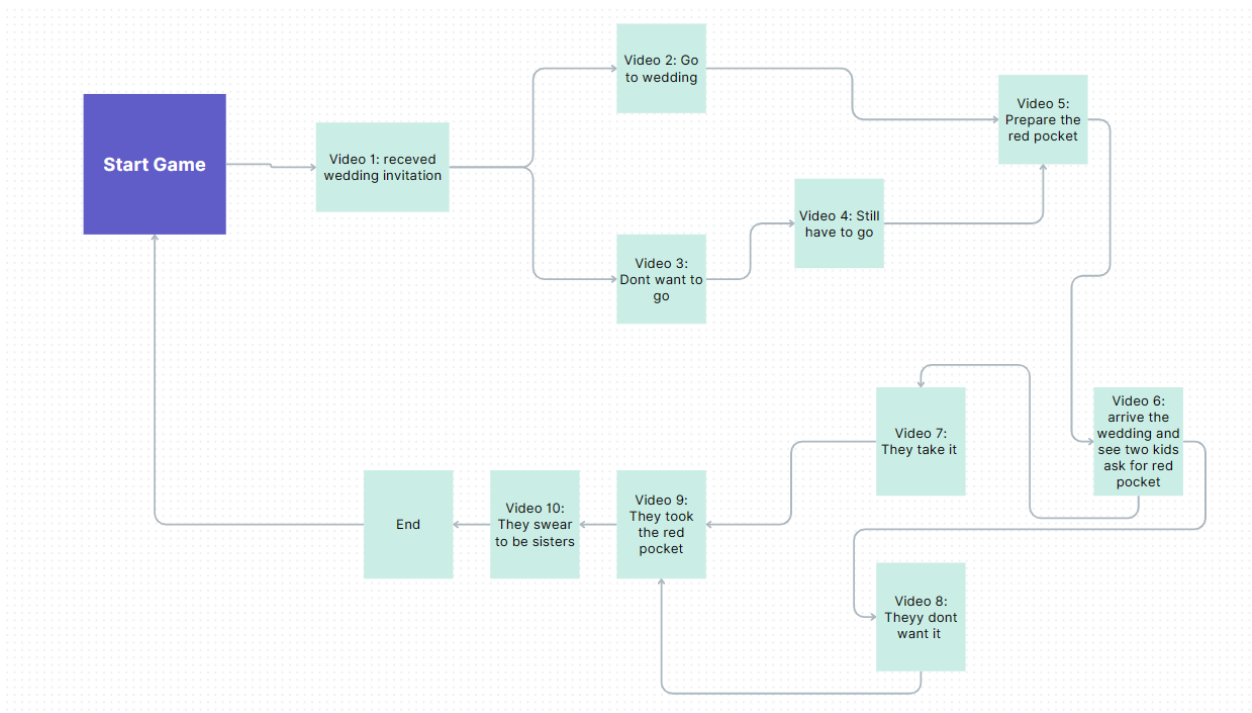
Figure 20. Game Options

Figure 21. Gameplay flow of prototype 2

For a game that helps people learn about Chinese culture, a mode consisting of videos of actors' scene renditions can be very straightforward for players to learn about the details of these

cultures, and even the local people's thoughts and attitudes towards them. While the main objective is to learn about the culture through the videos, the Chinese historical background music played by the pipa and the instrument controllers play a supporting role. The unique pipa music helps players experience the game in a more immersive way and get a feel for the sounds of the ancient Chinese instrument. The interaction between the player and the instrument not only allows them to experience a different way of controlling the game, but also allows those with no experience with the pipa to play this Chinese instrument for themselves. When the game changed from an open world to a linear narrative model, I found that the game design largely different. In the open world, the player can either explore or go on optional quests that are set in the map. By contrast, in the second prototype, while they have a lot of choices and are oriented to many different outcomes, the game gives them actually very little freedom so that their focus is on the storyline. This means that designers need to pay extra attention to the story and the culture itself, such as whether the story is coherent, whether the plot is what draws the player to keep playing, and whether the cultural details are true to the situation.

