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Preserving Tradition
A Game-Based Approach to Documenting Madeira Islands Wine Making Process

MASTER DISSERTATION

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INTERNATIONAL MASTER OF INTERACTIVE MEDIA DESIGN

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Abstract

Winemaking in Madeira is an antique tradition of significant cultural importance that has existed for over five hundred years.

Although these processes are an important part of Madeira's history, as wine making was and still is a family tradition that is practiced, very little is being done to educate, disseminate and preserve these old traditional methods to both locals and non-locals. As these old methods are considered an intangible cultural heritage, they suffer from lack of simple or effective ways for preservation, but as they hold a great cultural value for their community they need to be well preserved. One of the successful avenues for this is using serious games, which are games that focus on teaching the player instead of entertainment, as they can leverage Game-Based Learning (GBL) to a variety of benefits for the player.

To this end, this dissertation proposes the creation of a game with the main objective being to preserve and disseminate traditional wine making process from Madeira Island oriented towards both locals and non-locals. By using GBL learning principles, seven minigames were made relating to different stages to winemaking, to utilize knowledge transfer for dissemination. Later, to evaluate its success, questionnaires were used as a metric by asking different winemaking questions and comparing answers before and after playing the game. Results showed that a game of this type can leverage GBL learning principles to achieve the project goals, as a notable transference of knowledge was observed.

We conclude that while faced with limitations, this type of game makes a positive impact not only as a dissemination tool, but as a teaching tool if adapted further.

Keywords— Wine Making, Game-Based Learning, Cultural Heritage, Preservation

Resumo

A produção de vinho na Madeira é uma tradição antiga de grande importância cultural que existe há mais de quinhentos anos.

Estes processos são uma parte importante da história da Madeira, uma vez que a produção de vinho era e é uma tradição familiar praticada, muito pouco é feito para educar, divulgar e preservar estes métodos tradicionais, tanto para os locais como para não locais. Como estes métodos são considerados património cultural imaterial, sofrem com a falta de formas simples ou eficazes de preservação, mas como têm um grande valor cultural, precisam de ser bem preservados. Uma das vias bem-sucedidas para o fazer é a utilização de jogos sérios, que são jogos que se focam em ensinar o jogador, uma vez que podem utilizar a aprendizagem baseada em jogos para uma variedade de benefícios para o jogador.

Esta dissertação propõe a criação de um jogo com o objetivo de preservar e divulgar o processo tradicional de produção de vinho na Ilha da Madeira, orientado para a população local e não locais. Utilizando os princípios de aprendizagem da aprendizagem baseada em jogos, foram criados sete mini-jogos relacionados com diferentes etapas da produção de vinho, com o objetivo de utilizar a transferência de conhecimento para a divulgação desta tradição.

Posteriormente, para avaliar o seu sucesso, foram utilizados questionários como métrica, colocando diferentes perguntas sobre a produção de vinho e comparando as respostas antes e depois de jogar o jogo. Os resultados mostraram que um jogo deste tipo pode tirar partido dos princípios de aprendizagem para atingir os objetivos do projeto, uma vez que se observou uma transferência de conhecimento notável.

Concluímos que, apesar das limitações, este tipo de jogo tem um impacto positivo não só como ferramenta de divulgação, mas também como ferramenta de ensino, se for adaptado numa fase posterior.

Keywords— Vinificação, Aprendizagem Baseada em Jogos, Património Cultural, Preservação

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Acronyms

CH Cultural Heritage

GBL Game-Based Learning

RtD Research Through Design

1 Introduction

The process of making wine is said to be as old as the crop itself, as multiple civilizations hold records of its existence [6]. It consists in turning the grape fruit into wine and many of its steps that are often specific to the region that is manufactured on, but often revolves into broad steps as turning the fruit into juice, fermenting it and finally maturing the wine [7] [8].

For Madeira, just like its origin in the world, the process also seemingly started around the same time as the grape vines were planted in that region [9] [10]. Some records contribute to this hypothesis, showcasing that Madeira's wine industry was established in little over 20 years after people settled in the island [9] [10].

However, these local processes have not been well adapted or preserved in modern mediums, as it can become hard to find information about them unless one tries traditional mediums, like physical books, or word of mouth. Moreover, even less information can be found about the way different households used to, or still do their homemade wines. Due to the focus often laying with the commercial process, and different households naturally having different steps and processes, these family traditions run the risk of being lost if not properly preserved.

Processes like these are considered Cultural Heritage (CH), unique features of one's culture that defines those locations [11] [12]. It is then important to correctly preserve these processes for future generations. As defined by UNESCO, unique methods of traditional craftsmanship, such as the aforementioned wine making process, are considered to be intangible CH, which unlike tangible CH, are not able to be traditionally preserved or showcased [13] [14] [15].

The emergence of new technologies bring new possibilities to find better, more modern ways of preserving intangible CH. Some new methods that already have been tested include physical, technology augmented installations, but these fail to garner the attention of the modern audience [16] [17]. However, a more appealing avenue that also appeals to this audience is games, as they are able to immerse and engage the players while also effectively transmitting knowledge by using design methods to help knowledge acquisition [15] [11].

On such method is using Game-Based Learning (GBL) within the game. This term often has a variety of definitions depending on the context, and so it often is attributed with many different or clashing definitions [18], but the most aligned with this project, characterizes it as a method to use games as an activity to supplement the learning process [19].

Games can be used for teaching with great effectiveness simply by how games naturally work. They are able to make use of many learning principles that help knowledge acquisition

and retention, such as being able to go through the game at one's own pace and at their desired difficulty, the use of reinforcement and rewards to further motivate the player and the continuous and active testing of skills through a whole game [20].

Thus, when GBL is incorporated into games correctly, it leads to higher motivation and engagement with the content presented [19], as some have already demonstrated that it has been more effective over traditional methods, and even being used to aid in teaching school subjects [21] [19].

1.1 Dissertation Structure

This master's dissertation starts with the **Literature Review** section, which examines the current state of the art on wine making, cultural heritage and game-based learning to more accurately make design choices. Next, the **Game Development** section that focuses on the initial game concept, each mini-game early concepts and design choices. The **Game Design** section addresses the game's concept, its gameplay and how it flows. Next, **End User Evaluation** presents the protocol and measures, data analysis and the quantitative and qualitative results. Finally to conclude, there are the **Results and Discussion** and **Conclusion** sections.

2 Literature Review

This literature review section goes over the areas of research deemed important to research to best achieve the project goals. This section examines the history of wine making and its influence in the Madeira Island to understand the current preservation efforts, then a look on what Cultural Heritage is and methods of preservation, and finally Game-Based Learning as a method of knowledge preservation and dissemination.

2.1 Wine Making

Wine making, or Vinification, is the process of turning grapes into wine using various methods for the intended final product [7] [8]. These processes are said to be as old as the vine plant itself, since grapevine is one of the earliest crops that were cultivated by humans [6]. The knowledge that we have about wine and its process can be seen in various mediums and forms that were preserved through history, some examples are the Bible, where a passage in the Old Testament makes reference of planting grapevine and then proceeding to make wine [6], and Egyptian and early Roman civilization who crafted iconographic representations of not only people grape stomping but also of the winepress [*Lagar*](see Fig.1) [7].

Figure 1: Iconographic representation of Wine making in Nakht's Tomb. Photograph by Kenneth Garrett [1].

Although there is some variance in which steps or methods compromise the process of wine

making, it can often be summarized in three general stages:

Fruit to juice: At this stage, grapes are picked from the vines and then sorted, removing under-ripe and spoiled bunches out of the ripe ones and even cleaning salvageable grape bunches. Then these grapes are crushed and pressed to remove the juice out into a vat according to the desirable end product, as different methods of crushing and pressing are needed for different species of grape and different kinds of wine. Traditionally, this process was made with human foot-stomping for crushing the grapes, but this has long evolved to modern bladder-presses, as the need to produce more wine increased. At the end of this step, the pomace is removed from the juice [8].

Fermentation: The fermentation stage can be done in mainly two ways: Either by spontaneous or inoculated fermentation. In spontaneous fermentation, the wine uses the ambient yeast to ferment the juice, while inoculated fermentation is done by manually adding yeast to the product. Regardless of which method is used, due to the metabolism of yeast, sugars are converted into alcohol. The aftermath of this stage is insoluble material that rises up the liquid that must be removed, after which, the wine can settle and be stored for the final stage [8].

Maturation and Aging: In this last stage, the producer decides to either mature or age their wine. While commonly being used interchangeably, both terms are specific to the location where the wine is held in. Maturation is used when the wine is stored for a period of time in barrels or tanks, while storing it in bottles for an amount of time is defined as aging [8].

2.1.1 Wine making in Madeira

Madeira Island was discovered right after the start of the Portuguese discoveries and while the exact date for the plantation of the first vines is unknown, it is believed that the first settlers of the island brought them from Portugal and planted them, among other crops for trade [9] [10].

This is corroborated by historical records in around 1445, where an Italian navigator, Alvise da Mostro, also known as Luís de Cadamostro, relates the existence of grapevine already being planted on the island. These documents are valuable, as they show that after only 25 years since its colonization, Madeira Island had started exporting wine [9] [10].

Grapes were not the main focus at the time however, as sugar cane was the main economical export for its sugar, but as Brasil was competing in the sugar market, and an influx of British people established themselves in Madeira for the sake of wine commerce, the production of wine grew until it became the biggest source of regional wealth and its main agriculture activity [9] [10].

As the demand for Maderia wine grew, locals wanted to find a method to mature their wine

faster. After observing that wines that went through Ecuador and back to Madeira in the ships gained a special flavor and smell due to heat and swaying of the ships, the "*estufa*" was created to replicate this outcome. With it, the process of "*estufagem*" made it possible to artificially mature wine [9].

In terms of Madeira wine making process in this era, there has been a lack of information made available in modern avenues of knowledge dissemination. Word of these processes have spread through word of mouth or in older physical methods, moreover, since singular families also made their own wine for their own consumption, these process often differ from family to family and to the processes used for the commercial wine.

However, some cultural associations in Madeira still replicate and enact these processes as a cultural activity for the public. One such cultural association is Lírios do Norte, as they have documented one such recreation where people can follow the process in small videos [22].

The process shown begins with weeding out and pruning the vine, to ensure the best quality of grapes. The next step, after letting the vine sprout leaves, would then be to sulfate the vines, this was made with a traditional copper sprayer with the goal to ward off plagues, mainly what is colloquially known as *mangra*. After this, giant cane (*Arundo donax*) is cut and used as supports for the vine as to lift the grape bunches off the ground. After the grapes are ripe, using a trimmer and a traditionally woven basket, the grapes are then picked off the vine and cleaned. Having picked and cleaned the grapes, they would then be moved and stepped on in a winepress (see Fig.2). The pomace is then squeezed again using rope to get the most out of the grapes. Then finally, putting the juice on bags and funneling the juice in an wooden barrel, where it would stay until it has matured enough to be drunk [22].

2.2 Cultural Heritage Preservation

From the biggest countries to the smallest towns, a lot of history and unique cultures can be seen in each and every single one, as such, their CH is the culmination of their past history, ancestors, lifestyles and more, all of which hold great historical value which defines those locations' unique and diverse identities [11] [12].

One can divide CH into two categories: Tangible and Intangible. Commonly, when using the term, it is referring to tangible CH, which encompasses physical or material items such as monuments, paintings, artifacts or buildings, but it has since extended to intangible CH, which represents the uniqueness and diversity of a community [14] [15].

According to UNESCO, for CH to be defined as intangible, it must fall under one of the following [13]:

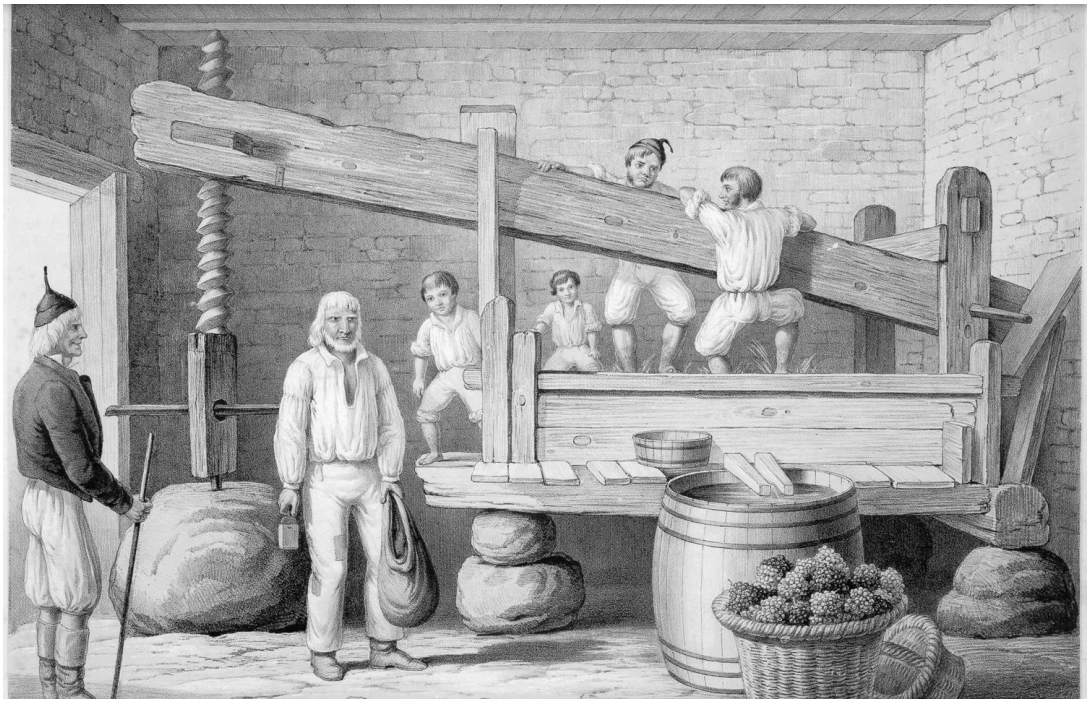

Figure 2: Lithography of a winepress, ca. 1843 [2].

- Oral traditions such as poems, proverbs, songs and more. Means of passing knowledge, social values and collective memories which is important to maintain cultures alive;
- Performing arts for instance playing instruments or singing, which reflect a culture's expressions;
- Social practices including rituals or festivities, as these reaffirm the culture's identity;
- Knowledge or practices concerning nature and the universe, for example knowledge about local flora and fauna or rituals, as these influence the set of values and believes of a culture;
- and finally, Traditional craftsmanship, where instead of preserving the end product (which would be tangible), one would preserve the unique method of creation for future generations.

2.2.1 Preservation Methods

Preserving CH has been a continuous process which has lead to numerous approaches with the shared goal of preserving one's CH to maintain individuality and empowering future generations with the knowledge and understanding of their own history and importance of their community in the world [15].

Unfortunately, due to changes in our society and technological developments, promoting traditional locations that disseminate CH, such as museums, face challenges in enticing the public. There might be multiple factors for this. The current channels for dissemination are limited and outdated which would already make it difficult to garner attention, but also how modern audiences show a lack of curiosity about these more traditional channels. A combination of these problems would then lead to a great difficulty in transmitting knowledge to the general public using these channels [16] [17].

Presently, to learn about one's tangible CH, they would have to visit a museum for its artifacts or historical sites, while intangible CH, traditionally, has been preserved in audio or video form. While traditional intangible CH preservation methods are good for documentation purposes, it leaves much to be desired in appeal [11] [14].

With the help of technology, some countries have been researching methods to archive CH digitally, and made able to explore new ways to preserve intangible CH as educational aids [14] [12]. However, if these perseveration methods are not sufficient or are inadequate, it can risk the loss of important details [15].

The emergence of interactive technologies, for example games, are an effective method that has successfully been used for CH preservation. Elements such as treasure hunts, interactive performances, methods for game-based knowledge acquisition, historical character dialogues, and virtual avatars promote and aid to a better visitors' experience and their learning process [15] [11]. There are, however, some issues with current CH applications or games that have education as its main focus. Most present the artifact objectively, much like a guided tour on a museum, which may emotionally disconnect the user with the artifact, ruining immersion [11]. Furthermore, virtual environments also possess unique problems [11] [14]:

- Realism may be misleading as it implies certainty about its environment;
- Certain records may result in subjectivity and misinterpretation of the environment or story;
- As cultures naturally interact and blend, it creates uncertainty about the roots of a culture;
- Some information may be recreated by data extrapolation, but it still requires one to know the traditions and skills of the past of said information;
- Past CH is a product of its time, and as such, some values or views may not be accepted in the present;

- and Intangible CH can only be defined as such when the culture is recognized.

2.2.2 Cultural Heritage Projects

In this section, a variety of other projects that have the main goal of preserving or disseminating CH in different methods and contexts are explored to better understand how to better design the contents of this thesis project. For this, keywords such as "Cultural Heritage Preservation", "Preservation of Culture", "Methods of Preserving Culture" were used on multiple search engines like Research Gate [23], ACM Library [24] and Google Scholar [25].

In an attempt to rekindle interest in traditional avenues of CH, such as museums, there has been an effort to make more interactive installations to showcase the CH in a more modern way that interests the current younger audience. One such example is the Vrouw Maria installation, about the titular wreckage of Vrouw Maria that was deployed at the Maritime Museum in Kotka in 2012 [3]. Due to the environment of the wreckage, a traditional visit is not available for normal visitors, as even experiences divers have difficulty in reach it. Thus, a virtual tour was designed to allow it to be conserved and allowing visitors to experience and learn about it (see Fig.3). This tour would allow visitors to interactively experience the wreckage while also navigating and learning the history about it. To achieve their goal, they designed the installation with certain features in mind: The use of real-scale graphics which were based on images and measurements from the wreck site; Gesture-based interactions; Info spots scattered on the site, offering further details about the wreckage; and sound design that fluctuates according to time and depth for increased immersion [3]. The results of this project showed a majority of the users finding the experience enjoyable and previous knowledge of users on the wreckage let them have a more immersive experience [3].

Another example is the Tinian Marble Crafts installation [4], an experience with the goal of promoting the heritage of Tinian marble crafts with the hopes of enhancing interest and engagement about the topic. As this installation deals with intangible CH, an interactive experience was made instead of a traditional exhibit, for the Museum of Marble Crafts in Tinos, Greece. In it, the visitor takes the role of a crane operator in a virtual quarry and must move marble volumes out of the quarry (see Fig.4). For this goal, a hands-on experience was made to enable visitors to relive how the quarry workers moved marble in the past and combining two museum's exhibitions for a playful learning experience [4]. When testing the learning effect, they found that participants that experienced their hybrid installation, showed an increase in gained knowledge about aspects of marble crafts due to its novelty and immersiveness [4].

Figure 3: Recreation of the Vrouw wreckage in a digital environment, displaying multiple UI elements [3].

In a different approach, there have been many games that were used as a method to show and disseminate CH, one of such is the Almeida Star Defense [26]. It was a project about the creation of a mobile game about a village in Portugal that holds important historical value for the nation. The game revolves around the events that took place in 1810 in Portugal, being the third French invasion and the player takes the role of a fictional plebeian archetype character that has been forced to join the war. The game aims to increase the involvement of tourists with the traditions of a location by using different mechanics and narrative to retell historical events through the visual novel genre. As they state, the visual novel genre would be an effective way to transmit all the information and feelings of the people of that era while also being an interactive method to learn about its history [26]. In terms of their results regarding knowledge transfer, it achieved a majority successful transference with 86% of participants correctly answering their questions [26].

Other smaller examples are Memorial Quest, a serious game, where the objective is to convey historical data with playful interactions. The player plays in the real world and can visit marked tangible CH for information about them and playing mini-games with the goal of conveying knowledge regarding those locations. Their findings showed a small increase in knowledge transfer by playing their game [27], and XiloVR, a Virtual Reality game with the goal of promoting woodcutting as intangible CH of Pernambuco. It explores the potential for education while providing a practical experience in the craft to ensure the preservation and transmission of knowledge to future generations. The game simulates the steps of the artistic

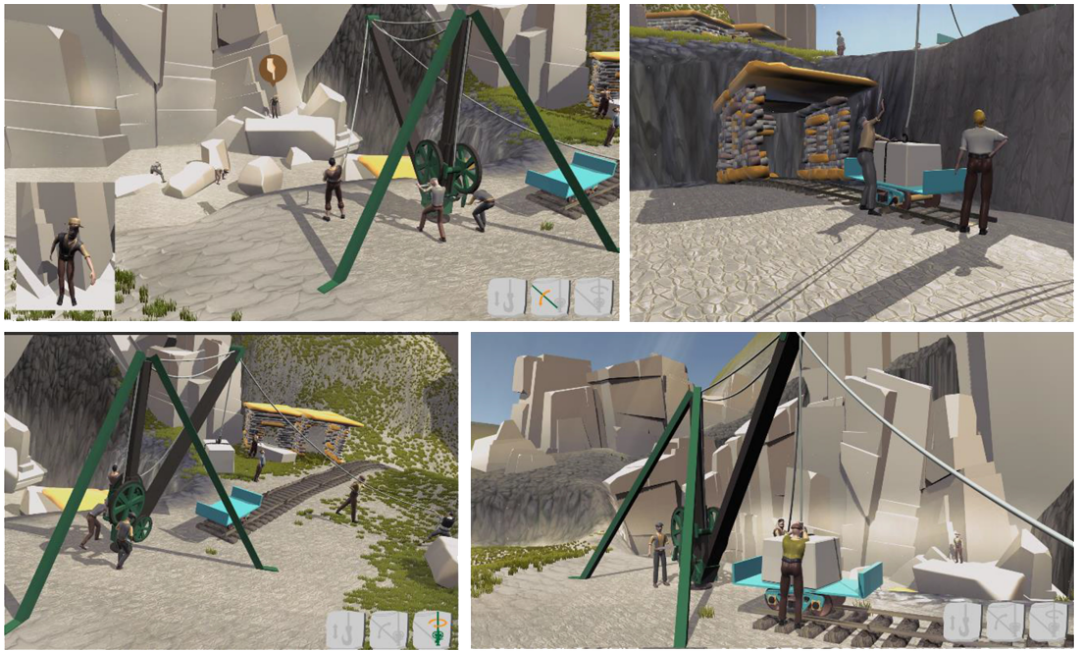

Figure 4: Various digital environments from the Tinian Marble Installation [4].

creation from woodcutting with the intent of creating a highly realistic experience which resulted in being well received by experts on the field as a possible good tool for teaching [28].

These projects can then be summarized in the following table (Fig.5. Table summary of the mentioned projects).

Name	Heritage Type	Project Type	Interaction Device	Goal
Vrouw Maria	Tangible	Instalation	Motion Controller	Preservation
Tinian Marble Crafts	Intangible	Instalation	Controller	Dissemination
Almeida Star Defense	Intangible	Game	Keyboard	Dissemination
Memorial Quest	Tangible	Game	Phone	Dissemination
XiloVR	Intangible	Game	VR	Dissemination & Preservation

Figure 5: Table summary of the mentioned projects.

2.3 Game-Based Learning

The term GBL does not have a consensus on its definition due to it being used in a variety of ways depending on perspectives or purpose [18].

Some researchers define it the same as "gamification" [29], being the use of game-like elements on non-game systems [30], while others view it as a method to use games as an immersive activity to further supplement the learning process [19], similarly to what "serious games" are, games focused on learning over entertainment [21]. This project will follow the latter definition as it would align with the previously stated objectives.

GBL, and in specific Digital GBL, has been a research topic with growing interest over the years in terms of its learning potential [18]. When properly utilized, incorporating GLB in non game contexts has led students being more motivated and incentivizing them to engage with the content [19]. Using Games as a vehicle for learning skills or information has been more effective over more traditional methods [21] [19], as such that, some games have been made and proven effective in teaching users a variety of school subjects. This happens because not only the medium is able to make use a myriad of learning principles [20], but also it provides learning pathways that are designed to enhance the user's learning behavior [19].

Game projects that contain GBL with the goal of transmitting knowledge, use learning principles that focus on engaging the user in diverse game situations while subtly teaching them. Games excel as an environment for teaching due to the nature of how a game works, as they naturally require the player to recall and perform prior learned knowledge to progress, provide immediate feedback to the player in a way that they can self-evaluate, are able to transfer that knowledge into other contexts, and also often contain communities around those games that players can interact and learn with [21]. There are also other, often unintended, benefits from games, such as being able to paying attention to multiple cues at once [20]. This then leads players to develop critical thinking skills and a heighten retention of knowledge [19] [21]. As previous work has put it, for the creation of digital learning games, there are four main factors that can be used to make it a positive learning experience: Critical thinking, collaboration, creativity and communication [29].

2.3.1 Learning Principles in Game-Based Learning

As previously remarked, GBL makes use of different learning principles that are important to understand to be able to effectively use GBL in games. Some of these principles go as follows:

- **Different difficulties:** The availability of different difficulties in games is arguably the most important principle for GBL. Everyone's learning speed if unique and so, a singular difficulty would in turn make learning difficult for a subset of users. By making multiple difficulties available, the user can learn at their pace [20].

- **Stress free environment:** A "low stakes" or stress free environment, gives users the chance of explore and solve problems, but more importantly, be free to make mistakes. In a low consequence environment, such as a game, this low penalty for mistakes usually improves user engagement [19]. However, challenging the user correctly is also an important factor for GBL, just as games normally have one difficult challenge a player must go

through to win, an appropriate challenge increases the user's enjoyment and facilitates the learning process [31].

- **Game difficulty increase:** A game's difficulty increases as the game progresses and often new knowledge requires the previous learned skills to be used, as such, unlike the traditional educational system, the knowledge and skills learned before are continuously being tested and refined. Moreover, these skills keep getting tested to the point of being "over-learned", as in, even after they are mastered, they are still required until it becomes so automated that requires little cognitive resources to be performed. Thanks to this, users would be able to focus and allocate their attention to new information in a more efficient way [20].

- **Learning as an active process:** In a game environment, the player performs tasks or skills and immediately gets feedback through the consequences of the game itself, and then keeps performing said tasks until they are able to master them. These tasks would provide the user with multiple experiences and contexts to apply the information that they have learned which would require them to understand that knowledge in more detail [29] [20].

- **Reinforcement:** A common method that games use to reinforce certain behaviors or actions is through rewards, and these can be classified as either intrinsic or extrinsic rewards. Extrinsic rewards are often already existing game features, such as points, but also more subtle rewards as flashy visuals for certain actions performed correctly, while intrinsic rewards are the ones that occur as a result of playing the game, such as personal satisfaction or a sense of accomplishment. However, these rewards are given periodically and not for every effort made by the user, as this helps bolsters the users drive to keep playing and progressing the game, resulting in users devoting more time into the game [20].

- **Knowledge transfer:** Information and skills learned in multiple different contexts become easier to transfer and be recalled. Having multiple cues to recall information makes it less dependent on the original context, which also means the user develops a more flexible and clear representation of the concept that can then be used in many new contexts in novel ways [20].

This dissertation then proposes the creation of an interactive and educational digital game, *Back Then In a Winepress*, where its main goal is to preserve the culturally significant family tradition of household wine making from Madeira Island while also with the intent of knowledge transference information of the wine making process. Designing the game using learning princi-

ples used by GBL, we hope to use a more accessible medium that is fitting for both preservation and fitting for learning information.

3 Game Development and Design

This game development section showcases the methodology used in the creation and the iteration process of the game. This section provides a look on how Research Through Design (RtD) was used to create an iteration focused workflow which helps to better understand key concepts and ideas [32], while also present the evolution of each mini-game through this method.

3.1 Game Concept

Back Then In a Winepress is a single-player serious game designed to preserve and disseminate the cultural heritage activity of wine making in ones household in Madeira Island. Its goal is to make an experience on a low stress environment where users ranging from teens to adults can learn about wine making in a more entertaining medium that is able to be shared and preserved with more ease.

The game was developed to cater to both teens and adults in an attempt to reach those who have not heard or practiced wine making so they can learn about the topic and to those who have, to relive those moments.

Originally, the game was designed to feature ten mini-games which would showcase different stages of wine making, starting from sowing and caring for the vines until the taking out of the barrel and wine tasting.

Furthermore, Madeira Island as a location, is also important to be properly represented, as such, various parts of the game have to showcase it, such as in the User Interface or even in Non-Player Character (*NPC*) attire, which they can be seen in Fig.6.

The goal of the game is for players to play around different scenarios of the wine making process and learn by extrapolating the mini-game objectives and actions as knowledge.

This goal, however, faces with multiple possible difficulties that need to prevented on its design stage. The risks stem from various areas such as:

- **Time Constraints**: The design and production of ten mini-games coupled with the project timeline would compromise the quality that can be put in each mini-game or even its completion.

- **Balance for Different Age Groups**: Large audience ranges where each side of said range requires different systems and preventions for better immersion and captivation in this medium.

- **Difficulty as an Inhibitor for Learning**: Difficult mini-games run the risk of boredom or early disengagement with the experience itself, which is more important when designing with such a large audience range in mind.

Figure 6: Traditional Madeiran outfits [5] (Left) with NPC colored models (Right).

To help mitigate these problems, the overall number of mini-games was reduced to seven, as the other three were more unrelated to the wine making process. This also helps to focus on which knowledge we intent to disseminate. Another precaution is a focus on GBL learning principles [20] being used throughout the mini-games to both make its goal to disseminate information in a more immersive way, but also make the game accessible to the large audience range. Finally, an assortment of design guidelines, such as simple objectives and mechanics and a lack of a fail state are used in every mini-game to facilitate the transference of knowledge and minimize any "quit out moments".

As per the chosen methodology, the progress from concept to finished game was iterative, doing continuous changes to reach the desirable end goal while understanding what are the best choices to keep improving the game.

3.2 Target Audience

As the goal of the game is to convey information to anyone who wishes to play it, the game aims to have a large target audience, and so, this broad spectrum of users lets us compare engagement and knowledge amounts of two different subsets within the audience: Locals and Non-Locals.

This project focused on these two subsets of the audience to draw conclusions for the game. As locals of Madeira Island, there should be a high innate knowledge of wine making processes

already, thus as most young adults or older may have participated in making wine themselves, a special look will be given to any users of lower age brackets (under twenty years old). Meanwhile, Non-Locals, often through tourism, learn about our wine, and so it could be of importance to test the effectiveness of other avenues of knowledge transference in this area.