Compared with the first prototype, I deem that the strength of the second prototype was that it presented a story-driven approach to cultural learning (not just through static buildings, etc.), and better in showing the impact of these cultures in a way that was as subtle as a change in people's senses. And because it's a video game, the player doesn't need to learn about these influences through words or pictures alone, but rather through changes in the game's UI and the expressions and demeanor of the characters in the video. The second prototype is clearly more playful and meaningful than the first prototype and is also more effective in cultural learning.

The original Intention of the second prototype was to be able to allow a natural experience of Chinese culture through the experience of an interesting form of storytelling, but as mentioned before, when the game is dominated by linear storytelling, the player pays extra attention to the quality and consistency of the story itself Since the game consists of a combination of different videos, the alternation of videos doesn't allow for the relatively smooth articulation of different scenes as in a real video game, such as an open-world game. Even if it could be done relatively smoothly, it would require more time and effort on the part of the designer to work on those details, and my project didn't have much time to get those details right. Equally time-consuming is the preparation of the video, the selection of environments for filming, the script design, the actors' facial expressions and movements, and the post-production work needed to add the game elements to the screen of the video all take a lot of time to accomplish. Although my project was a prototype that only included 4 or 5 scenes, it still took a lot of time to produce, and the cost to actually develop a full game like this is even more massive. On top of that, another problematic point is the interaction design. Since my music controller was designed with one of the purposes I wanted to accomplish with the last prototype in mind (playing simple music), I designed the strings as the main area of interaction. However, in the second prototype the use of the strings became a selection tool, which is too simple an interaction since it can only be touched, and it doesn't make sense to use the strings to make a selection. At least I had better options, such as reducing the size of the musical instrument controller considerably to make it easier for the player to hold it in their hand or having other areas of interaction to make the selection more comfortable (like the XBOX's controllers have two zones, left and right).

The focus on interactivity in the first prototype enables players to actively engage with the cultural content, fostering a sense of curiosity and exploration. Through hands-on learning experiences such as solving puzzles or making dialogue choices, players not only acquire knowledge but also develop a deeper understanding of the cultural context. This approach is particularly effective for players who prefer a more interactive and experiential learning style, as it allows them to learn at their own pace and actively participate in shaping their gaming experience.

In contrast, the emphasis on storytelling in the second prototype provides players with a compelling narrative framework through which to explore cultural themes and values. By immersing players in a richly crafted story world populated by relatable characters and engaging plotlines, this approach elicits emotional connections and fosters empathy towards cultural perspectives and experiences. Through the power of storytelling, players are transported to different cultural settings and are given the opportunity to walk in the shoes of diverse characters, thus broadening their cultural horizons and promoting a deeper appreciation for cultural diversity.

Furthermore, the combination of interactivity and storytelling in both prototypes offers a holistic approach to cultural learning and engagement. By integrating interactive elements into a compelling narrative structure, players are provided with a multifaceted gaming experience that caters to different learning preferences and styles. The interactive nature of the first prototype encourages active participation and exploration, while the immersive storytelling of the second prototype captivates players' attention and fosters emotional connections. Together, these elements create a dynamic and engaging gaming experience that not only educates but also entertains, ultimately promoting cultural understanding and appreciation in a meaningful and impactful way.

Finally, while Unity is a specialized game design engine, my two experiences using Unity for prototyping have given me some thoughts on the game design platform. There is no doubt that this game design software, like many others (e.g. Unreal, Gamemaker: studio) has a powerful system and countless features for users to design the game they want. However, While Unity is capable of creating visually impressive games, performance optimization can be challenging. As more game assets were added to the scene, my game started dropping frames as well as taking longer to load, even though the size of my game was nowhere near the real thing. At the same time, learning to use Unity takes time for designers like me who have only a limited programming foundation and game development experience. Navigating the Unity interface, understanding scripting languages like C#, and mastering game design principles can take time and effort.