3.3 Development

The development of the game was made using the Unity engine (version 2022.3.19f1) and additionally utilizing the support of plugins for visual coding, specifically Game Creator, with the game being made for computers with the Windows operating system. The choice for this tool pertains on the familiarity with its use and the availability of said plugins to better and more efficiently create the game.

As previously stated, the game is likely to face numerous risks. In consideration for these, the mini-games were designed with two considerations as their pillars:

- The mini-games will not have any fail condition;
- Each mini-game should give the player a rating for their performance.

The presence of a fail condition could give players a sense of frustration while also diminish the effectiveness of the dissemination of information. In accordance with the stress free environment learning principle from GBL, removing these conditions would therefore allow those specific players a more stress free experience and higher possibility of willingness to retry and minimize mistakes.

In another hand, the lack of a fail condition would lead the game being far too easy and without any re-playability. Based on another GBL principle, in this case reinforcement, players should have some way of gauging their performance in the game as an incentive to do their best. As a study has found, the use of something as simple as badges can lead to an increase in motivation. This representation of skill does not particularly need to have a practical value to the users, but its simple existence motivates the user into trying their best to score the best results [30]. Adding a rating at the end of each mini-game would therefore give players a goal that they can strive to achieve if they so want, while also allowing them to optionally restart the level until they get their desired rating. A simple rating using stars was then chosen for the game, as it is a familiar shape for this system in other games, and should therefore be easily understood.

3.4 Game Stages

As spoken previously, the steps are often dependent on the specific household and thus there is not a "one set of steps" that can be chosen. Even so, the most important and recognizable set of actions begins at harvesting the grapes till the fermentation stage, and so, the mini-games will be set within this frame of reference.

In addition to the previously mentioned considerations made for the possible risks, every mini-game is further designed with two more GBL learning principles in mind: Leaning as an active process and Knowledge transfer.

As explained in the literature review section, since learning in games is an active process, the player is able to learn and receive feedback of their performance just by playing the game. Experiencing the mini-games would then, subtly teach these wine making stages without the need for a large text volume.

This also goes in tandem with Knowledge transfer. While the mini-games theme would teach the player the steps of wine making, the tasks of said mini-games would give the player different contexts to use already learned skills, like math, logic solving or reflexes to create more cues to remember the game, which then would increase the success chance of disseminating this knowledge.

The game has a total of seven mini-games in the following order:

3.4.1 Catching Grapes Mini-Game

For this initial mini-game, there were two concepts developed, as shown in Fig.7. The first concept put the player in control of pruning shears and they would need to find scattered grape bunches hidden in the grapevines. They would need to use their free arm to hold branches but also remove or move leaves, so they would have to choose the order of actions to gain access to all the grapes. The second concept instead presents the grapes that are required to cut, but the player also controls a basket at bottom on the screen using the keyboard.

After considering both of the concepts, the latter concepts was chosen, as it was the more mechanically simpler of the two. However, the concept was then expanded to increase play time and subtle environmental knowledge transfer. The number of stages on this mini-game was increased from one to three, while making the basket slide on the screen automatically and also increasing the speed that the basket moves slightly as the stages increase, furthermore, adding a cutaway after each stage completion, where the camera pans upwards and shows a scene of NPCs harvesting grapes in old traditional Madeiran attire.

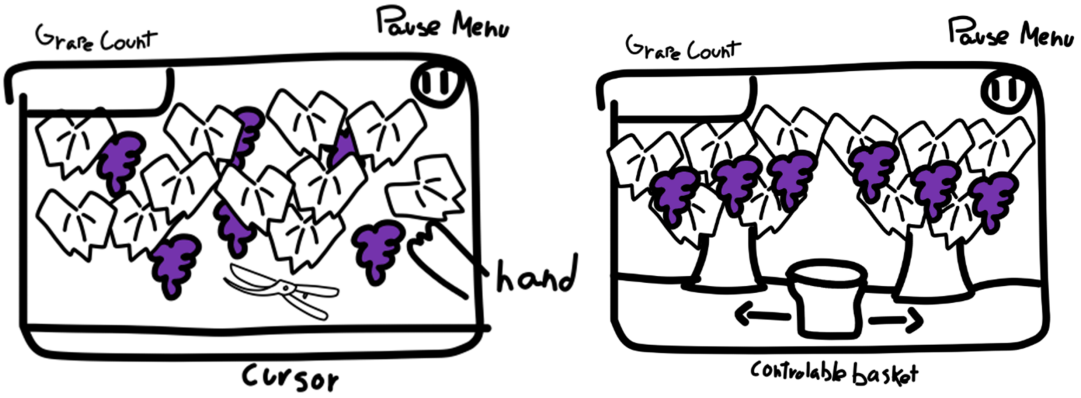

Figure 7: Concept Art for the first mini-game.

These changes were based both on observations throughout the iterations and the first testing phase of the prototype. The overall feedback of these showed us that the original mechanics made the game too slow and not very enjoyable, so a slight increase in challenge for the player would help immerse them while also help tie in the Madeira island connection at the time as the mini-game resets and prepares the next stage.

3.4.2 Removing Rot Mini-Game

As for the second mini-game, only one concept (Fig.8) was iterated upon. Originally concepted as the player being presented a grape bunch that can rotate with the mouse to locate any part of it being either rotten or bitten by wild animals. The mini-game would then give the player more grapes with the removable parts randomized.

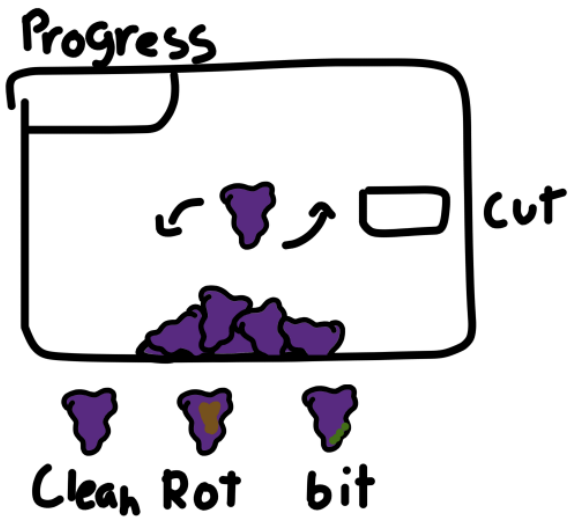

Figure 8: Concept Art for the second mini-game.

During the iteration process however, the rotation system had to be changed due to implementation difficulties, being later replaced by a keyboard based one. Additionally, the number of grapes needed to clean before mini-game completion was increased, and NPCs were added in the background doing the same task as the player.

Through iterations, observation, and internal testing, these changes were made to strengthen the core of the mini-game and further show its ties to Madeira island.

3.4.3 Filling the Winepress Mini-Game

For this mini-game another two concepts were developed (Fig.9), the original concept involved the player to choose a correct shape that is missing on a basket and drag it to make it a full picture. This would then move the basket and drop its contents inside the winepress and a new one would appear for the player to continue.

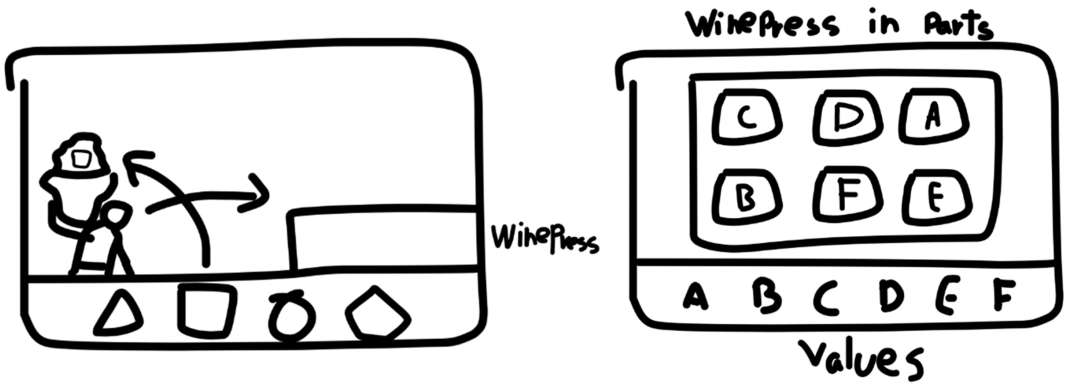

Figure 9: Concept Art for the third mini-game.

During the first testing phase however, this mini-game was badly received with a variety of problems, such as being too slow in the order of operations which then gave the players a period of "dead time" that often made the players zone out. Other issues raised were, even with slow animations, the game felt far too short and the difficulty far too easy. All of this resulted in the decision to give a total rework to this mini-game.

After considering what to avoid by using player feedback, the new concept for this mini-game was developed to be a math puzzle. Players are presented with various baskets with grapes that are filled in different percentages and a top view of the winepress with locations that are also already filled with a certain amount of grapes. The players then has to drag the correct basket to the correct location to completely fill the winepress to 100%.

3.4.4 Stomping Grapes Mini-Game

In this mini-game, the concept developed was of a moving foot that moved left to right on top of the screen with the player being able to control it to drop it down into the winepress, as seen on Fig.10. Inside the winepress would be multiple moving grape piles and the player is tasked to drop the foot on these piles to slightly stomping them.

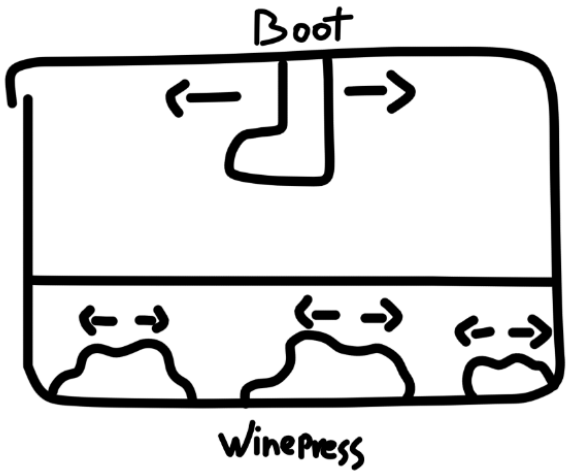

Figure 10: Concept Art for the fourth mini-game.

As the testing phase and observations resulted in positive reviews, this concept remained unchanged during the iteration phase, but slowly improved with better visual consequences for actions, such as grape juice building up when a grape is stomped, and a detection system for which direction the foot should continue after being triggered. These changes resulted in a more refined and polished mini-game early on, leaving more time to sort and optimize the order of actions for this mini-game.

3.4.5 Smashing the Pomace Mini-Game

For this next mini-game, before the concept could be fully planned, the pressing method had to be decided between using ropes or a lever system. Both were used traditionally, however, they also depended on the household traditions. Due to personal familiarity with the lever system, it was ultimately chosen for this mini-game.

As shown in Fig.11, the concept then requires the player to move stones into the scale of the lever to drop and exert force into the pomace. It challenges the player in three stages that slightly shrink the scale size while also requiring more stones to successfully finish each stage.

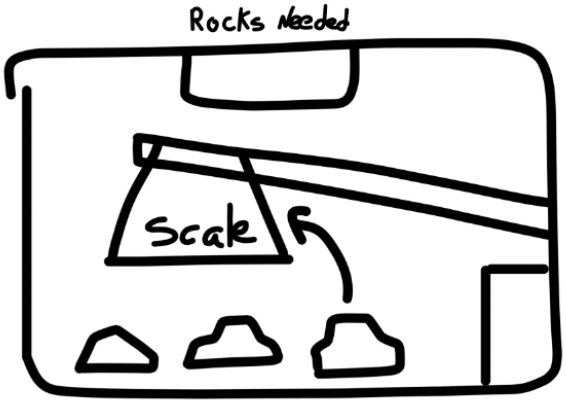

Figure 11: Concept Art for the fifth mini-game.

While the testing phase feedback was positive, some observations were made that required the mini-game to go through more iterations. Most notably in the last stage of the mini-game, the time to completion spiked compared to the first two. While player opinion was often that the stage was fun, some showed frustration dealing with stones often falling off the scale.

To alleviate some of the frustration, the stone collider was changed from a cube to a rectangular cuboid as it would allow for less bounce and higher drag between them, the scale in the last stage was made slightly larger, and giving the scale a protrusion on each side to better keep the stones.

3.4.6 Filling the Keg Mini-Game

Originally, this mini-game was conceptualized as math puzzles that the player must solve to beat the mini-game. The questions would task the player to figure out how much sugar to add per amount of liquid juice given different ratios by selecting the correct answer between multiple choices. These questions would be easy enough that could be done without the need of a calculator.

However, during the iteration process, a contextual problem was observed. The correct answers were numbers far too unrealistic or too big. While this could be dismissed as being simply a game, we rather keep the game grounded in reality as much as possible, and as such, changes had to be made to this mini-game. After considering possible paths and implementations, it was decided to fully rework the mini-game to a new concept, as seen in Fig.12.

This new concept consists in the player looking for sugar bags to pour inside the keg. The players screen would have the view of a keg room with interactables scattered across it that can potentially hide the sugar bag. The player has to find sugar bags in three stages for the

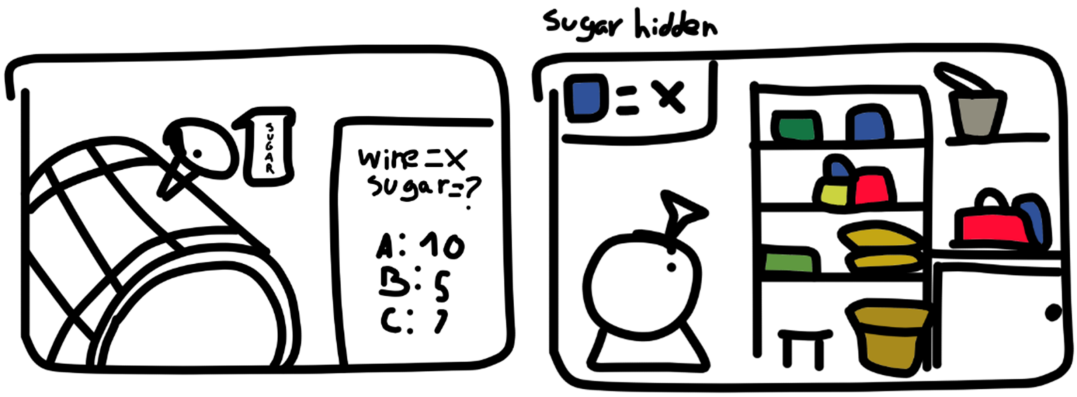

Figure 12: Concept Art for the sixth mini-game.

completion of the mini-game.

3.4.7 Fermentation Mini-Game

For the final mini-game, the concept chosen was putting the player in control of a yeast cell with the objective to collect sugar grains to ferment the wine, all the while avoiding ethanol molecules (alcohol) as seen in Fig.13. When collecting sugar, alcohol would spawn in the area and would slowly walk towards the player, as a tie in to the real fermentation process.

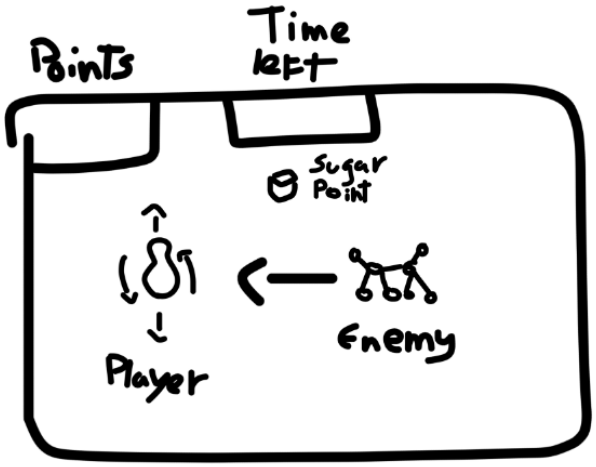

Figure 13: Concept Art for the seventh mini-game.

From observations, the implementation of a randomize system for both the point (sugar) and enemy (alcohol) spawn systems proved challenging, as they worked in isolation, but brought problems when running simultaneously. This was further apparent during the testing phase, where multiple instances of system breaks happened.

During the iteration phase for this mini-game, various measures were taken to reduce these issues, such as reducing and reorganizing the spawn locations for both the enemies and points and creating a system to force the enemies to be kept inside the playable zone. These changes kept being polished until the final game to minimize most of the problems encountered.

3.5 Gameplay

In this section, the game flow and gameplay will be explained in detail. The game can be describe to have a circular flow, where the player has control to either choose a specific mini-game to play any amount of times, or go through all of them in order until they are satisfied. A simplified diagram of the flow is displayed in Fig.14.

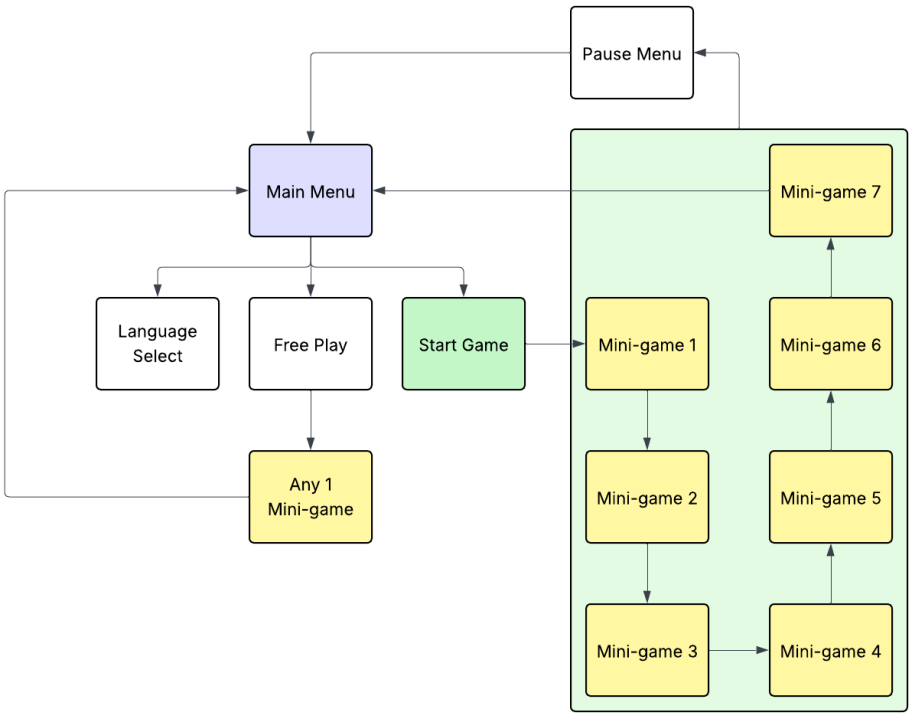

Figure 14: Flow Diagram of the game progression in a session.

An average play session of the game would go as follows: On game start, the player is presented with the main menu which holds multiple options (see Fig.15):

- A language setting which can change the game language from and to Portuguese and English;
- A credits window that showcases the makers and origin of assets;
- A free-play screen where players can replay a mini-game in specific;

- The start game button where players can get the whole experience while being graded at the end.

Figure 15: Main Menu of the game.

By clicking on start game, the game fades in to fully load the first mini-game before showing the screen to the player, and then fade out when the scene is ready.

The screen then presents the player with a vineyard filled with grapes with the stage name, objectives and controls for the first mini-game: *Catching Grapes*. In the objectives, a small section explains the purpose of the stage in the wine making context and provide a small curiosity about it. When has read the objectives and controls, they can click on the start button to begin playing the mini-game. This segment is true for all mini-games (see Fig.16).

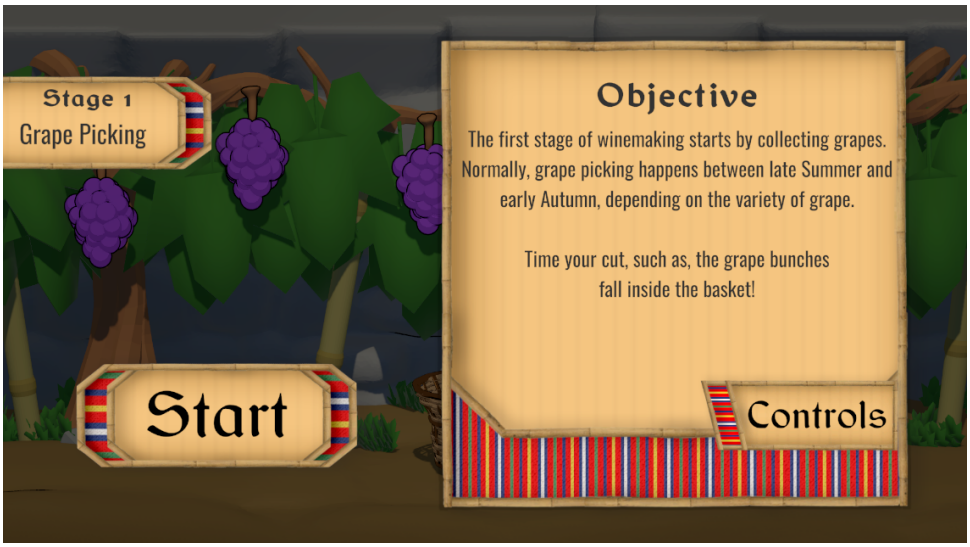

Figure 16: Example of start screen of every mini-game.

The mini-game (Fig.17) consists of three stages, each requiring the player to cut six grape bunches and make the fall inside of a moving basket. In each stage, the basket moves slightly faster, requiring the player to predict their cut with a greater focus, in the first stage, if we consider the initial speed on this stage as 1, the second stage increases the basket speed to 1.1 while the third increases it to 1.25.

Figure 17: Mini-game 1: Catching Grapes.

Sound cues are given to the player depending on their performance during gameplay, such as positive sound effect for any grape successfully caught or a grape squash sound effect if not. Furthermore, after a stage completion, a pause is made, where the camera pans upwards showing NPCs harvesting grapes, to witness the action they are currently doing and to give a small break to the player.

By the end of the third stage, as shown in Fig.18, a completion screen is shown to the player where they are able to get a rating based on how many grapes they successfully caught. The rating goes from zero stars to three stars, where the more grapes caught, the more stars the player can get. The star amount goes as follows:

- **0 Stars**: Grape bunches gotten is 5 or less;
- **1 Star**: Grape bunches gotten is between 6 and 11;
- **2 Stars**: Grape bunches gotten is between 12 and 17;
- **3 Stars**: Grape bunches gotten is 18 or more.

By continuing to the next mini-game, as seen in Fig.19, the player is presented the mini-game objectives and title: *Removing Rot*. The setting takes place on the outside of a home and

Figure 18: Example of the end screen of every mini-game.

a vineyard, with NPCs also cleaning grapes in the background. The objective of this mini-game requires the player to rotate grape bunches to find any segment that is rotten or bitten and then remove it.

Figure 19: Mini-game 2: Removing Rot.

The player has to process a total of six grapes until the mini-game is completed. The mini-game difficulty does not increase with each grape, but the locations of the removable parts are in different locations per each grape.

After the last grape bunch is cleaned, the completion screen is displayed and their rating is given based on the time to clean all six grapes. The star amount is tiered as follows:

- **0 Stars**: Took more than 81 seconds to finish the mini-game;

- **1 Star**: Took between 71 and 80 seconds and to finish the mini-game;
- **2 Stars**: Took between 61 and 70 seconds and to finish the mini-game;
- **3 Stars**: Took less than 60 seconds to finish the mini-game.

The subsequent mini-game, *Filling the Winepress*, is then shown to the player, placing them inside a winepress in a top-view, where multiple grape baskets can be seen as well as multiple locations with different numbers (see Fig.20). The objective is to drag the correct basket that holds a certain percentage into one one the slots in the winepress to add them together to a 100% total.

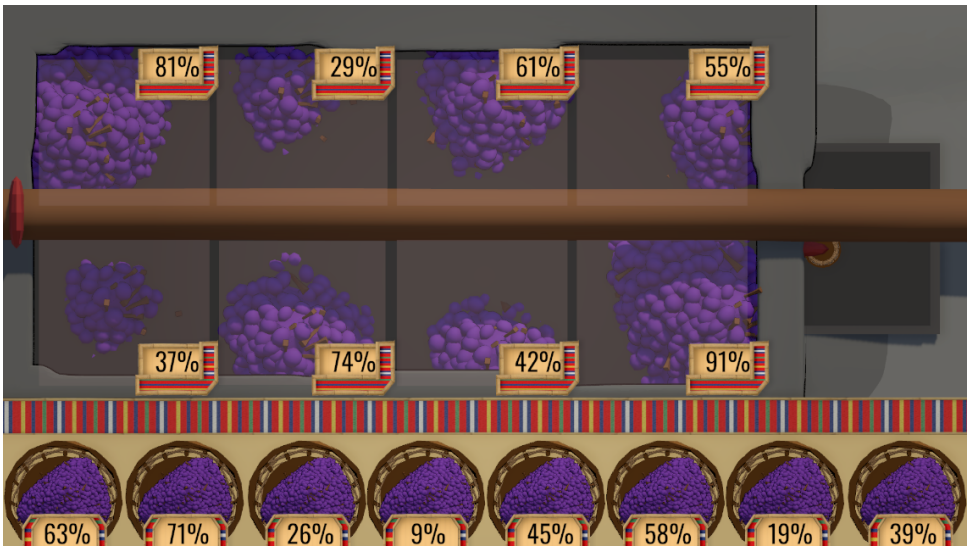

Figure 20: Mini-game 3: Filling the Winepress.

If the player does not drag the correct basket into the right area, the basket returns to its original space while a correct one would give a sound and visual cue that lets the player know that their choice was correct while also dynamically raise the amount of grapes to close the specific winepress area.

When all the areas in the winepress are completely filled, the completion screen is brought up and a rating is displayed based on the amount of time taken to fill the winepress. The star rating is divided in the following way:

- **0 Stars**: Took more than 81 seconds to finish the mini-game;
- **1 Star**: Took between 71 and 80 seconds and to finish the mini-game;
- **2 Stars**: Took between 61 and 70 seconds and to finish the mini-game;
- **3 Stars**: Took less than 60 seconds to finish the mini-game.

Moving towards the next mini-game, being *Stomping Grapes* (Fig.21), the player is set on a side view of a winepress with grape piles inside it and a foot that is positioned at the top of the screen. The player objective is to smash all of the piles to create grape juice.

Figure 21: Mini-game 4: Stomping Grapes. (No Wine)

Figure 22: Mini-game 4: Stomping Grapes. (With Wine)

While the foot automatically moves from left to right automatically, the player is able to action it to drop down into the grape piles to smash them. After the foot is triggered to drop down, the automatic movement will resume its direction to the right, if triggered on the left side of the screen, while it returns to the left if triggered on the right.

Each successful smash will decrease the size of the grape pile while also raise the juice level inside the winepress. When all the piles are gone, the mini-game ends and the completion screen

is shown, with the rating based on the amount of time taken to smash all the grape piles. The ratings are shown as it follows:

- **0 Stars**: Took more than 71 seconds to finish the mini-game;
- **1 Star**: Took between 61 and 70 seconds and to finish the mini-game;
- **2 Stars**: Took between 51 and 60 seconds and to finish the mini-game;
- **3 Stars**: Took less than 50 seconds to finish the mini-game.

The next mini-game presented is the *Smashing the Pomace* (Fig.23). The player is presented with a level system on the side of a winepress. A wooden beam has a scale for rocks and a total of seven stones are provided. The objective is for the player to stack enough stones each stage to smash the pomace.

Figure 23: Mini-game 5: Smashing the Pomace.

The mini-game is divided in three stages, each requiring more rocks to be placed in the scale while also reducing the scale size slightly. In the first stage, the player needs to place four rocks on a default size scale. In stage two, a total of five rocks are needed to be placed on a scale that is roughly 10% shorter than default. As for the last stage, the player needs to place all seven rocks in the scale that is approximately 25% smaller than default.

The player can move the rocks using the cursor by dragging them around the screen and they possess gravity, so the player must stack the rocks effectively to manage to get all required rocks on the scale. On mini-game completion, the player is rated based on the amount of time that it took to complete the mini-game. The rating grades is as it follows:

- **0 Stars**: Took more than 181 seconds to finish the mini-game;
- **1 Star**: Took between 151 and 180 seconds and to finish the mini-game;
- **2 Stars**: Took between 121 and 150 seconds and to finish the mini-game;
- **3 Stars**: Took less than 120 seconds to finish the mini-game.

As for the next mini-game, *Filling the Keg*, takes place in a room holding the keg and other tools with many interactable objects that are scattered in the area, as in Fig.24. The objective is for the player to find sugar bags to pour them in the keg.

Figure 24: Mini-game 6: Filling the Keg.

This mini-game features three stages that are completely equal, but the sugar bags are in different locations. After going through all three stages, the player is given a rating based on the amount taken to find all the sugar bags. The star rating given is based on the following criteria:

- **0 Stars**: Took more than 151 seconds to finish the mini-game;
- **1 Star**: Took between 141 and 150 seconds and to finish the mini-game;
- **2 Stars**: Took between 131 and 140 seconds and to finish the mini-game;
- **3 Stars**: Took less than 130 seconds to finish the mini-game.

For the last mini-game, *Fermentation* (Fig.25), the player takes the role of a yeast cell inside the wine keg. The objective for the player is to collect the randomly spawning sugar in the liquid to ferment the wine.