CONCLUSION

One of the goals of this project to allow players to experience specific cultural history and gain cultural knowledge by embedding Chinese history and culture in the game. Although game production requires a lot of time and specialized coding skills, the ultimate goal of this project is not to deliver a complete game project, but rather to allow players to experience the novelty of what happens when music, history and culture, and musical instruments are combined as a means of game interaction. I used a variety of handmade, digital software, and laser cutting techniques to complete the exterior, and then placed Arduino Boards inside to allow the player to manipulate the controllers to interact with the game. I then used programming software and the game engine Unity to design a game that incorporates Chinese culture and history. By connecting the Arduino and Unity, users can play simple music, which allows them to experience the fun of the game and at the same time learn about the pipa, a unique Chinese musical instrument, and how to use it.

One problem during design process is that my definition and understanding of culture was skewed in the early designs. In the first prototype, I superficially defined culture as historical elements, such as ancient architecture, the styling of the game's characters, explanations of each dynasty's text, ancient musical instruments, etc. I then visually put the player in an environment made up of a bunch of Chinese elements, so that they could feel the uniqueness of Chinese culture. This can indeed make players and users feel that this is a video game made up of Chinese elements, but later I realized that this does not promote their learning of Chinese culture. First of all culture cannot be directly linked to history. Culture should be an indigenous habit or phenomenon formed by the accumulation of a country or nation's traditions and customs over time, rather

than simply consisting of static objects such as architecture and clothing with local characteristics.

Secondly, whether it is the architectural ensemble with local characteristics or the descriptive text that goes with it, these static objects are relatively uninteresting.

Another problem that I needed to overcome during the research and design process was how to ensure that my research questions were answered as best as possible in a technical environment. Specifically, a common design decision can be presented in many different ways, for example, when I designed the first prototype I needed to use the least complex programming possible to give the player the necessary gameplay experience as well as an understanding of Chinese culture. In the initial idea, I spent a lot of time thinking about how to make the game character fit perfectly on the ground and collide with buildings through the programming of gravity and the collision conditions of different objects. This would have enhanced the player's experience, or at least made it look more polished and complete. But this proved to be unnecessary, firstly because the technical issues that required a lot of time and effort were not directly related to my research problem, and secondly because time constraints made it necessary for me to leave only the most central features and discard those that were less important in comparison. One of the unfinished but important features is that the player matches the sheet music and music that appears on the screen by manipulating the strings of the instrument. It is difficult to play a musical instrument controlled by an embedded Arduino while manipulating the character to match the music. Technical limitations and time costs forced me to abandon this feature, but in the future I hope to complete this interaction to make my first prototype more complete.

Reflecting on culture also allowed me to answer my primary research question: How to design a video game that allows players to comprehend and learn about some specific China's unique

culture? The solution that I explored combined linear story consisting of a bunch of specific and interesting cultural habits unique to Chinese culture. In the first prototype I tried to let the user play simple notes with an instrument controller to give them an understanding of the basic form of playing the pipa, a unique Chinese instrument, and to give them an idea of what music played by the pipa looks like through aural music. In the second prototype I also used the pipa music as the background music of the game to add a sense of Chinese cultural ambience. By placing Arduino-related technology in both handmade and computer-generated objects, and by utilizing the characteristics of different sensors (such as the capacitive sensing I used in the prototype), I was able to achieve the desired effect that players are able to use the interactive and novel controller to engage with games. In the case of the pipa, because of the fixed way of holding the instrument and the large size of the instrument, the player is not able to use both hands freely and quickly touch the various areas of the controller, so many factors must be considered, such as whether the interactive areas can be reached quickly by the user, whether there are any uncomfortable operations, and the mapping of the interactive areas, etc.

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