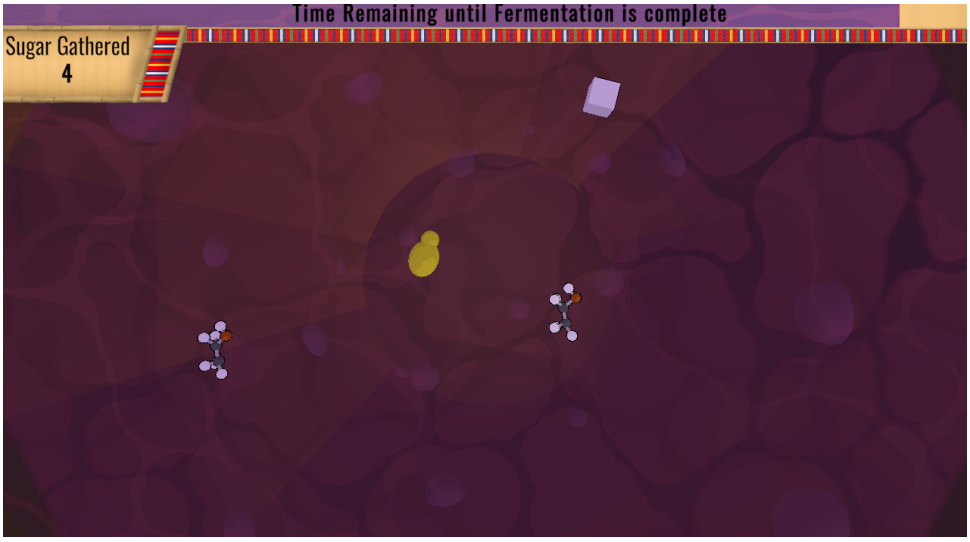

Figure 25: Mini-game 7: Fermentation.

During the mini-game, by collecting a sugar, it has a chance to spawn an alcohol molecule. These molecules act as enemies, as in real fermentation, yeast cell produce alcohol by processing the ambient sugar, but then would destroy the yeast. In the mini-game however, getting hit by an alcohol molecule will not destroy the player yeast cell, only reduce a point from the end score.

After a total of three minute play time, the fermentation is considered done and the mini-game ends, which then a rating is given based on the total sugar collected by the player by following the following amounts:

- **0 Stars**: Sugars gotten is 8 or less;
- **1 Star**: Sugars gotten is between 9 and 14;
- **2 Stars**: Sugars gotten is between 15 and 18;
- **3 Stars**: Sugars gotten is 19 or more.

Upon completing every mini-game, the game moves to the score scene where the game calculates the players final score by adding the amount of stars from all mini-games. An outside scene is presented with the view of the top of a table, and by showing the results, a wine bottle drops and the overall rating of the game is given as shown in Fig.26.

Each star amount is worth a different amount of final points. Zero stars in a mini-game is worth 1 final point, one star is 2, two stars is 3 and three stars is 4 final points. As such, the maximum amount of final points possible is 28. These final ratings have names characterizing how well the player made the wine and follow this amounts:

Figure 26: Result screen.

- **Subpar Wine**: Total amount of final points is 13 or less;
- **Average Wine**: Total amount final points is between 14 and 20;
- **Good Wine**: Total amount final points is between 21 and 27;
- **Fantastic Wine**: Total amount final points is 28.

Upon then receiving their rating, the player may choose to continue playing in the stage mode, or choose to replay a certain stage using free play mode.

4 End User Evaluation

This evaluation section had as a major goal the determination of the effectiveness of the game to fulfill its objectives, namely of CH preservation of wine making traditions and its dissemination, using the medium of a video game as a method to better interact, maintain and distribute these traditions. This section seeks to provide an overview of the user study, including its design, protocol, and metrics, finishing with an overview of their procedure.

4.1 Study Design

This evaluation was made in two phases: An early one, in the prototype stage of game development, where only qualitative data is gathered using informal interviews to judge early enjoyment and mini-game potential, and a second one where these concepts are tested using quantitative and qualitative data using a Pre-Test & Post-Test design of data collection. This multi-method collection of data enabled us to understand the strong points of the game and its concept and help finding areas of improvement.

Furthermore, to determine if the game objectives were successfully attained, the study focused and was built around testing two main concepts: *Knowledge Transfer* and *Enjoyment*. These concepts served to measure different areas about the game:

Knowledge Transfer:

Knowledge Transfer is evaluated to determine the success of the game, the forms (only applicable for the testing phase 2 forms) include seven questions about the wine making process that are formatted as multiple choice questions. As each mini-game is themed about a specific step of the wine making process, each question is related to each mini-game. These questions are asked twice in the forms, once before the tester tries the game and once more after. This way, it is possible to determine the immediate result of the game. However, due to some regions of mainland Portugal and some foreign countries also being known for their wine, this data might become skewed. As such, when evaluating the effectiveness of this concept, these regions will be treated differently.

Enjoyment:

Enjoyment is evaluated to determine the overall quality of the game. In both phases, forms include questions, adapted from the Mike Compton evaluation metric [33], where the tester rates a game on perceived clarity of use, flow of the game, how balance the game feels, if the game's

duration was appropriate, if the theme and elements were integrated in a satisfying manner and the tester's fun with the game. These questions are quantified using a smaller measurement scale, such as the Likert scale, quantifying the answers between 1 (strongly disagree) to 5 (strongly agree).

4.2 Protocol and Metrics

This subsection will outline how the data was gathered and then processed to assess the game's design, enjoyment and ease of knowledge transference. The multiple methods of data collection encompass the following data:

- **Quantitative Data**
  - **Pre & Post Questionnaires:** To determine the users baseline knowledge on the topics shown and knowledge transference rate after playing.
  - **In-Game Metrics:** To assess player performance, using ratings at the end of each mini-game.
- **Qualitative Data**
  - **Observations:** Researchers noted any comment made about the user's experience and difficulties that they may have struggled with.
  - **Informal Interviews:** At the end of the testing period, an informal interview was made to better understand the user's experience in a less formal setting. This open-ended and casual conversation often gave more honest and nuanced views than would be lost in the Post-Questionnaire.

These tests were done one on one to reduce performance stress on the user and for easier data tracking, and the examiner will be non-intrusive while tracking behaviors or comments made by the testers.

4.3 Testing Phase 1: Prototype Stage

The first testing phase, as previously mentioned, consisted in only gathering qualitative data on the game while in its prototype state with the goal of understanding early opinions and gather feedback on the game to then further iterate each mini-game. This phase was done with a final

total sample size of 7 participants, 5 male and 2 female, who were directly approached and no remuneration was given for participation. This testing phase progresses as displayed on Fig.27.

The selection of participants was based on willingness to participate in the study, the know-how of playing computer games and availability for the study itself which lasted for around 15 minutes.

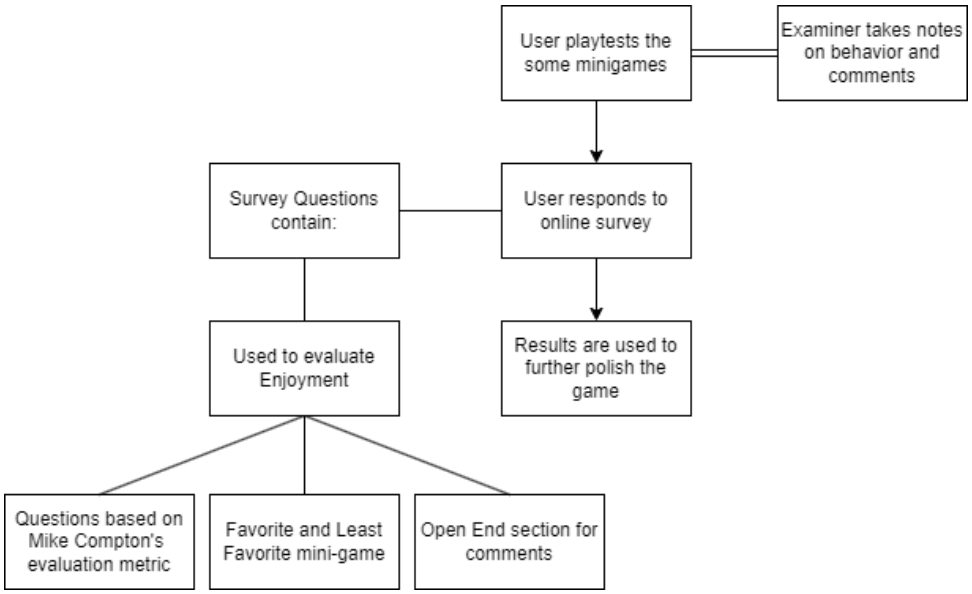

Figure 27: Diagram of Testing Phase 1.

On the arrival of the participants, the play-test session was then explained, focusing on the order of operations for the session and reiterating the early stage of the prototype to the participants. After giving the necessary information to the participants, the researcher took a less involved role, only explaining the controls and objective of each mini-game, as they were not present at the prototype stage, and listen and responded to any inquiry the participant might get during the experience.

During the experience, the researcher took notes about their observations. These included notes about participant passing comments and mood during gameplay, any flaw in the game's system, time taken per mini-game and general difficulties that participants had with the system mechanics or controls. Participants experienced the prototype on a laptop provided by the researcher.

After finishing playing the prototype, participants were asked to fill a feedback form. This form contained questions regarding qualitative aspects of the game to better understand which mini-games worked to the benefit of the game's objective and which ones require more iterations. A Likert-scale with five total levels ranging from "Very Bad" or "Long" to "Very Good" or "Short" was used to assess the following questions:

- 1) How clear were the objectives and instructions of each mini-games?;
- 2) How would you overall rate the controls?;
- 3) How fair did the overall game feel?;
- 4) How would you describe the overall length of the mini-games?;
- 5) How well did the themes of each stage match the mini-games?;
- 6) How fun would you rate your experience with the overall game?.

Furthermore, multiple choice questions were asked regarding more aspects of the game, asking which mini-games felt that needed more changes in the future. The participants were asked the following, being able to nominate multiple mini-games:

- 1) Which mini-games did you feel had unclear objectives or instructions?;
- 2) Which mini-games did you feel had bad controls schemes or controls felt unresponsive?;
- 3) Which mini-games did you feel unfair?;
- 4) Which mini-games did you feel did not last an adequate amount of time?;
- 5) Which mini-games had a bad match with its theme?;
- 6) Which mini-games were not fun?.

Finally, after the form was completed, an informal interview was conducted to further understand the participants feeling about the game on a less formal setting. This interview focused on more general opinions on the game, asking potential additions or changes that participants would like to see in the game. This less formal environment was helpful to get more truthful and nuanced opinion from participants which will bring a more broad view on which systems work and what the audience is looking in a game like this.

4.4 Testing Phase 2: Final Game

In the second testing phase, both quantitative and qualitative data was gathered with the goal of determining if the project goals were met and what was the reception of a game like this.

This phase was concluded with a total sample size of 17 participants, of which the majority were male at 14 participants, and majority Europeans between the age of 19 and 35. As similar to the Phase 1 tests, the participants were directly approached or by doing public posts in different internet communities, and no remuneration was given for participation.

The selection of participants was based on willingness to participate in the study, and availability for the study itself, which could take between 13 to 17 minutes. This testing phase progresses as displayed on Fig.28.

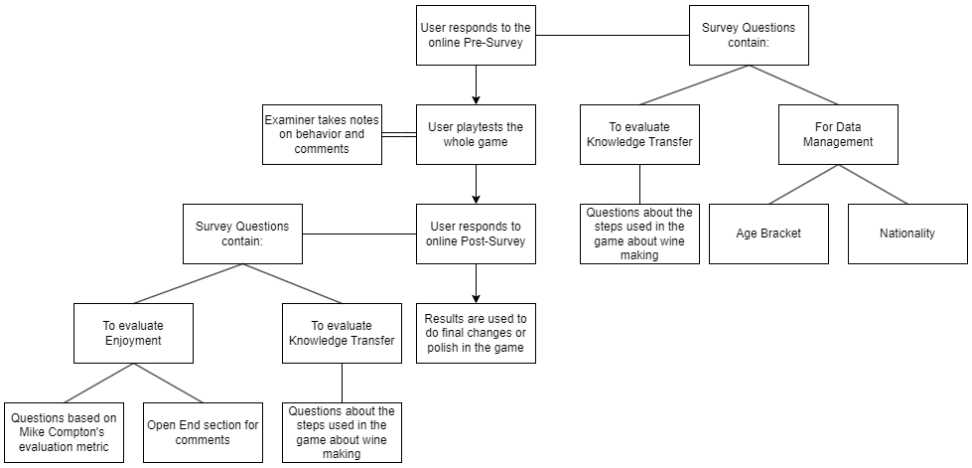

Figure 28: Diagram of Testing Phase 2.

Before beginning the playtest, a summary of the purpose of the game was given to participants and then they were asked to fill in a questionnaire (Pre-Questionnaire). This questionnaire contained questions regarding the participants demographics, habits and preferences in games, and questions about winemaking, which include if the participant has ever tried to harvest grapes or made any wine before.

The questions regarding demographic were made as to understand if participants live or interacted with winemaking as a whole. Traditionally in Madeira, when families made their household wine, children also help the adults in picking grapes and sometimes stomping them for juice. Furthermore, certain regions around the world are also known for their wine, so understanding if the participants are already familiarized with this topic would allow us to avoid misinterpreting the knowledge transfer data.

As for questions regarding gaming habits and preferences, these are to know how well do participants know and understand common game aspects (such as points or implicit movement control keybinds) and their game genre preferences. Knowing how familiar participants are with games can let us know if different game familiarity can impact how knowledge transfer success, while knowing which types of games participants enjoy or dislike could let us know why some mini-games were more or less favored than others.

Finally, the questions regarding winemaking are used to test the participants' current knowledge of winemaking. An important question asked first is whether the participant has ever taken part in harvesting grapes or making wine. This question lets us know if the participants' knowledge was actively (learn by doing) or passively (learn by reading or watching) gotten. As for the

other winemaking questions, these are various questions about the steps to make wine, and are used as the benchmark to gauge the participants' knowledge before engaging with the game, as these are later asked once more. The following questions are the ones asked for the winemaking section:

- 1) At which time of the year do we harvest grapes?;
- 2) Which ones of these is not a Madeiran variety of Grape?;
- 3) How many grapes does it take to make a single wine bottle, on average?;
- 4) Why is there still some wineries that still use the traditional grape stomping method of crushing grapes by foot?;
- 5) What happens to the pomace right after the grape stomping?;
- 6) Why would you add sugar to the wine before fermenting?;
- 7) What breaks down the sugar into alcohol in the fermentation process?.

Once the participants have completed the questionnaire, they got access to the game, and the researcher took on a spectator role where they would not aid the participant unless strictly asked by the participant or a game-breaking issue arose. During the playtest, the researcher took notes about their observations. These included notes about participants' methods to complete the or interact with the different mini-games, any comment made by the participant regarding the game and time taken to fully complete the game. For these playtests, participants could choose to use a laptop provided by the researcher or use their own.

After completing the game, participants were then asked to fill in a second questionnaire (Post-Questionnaire). This questionnaire asked question about qualitative aspects of the game and the same winemaking questions from the first questionnaire. Questions about the qualitative aspects are asked to provide the researcher with a degree of certainty on the game's quality. A high quality game would help in the project's objective of knowledge transfer and dissemination and as such, to quantify the game's quality, questions are answered using a Likert-scale with five total levels ranging "1" to "5" on the following questions:

- 1) How clear were the game objectives?;
- 2) How well would you rate the game controls?;
- 3) How would you describe the length of the game?;

- 4) How well do you think the game matched with the winemaking theme?;
- 5) How would you rate your overall experience with the game?;

In addition, a question asking which mini-games did participants' enjoyed and disliked the most was asked, including a facultative open ended field to justify the choices, and another open ended field for any other comment that the participant might have, to determine which mini-games genre or structure benefited more to the projects objective.

As for the winemaking questions, as mentioned before, these are the same questions made in the Pre-Questionnaire. These questions would let us see if any knowledge was successfully transferred correctly in the game.

Finally, after this questionnaire was completed, an informal interview was also conducted to further ask the participants about their feelings on the game in a less structured and less formal setting. This interview touched upon more subjective feelings or suggestions that participants had about the game which would be harder to quantify using the questionnaire. This type of interview was helpful to better understand what participants felt about the game, as most were much more open when outside the formal playtest experience.

5 Results and Discussion

This discussion section will look at the results from the User Evaluation and discuss the project goals and reflect about its performance by using the user's evaluation results to determine on how successful it was. Furthermore, we will consider which factors benefited or limited the game's reach or educational value and suggest improvements or considerations for future educational games.

This section will have a bigger focus on the dissemination goal, as this project itself is a method of preservation similar to F. Gao's "*Spirits of Artifacts*" [11] or S. Rattanarungrot's "*Nara*" [15], but on the context of a computer based game, unrelated to museums, and so we believe this part of the goal was already successfully reached. Reiterating these concepts from chapter *4.1 Study Design*, Knowledge Transfer, and Enjoyment to a minor effect, are used as the concepts to verify successful dissemination.

5.1 Phase 1 Analysis

In the first testing phase, the data collected from the playtest form was analyzed using Microsoft Excel. In addition, this data was supplemented with the observations made during testing to gather a better inside on the data gathered.

The total sample amount for phase 1 was composed of seven participants, being predominant male (5 male and 2 female), situated on a young adult age bracket (between 20 and 30 years old) and being knowledgeable on video games. While this sample group fits within the target audience, the sample size was limited thus lowering the degree of certainty from the results. However, with the participants being knowledgeable on video games to a higher degree, their input should still be relevant and important to take in consideration.

The first area of study is how well the objectives and instructions were understood by the participants. As shown on Fig.29, the data suggests that the objectives and instructions were understandable for participants, however, they could have been streamlined even further. An important observation made in this section was the need of writing with the least amount of embellishment as possible. Participants often read the objectives quickly, jumping over words to fully read the text. Further iterations tried to simplify the objective text to as understandable as possible. This would also ensure younger participants could understand the objectives without much trouble.

When asked which mini-games were in need of further clarifications with the results shown on Fig.30, four particular mini-games display potential problems, being either confusing tasks

or convoluted grammar making it difficult for the participant to fully understand what each mini-game asks from the player.

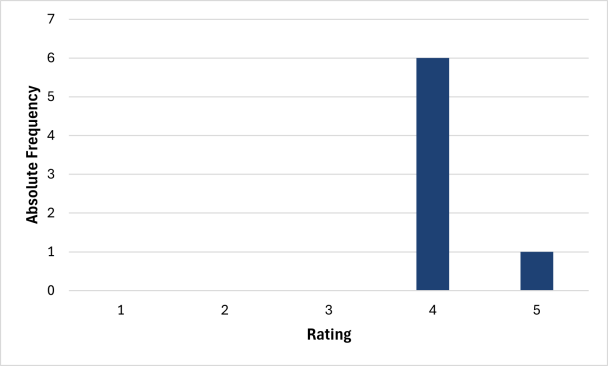

Figure 29: Test Phase 1 form answers to question 1: "How clear were the objectives and instructions of each Minigame?".

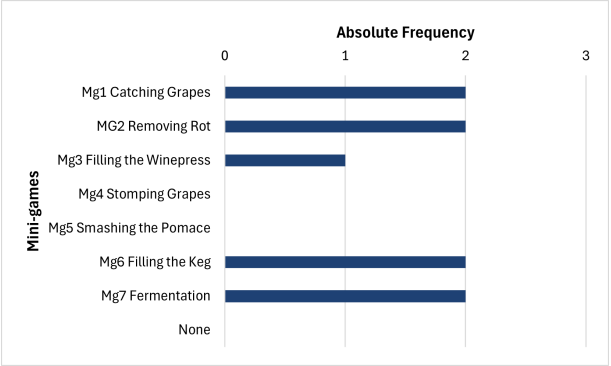

Figure 30: Test Phase 1 form answers to question 2: "Which Minigames did you feel had unclear objectives or instructions?".

A similar issue was seen when reviewing game controls (Fig.31), when asking participants to rate on understandable, easy and comfortable they were. While overall the controls were well reviewed, each participant had issues with at least one mini-game. These problems often stemmed from the same reason as how well the objective were understood, the way they were presented was poor and confusing. This then shifted the way the game presented the controls in future iterations, by using graphical elements to visually supplement the control page.

The feel and responsiveness of the controls however was more positive with more than half participants felt the controls were globally good. By looking at the list of which mini-games that had bad reviews, as seen on Fig.32, at least one participant had an issue with almost all mini-games, but often was from how rough the controls felt, which was understandable at development stage that the test took place. One mini-game in particular had a particular subjective issue with the control scheme that was deemed not intuitive by a group of participants and further supported by various comments made by them where they shown negative reactions to this control scheme. The problem was caused by the difference in perspective in rotating a 3D object, the question being: *"If one wishes to click right, would the object rotate to its right (anti-clockwise) or follow a clock system and rotate clockwise?"*. After deliberating, it was decided to follow a clock system rotation, as after playtesting both scenarios, the clock system felt more natural and adaptable.

Knowing first how the game controls are rated, we can somewhat reliably discern how difficult the game is. If the controls were functional with no game breaking error, any challenge

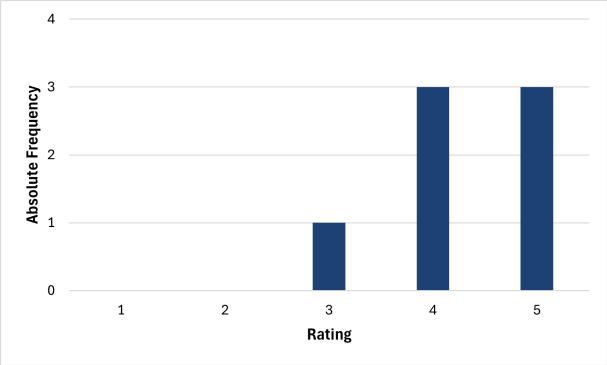

Figure 31: Test Phase 1 form answers to question 3: "How would you overall rate the controls?".

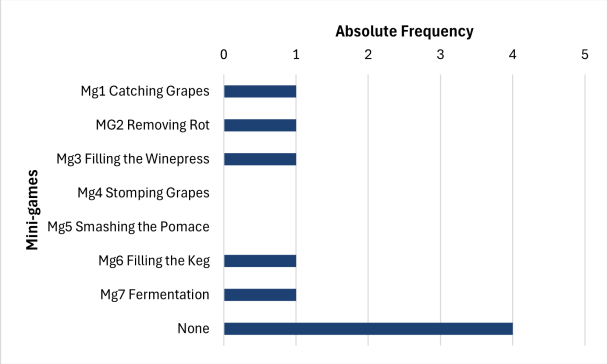

Figure 32: Test Phase 1 form answers to question 4: "Which minigames did you feel had bad controls scheme or controls felt unresponsive".

in the game could be somewhat quantified in difficulty. As no big mechanic shifts were planned, knowing how difficult the game felt would let us know if any mini-game needed to be made easier or if any mechanic felt too punishing to the player very early in the iteration process. While difficulty increase is a GBL learning principle that is followed in the game, difficulty is a very subjective thing between participants, so minimizing any big step up in difficulty could prevent a progression wall for the player. When asked on how fair the game feel to the participants (Fig.33), the data shows that the participants felt the game was fair towards the player. Fairness here is linked to difficulty, where an unfair mini-game would thereby be very difficult. This however might have confused some participants as many asked for clarification on what "fair" meant. This however was clarified to every participant.

When looking at the mini-game list for which mini-games the participants felt were unfair, see Fig.34, mini-game 5 had a higher amount of focus on both in data but also in observations. These reactions stemmed from the third stage of that mini-game, where multiple aspects of the mini-game were seen as very player-unfriendly, which were spoken on chapter *3.4.5 Smashing the Pomace Mini-Game* with their solutions.

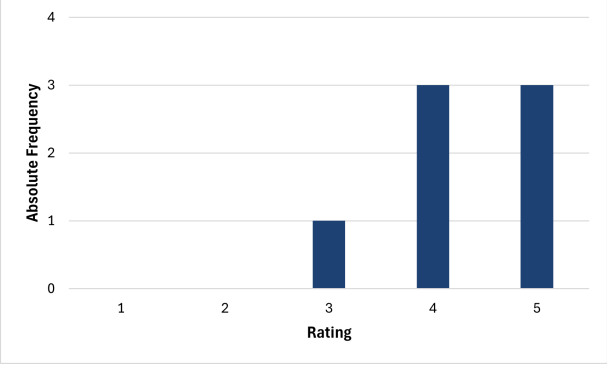

Figure 33: Test Phase 1 form answers to question 5: "How fair did the overall game feel?".

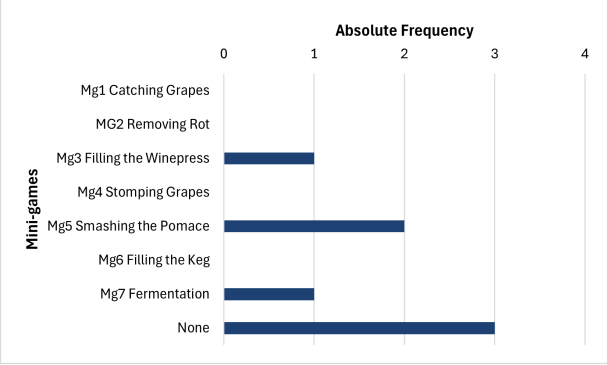

Figure 34: Test Phase 1 form answers to question 6: "Which minigames did you feel were unfair ?".

In a similar note to difficulty, we wanted to quantify the participant's fun factor with the game in a general sense, as shown on Fig.35. Both of these concepts can influence the other and their balance is necessary to ensure the best experience to players. Overall, the game was highly rated, with some participants commenting that going through various mini-game genres with different mechanics in a short time kept the game fresh. Combined with the analysis of game fairness, the prototype was deemed to be in a good spot in terms of mechanics and difficulty, and this further increased the time to polish and fix errors on the game.

When asked for which mini-games participants felt were not fun to play, a variety were chosen as displayed in Fig.36. The reasoning for this variety can be from different participant having one mini-game that were from a genre that they either disliked or was exceptionally mechanically rough, with a particular example being mini-game 3. This gave further reason to further iterate mini-game 3 into a new concept.

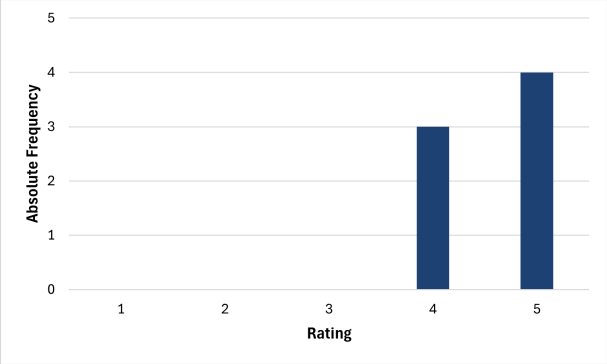

Figure 35: Test Phase 1 form answers to question 11: "How fun would you rate your experience with the overall game?".

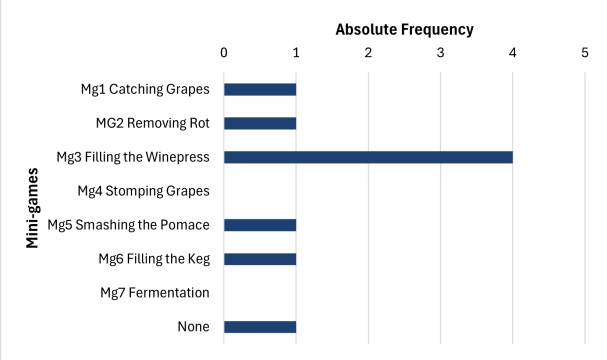

Figure 36: Test Phase 1 form answers to question 12: "Which Minigames were not fun?".

The last factor from a game standpoint to look into was game length. The goal was for the game not to take over twenty minutes. Reasoning lies in repetitiveness in play and exhaustion due to boredom. A diverse target audience means a varied attention span length and tolerance to how long a game session should be, so condensing as much as possible in a short, informative and fun game experience would benefit the project goal.

When rating how long the game was (Fig.37), participants enjoyed the game length, which let us know that content wise, the mini-games do not under deliver and match the participant expectations. This let us allocate further development time into polishing game mechanics and environment and model work. When asked for which mini-games did not last for an adequate amount of time, see Fig.38, and using the observations made during the testing, three mini-games raised problems for the future iterations.

Mini-game 3 had slow animations which would be further slowed down by consecutive animations playing one at a time instead of at the same time. Mini-game 5 had a high variable play time due to the randomness of the mini-game itself, and as spoken on the previous analysis, stage 3 of this mini-game introduced a difficulty spike which further artificially extended the mini-game. Finally, in mini-game 7, participants felt the mini-game was too short while it was in fact designed to be the longest running of all of the mini-games. Participants might have felt that they did not have enough time to collect enough points and or spawn enemies to make the mini-game more fun.

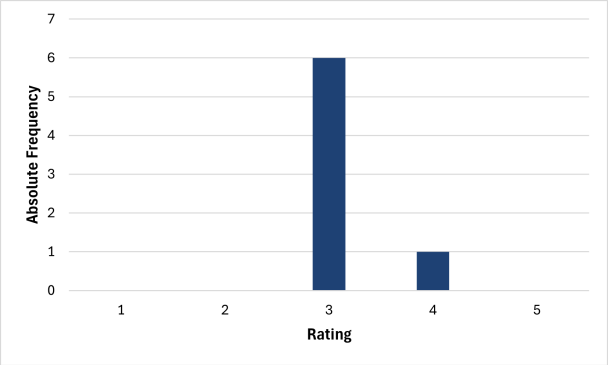

Figure 37: Test Phase 1 form answers to question 7: "How would you describe the overall length of the minigames?".

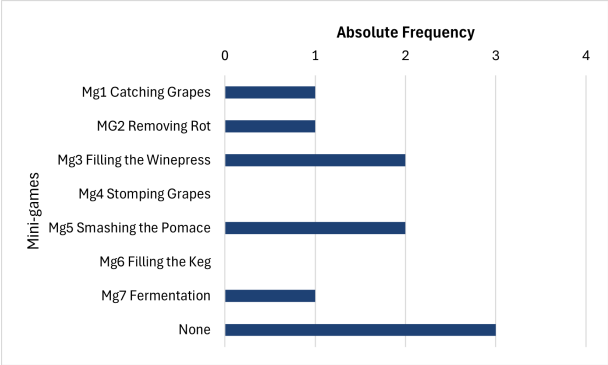

Figure 38: Test Phase 1 form answers to question 8: "Which minigames did you feel did not last an adequate amount of time?".

Finally, an important factor to gather data on is how well each step of winemaking were adapted into the mini-games. As the project goal is to preserve and disseminate this topic, knowing how well it is adapted into the game is paramount to successfully reach the project goal. To test this, participants were asked how well the themes matched with the mini-games, see Fig.39. A majority of participants felt that that the themes were well adapted into the mini-games, which let us know that stages chosen for the mini-games where comprehensible enough to be compared to the real action.

However, when looking at the specific mini-games that participants felt did not match its theme, see Fig.40, mini-game 3 was shown to not have matched the participants expectations. Although it was mechanically related to filling an winepress, participants did not like how they had to fill the baskets instead of the winepress itself. This data was the main reason why mini-game 3 was later fully reworked to more accurately tie the theme with the mini-game.

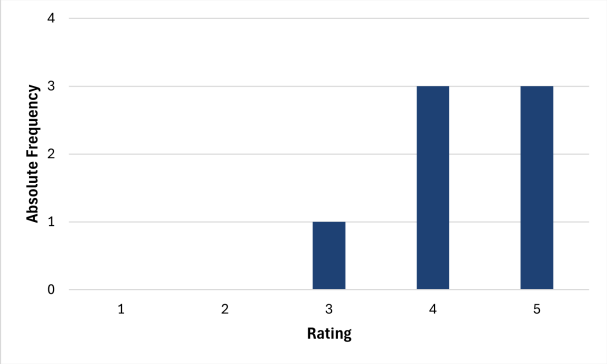

Figure 39: Test Phase 1 form answers to question 9: "How well did the themes of each stage match the minigames?".

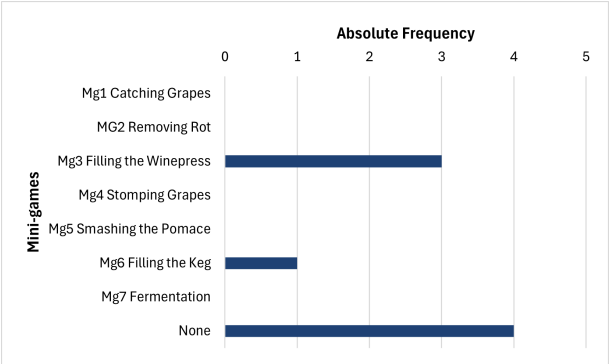

Figure 40: Test Phase 1 form answers to question 10: "Which minigames had a bad match with its theme?".

5.2 Phase 2 Analysis

For the second testing phase, the data collected from both the pre and post-questionnaires was treated using Microsoft Excel. This data was also supplemented with the observations made during playtest.

5.2.1 Demographics

For this project, as previously stated, the target audience is older teens to adults (between ages 16 to 50) that are both Locals and Non-Locals to Madeira Island. This range was chosen due to the high possibility to find participants that interacted with winemaking either in their childhood or currently still interact with it.

The total sample size for this phase was 17 (Fig.41), composed mainly by male participants (14 male and 3 female). In terms of age, the majority was placed in the young adult category of 19 years old to 35 years, which misses the younger section of the target audience.

Furthermore, in terms of nationality, around half of participants were locals (9), and within the local subset, a majority were Madeira natives (6). This spread on participants was helpful to compare both Local and Non-Local on if both had different interpretations or were impacted differently. The majority of the nationalities present in the sample size are known for their wine, more specifically their production quantity. According to the "State of the World Vine and Wine Sector in 2024" from the The International Vine and Wine Organization [34], Portugal, Germany and Romania were some of the biggest European producers of wine for the year.

Overall, while the sample size is rather limited, the variety in participant nationalities and most of them being from the age group from the target audience was helpful to get more accurate data to interpret future data.

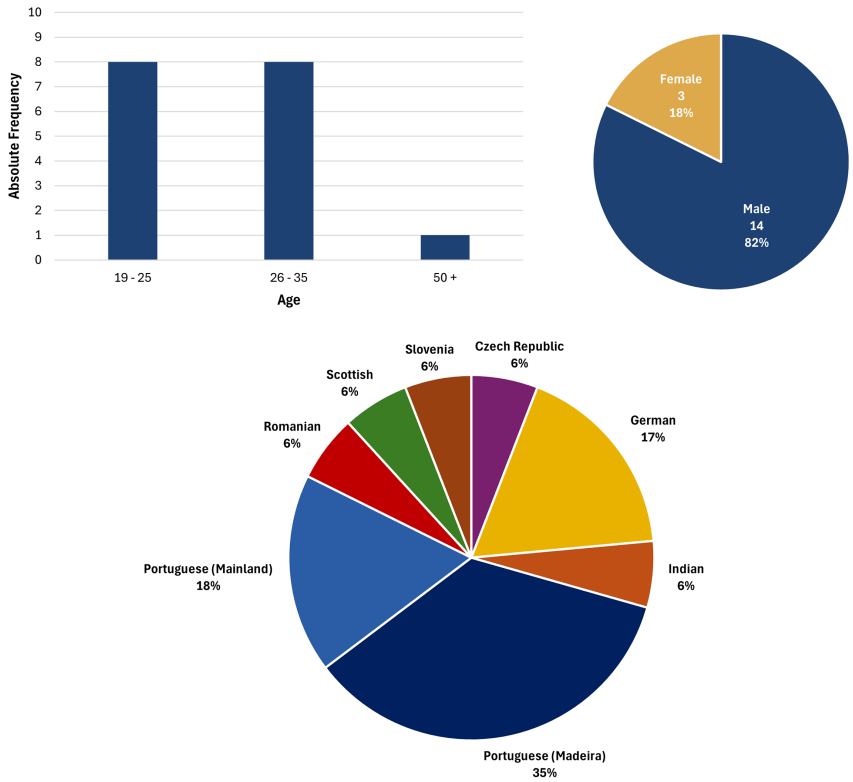

Figure 41: Demographic Graphs. (**Top Left:** Age Ranges / **Top Right:** Gender Ratio / **Bottom:** Nationality Spread)

5.2.2 Game Habits and Preferences

In an attempt to accurately quantify knowledge transfer, there is a need to better understand the participants. While not directly related to knowledge transfer, knowing about the habits and preferences in games from the participants could give further insight when learning principles from GBL are not having their suggested effect.

When looking at the participants' experience and preferences on games (Fig.42), participants were very used to games and avid players with well over half of participants playing games daily, this is further reflected on participants self reported experience where the majority self describes as very experienced.

While this sample group means that further qualitative data can be judged at a higher degree of certainty, it lacks the comparison to unskilled video game players which could show a difference in how knowledge transfer worked on this group.

Regarding the most favored platform for participants, PC was the most used (15), with the second most being phones by slightly over half of PC (6). While this goes against the current global market share research [35], with mobile making double the revenue than PC, this can be explained by the genres that participants said that they enjoy. Participants enjoyed more action oriented game genres, with top three containing RPGs, Shooters and Sandbox type

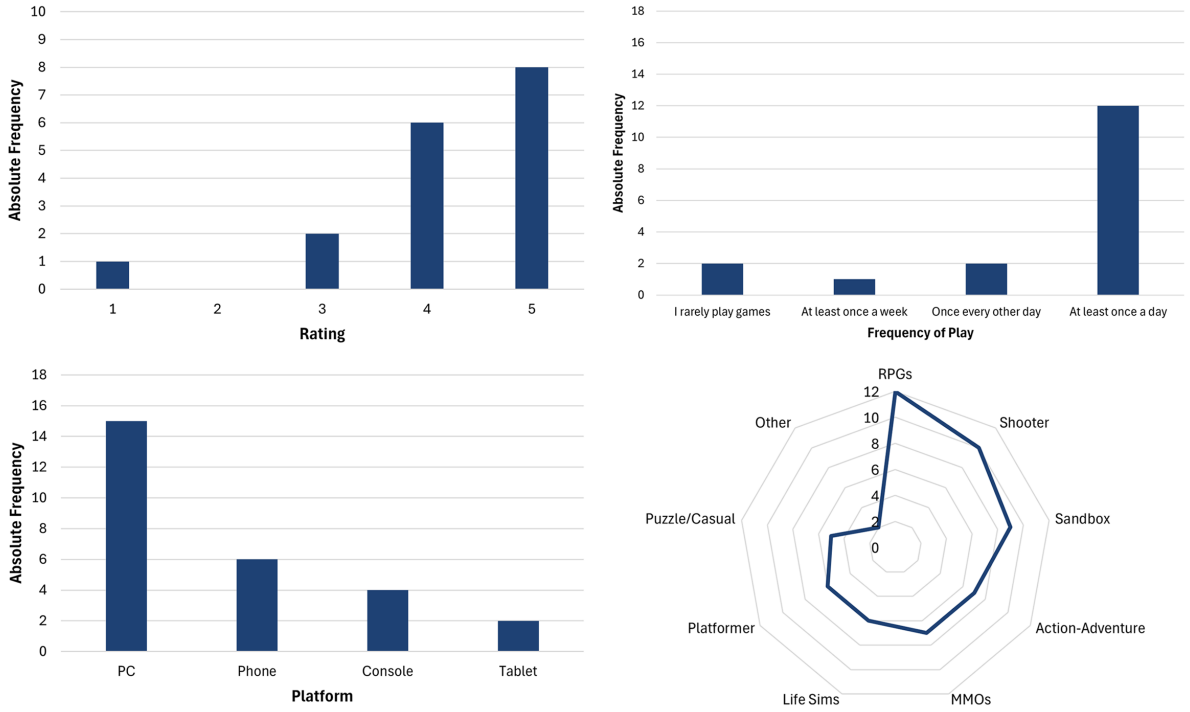

Figure 42: Game Habit Graphs. (**Top Left:** Game Experience / **Top Right:** Frequency of Play / **Bottom Left:** Gaming Platform / **Bottom Right:** Genres of Choice)

games. These genres are not common for phone games but more common on PC, so an increase in PC as a platform make sense on this sample. Additionally, this game project is classified as a puzzle/casual game, which was not a genre that participants seem to enjoy often. By looking at how participants felt playing the game can let us determine if this factor might have affected knowledge transfer.

5.2.3 Game Qualitative Data

Game quality is an important factor for this project, as it directly influences how GBL learning principles affect the player. Confusing mini-game objectives or rough mechanics impact the enjoyment of the game, which in turn decreases interest and immersion and overall decreasing the effectiveness of knowledge transfer.

First, we take a look at how the mini-game objectives were understood by the participants (Fig.43). Similarly to Phase 1, the objectives were rated very positively by the participants. This is a positive for knowledge transfer, as it means that the context is being successfully given to the participants. Nonetheless, some participants still had trouble understanding certain mini-games. An effort was made after Phase 1 to simplify the objectives, but some contexts were not clearly written. An example was mini-game 5 (Squeezing the Pomace), where most participants quickly understood the mechanics of the mini-game, but its objective was not as clear. It might be possible that the cause was the way participants read the objective. Slow

readers can pick up the information clearly, but if the participants reads the mini-game level name and assumes what the objective are, thus reads over words quickly, it might explain why this occurrence happens.

Another area of impact is with game controls (Fig.44). Participants have rated the game controls fairly highly which lets us know that there was a low amount of friction introduced to knowledge transfer by the controls, as badly configured or unresponsive controls would interrupt immersion for participants. Although most of the ratings are on the higher side, a fair amount of participants commented some issues they had with controls, such as lack of feedback when pressing keys. These comments however, were not obviously seen in the rating graph, possibly due to being very minor to participants and thus ignorable. Since the participant base is made of mostly avid video game players, their experience with different controls might consider slightly rough controls as being enough.

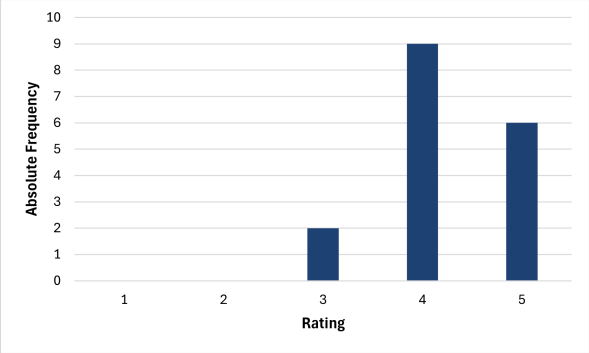

Figure 43: Graph on clarity of objectives.

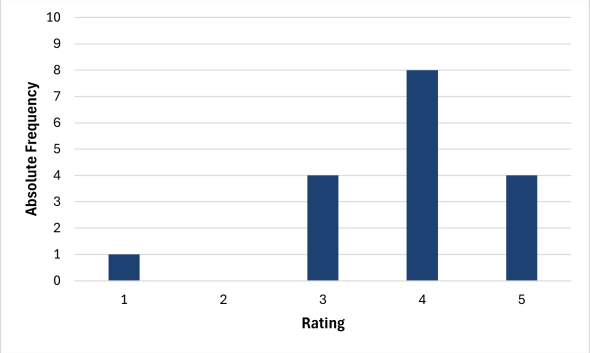

Figure 44: Graph on rating controls.

As previously mentioned, the goal for the game's duration was to be no longer than 20 minutes, as this potentially reduces exhaustion by repetition and boredom which again would be a detriment for knowledge transfer. An appropriate balance between playtime and downtime due to level change may help with these risks, but the more straightforward way to prevent it is to streamline the gameplay to small and quick play sessions.

When looking at how participants rated how long the game took to complete (Fig.45), the majority felt that the length was appropriate, although, a surprisingly high amount of participants seemed to feel the game was on the shorter side. This curious case gets even more odd when looking at the participants comments, where a strong sentiment was shown for a variety of mini-games feeling too slow. This slowness can be identified as slow animations on mini-games or difficult mechanics such as Mini-Game 5's physics-based stones. This duality could be stemmed by only one or two mini-games to truly be slow and thus getting more comments about them, but the game overall taking an acceptable time to complete.

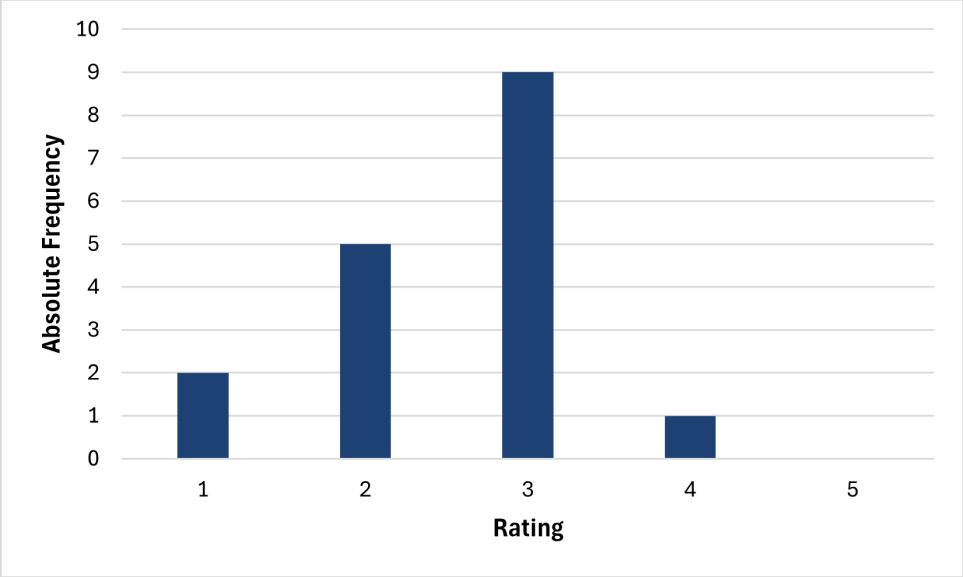

Figure 45: Game Length Graph.

The time taken by participants was recorded (Fig.46) to get a more objective idea of how much time the game takes to be completed. Overall, the goal of keeping the game under 20 minutes was successfully reached. The majority of participants took between 13 to 14 minutes to fully complete the game, with the median sitting at almost 14 minutes, and the arithmetic mean sits closer to 15 minutes. This higher mean came as two participants had either trouble with mini-games due to not being accustomed to playing video games or would pause the game to address the researcher with comments before continue the game.

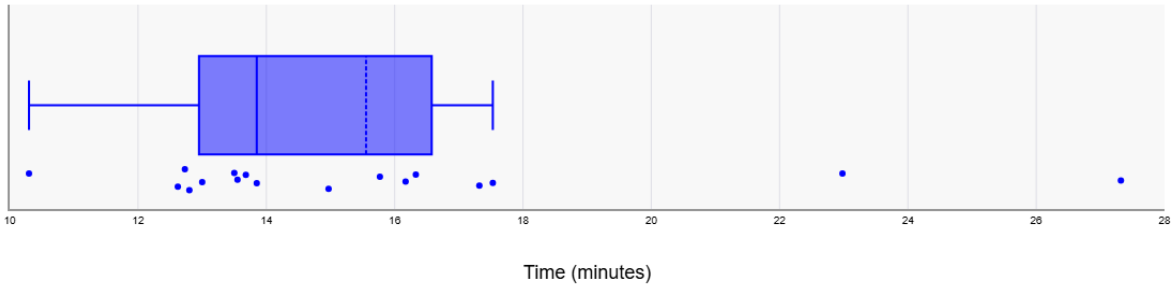

Figure 46: Box Plot graph of time taken in all testing sessions. Dashed line represents the arithmetic mean.

With different factors that influence the knowledge transfer now discussed, an important point to test is if the themes of winemaking were well adapted into the game (Fig.47). The quality of implementation of these themes are the main cornerstone of this project, where a bad implementation could not only make the knowledge transfer more difficult, but transfer completely wrong information to players. Participants have rated the themes to be very well implemented on the mini-games. This is further reinforced by multiple comments on the mini-

games being fun ways to learn about this topic or any other topic in general.

This gives us a degree of certainty for the results of the winemaking questions, as the different metics to ensure high successful rate of knowledge transfer were rated highly and so were the implementation of the themes.

Finally, we asked participants their overall thoughts on the game (Fig.48). This section acts more of a summary of all of the previous Qualitative questions, but it can serve as an indication for any future game of this type.

Participants rated the game very highly, commenting about various aspects of the game, such as how "arcadey" it felt (being characteristic of an arcade game) or the music selection for the game. These grades suggest that the participants' preferences did not negatively effect the enjoyment from the game.

Furthermore, this was a similar finding to Bjørner (2022) [18] where participants commented on how refreshing and fun it was to learn a topic on a game. This could have been due to participants being frequent players and thus the medium is more beneficial, could also be as Reunanen (2015) [3] has found, higher immersion on the topic led to participants enjoying the experience more. Another possible reason could be a self-competitive instinct in the participants to get a better rating, as Hakulinen (2015) [30] concluded, the use of badges to rate participant performance led to higher concentration and positive attitude towards the game when they achieved a high grade in the mini-games.

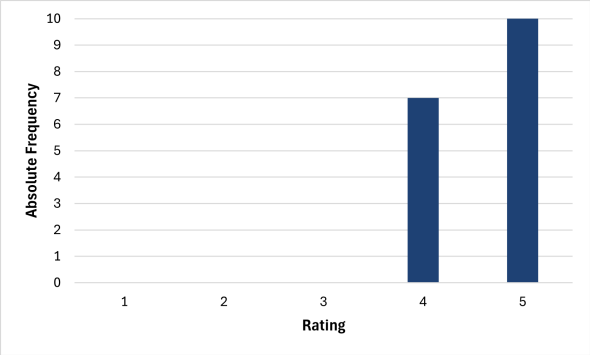

Figure 47: Graph on rating how the theme matched the mini-games.

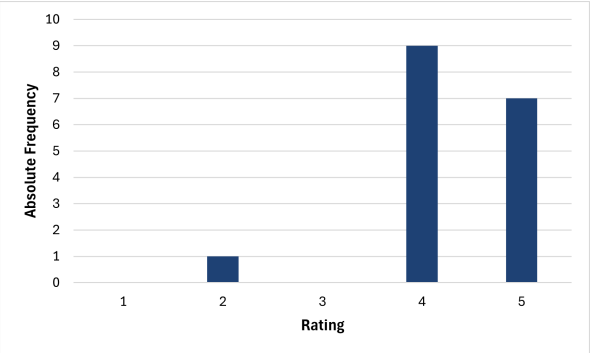

Figure 48: Graph showcasing overall game experience.

Overall, this positive impression from the participants show that this medium of video games can help with the goal of preservation. This is supported by Wu (2022) [36], as this gamification led to facilitating preservation and raising awareness to the topic. However, it was also noted that these types of products should be used as a complement to already existing cultural tourism, although, in the context of this project, wine tourism is more tailored made for Non-Locals, and so his observation might not be entirely possible to agree to. At the same time,

Poole (2022) [19] results on his wine education utilizing GBL, can raise a potential compromise between this kind of project and traditional tourism. Poole results show that interest in the topic after his gamification activities raised interest from participants about the topic. With the use of games, such as this project, as adverts to give curiosity for tourism, both mediums could be used to maximize the preservation and dissemination of these traditions.

5.2.4 Winemaking Knowledge

In an attempt to figure out how successful the goal of knowledge transfer was, a set of questions were used in both forms of this phase, as explained in the study protocol. The difference in correct answers before and after will showcase if the game influenced positively in the transference of knowledge.

As mentioned before, these were the questions used:

- 1) At which time of the year do we harvest grapes?;
- 2) Which ones of these is not a Madeiran variety of Grape?;
- 3) How many grapes does it take to make a single wine bottle, on average?;
- 4) Why is there still some wineries that still use the traditional grape stomping method of crushing grapes by foot?;
- 5) What happens to the pomace right after the grape stomping?;
- 6) Why would you add sugar to the wine before fermenting?;
- 7) What breaks down the sugar into alcohol in the fermentation process?.

Before looking at the winemaking questions however, we first asked participants if they have ever participated in grape harvesting or the act of making wine (Fig.49). This gives us an additional data point to nationality to determine the participants knowledge on winemaking, as purely being in a country that is known for their wine production does not mean their population will be knowledgeable about it.

The results of this question show that only a third of participants (6 in total) have ever participated in such events, from which, all of them were locals. This means that a bit over half of all locals that have participated, had been previously involved in winemaking activities. Although some participants from the Non-Locals group are from countries that have a strong wine industry, none ever participated in any winemaking activity. This however can be due the small sample size for Non-Locals or if the participants are from more urban areas from their countries which would decrease the chance to encounter such experiences.

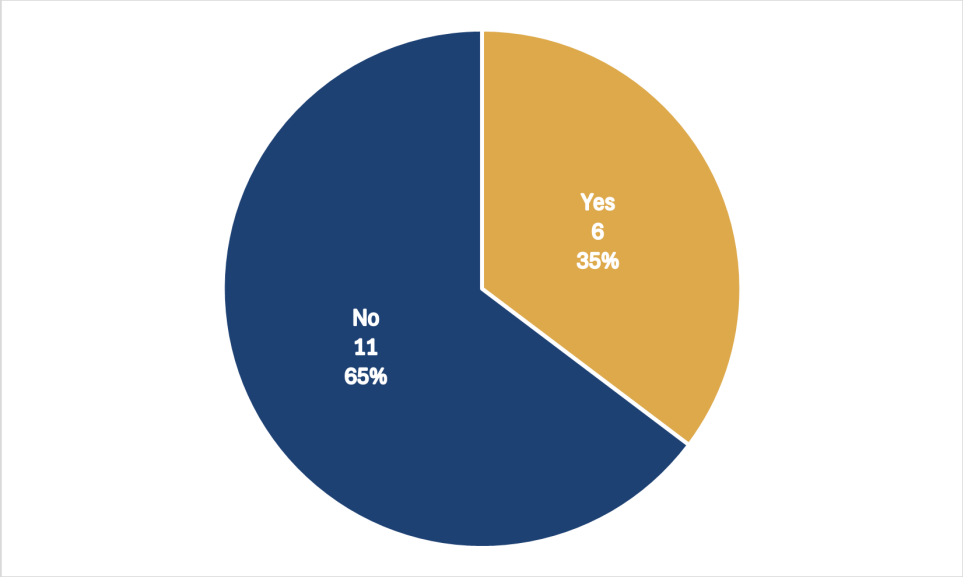

Figure 49: Test Phase 2 questionnaire answers to the question "Have you ever participated in a grape harvest or made wine traditionally?".

Looking at the difference between before and after for the winemaking questions, a notable increase can be seen in correct answers after playing the game (Fig.50). We can then infer that there was a correct and successful knowledge transfer due to playing the game.

Questions about more broad and common knowledge of winemaking, such as Q1 and Q7 that relate to harvest season and fermentation, while already having a high amount of correct answers in the Pre-Questionnaire, still showed a slight improvement after playing the game, in fact, Q7 in specific showed a perfect score in the Post-Questionnaire. Although its a small increase, we can additionally assume that the game further reinforces correct knowledge upon the participants due to how GBL learning principles were implemented into the game.

Meanwhile, for more specific questions, such as Q3, Q4 and Q5, which relate to quantity of grapes per bottle, traditional methods of winemaking, and usage of pomace respectively, showed an expected low rate of correct answers in the Pre-Questionnaire. On the Post-Questionnaire however, these three questions showed the biggest spike in correct answers.

Overall, the increase in correct answers shows the success of knowledge transfer, and while some questions had a lower increase than expected, such as Q2, that relates to grape types, we believe that it still remains a notable use of GBL learning principles to disseminate knowledge. These findings are comparable to other works with a similar objective (preservation and dissemination), such as Almeida Star Defense by Coanhas (2023) [26], DayaBaya by Hasibuan (2011) [12] and Spirits of Artifacts by Gao (2024) [11].

In an attempt to further understand this data, we divided it by Locals and Non-Locals to maybe find any noteworthy difference.

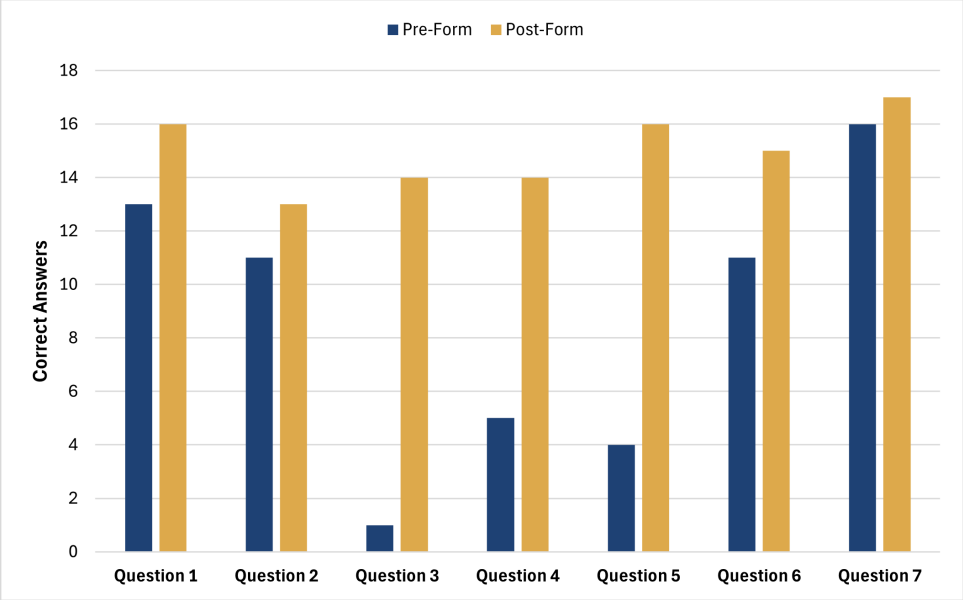

Figure 50: Rate of correct answers in the winemaking questions.

Starting from the Local population, an overall higher amount of correct answers from the Local population was noticed, as seen in Fig.51. This may be due to wine tourism in Madeira Island which then gets exposed to locals as well, and of course the family traditions of rural families of homemade wines.

In their Post-Questionnaires questions, participants answered perfectly to two of them (Q1 and Q7, relating to harvest season and fermentation), in fact, Q7 was perfectly answered in both the Pre and Post Questionnaire. Surprisingly, most locals were not sure which kind of grapes are known in their own island as some participants never heard of their names. A possible assumption for this is the lack of advertising for their own grapes, but also possibly as them being more familiarized or growing the "*Americana*" and "*Jaqué*" grape types instead.

As for Non-Locals (Fig.52), a lower amount of correct answers is seen in the Pre-Questionnaire. This gives further credence to the hypothesis that simply being from a country that is known to be a big producer of wine does not exactly mean that their population will have a good knowledge in winemaking.

Of note, Q3 and Q5, relating to quantity of grapes per bottle and usage of pomace respectively, had no correct answers in the Pre-Questionnaire which is contrasted with their spike of correct answers on the Post-Questionnaire, in fact, Q5 in the Post-Questionnaire was perfectly answered by all Non-Locals. Furthermore, in the Post-Questionnaire, Non-Locals scored three perfectly answered questions being Q4, Q5 and Q7, relating to traditional methods of winemaking, usage of pomace, and fermentation respectively.

A possible noteworthy hypothesis is if the knowledge was better transmitted in English

than Portuguese. The sample size is far too small to determine this, but most questions in the Post-Questionnaire were missed by mostly only 1 Non-Locals, while by 2 Locals. Differences in sentence building or translations might have affected the clearness of the information.

These results are nonetheless very positive and demonstrate that knowledge transfer was not only successful but had an impacted in less common knowledge about winemaking. This then means this game has the potential to teach and share knowledge in a way that satisfy the project's goal.

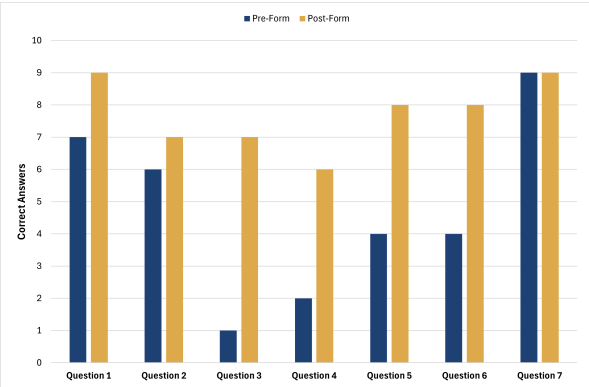

Figure 51: "Local" Participants rate of correct answers in the winemaking questions.

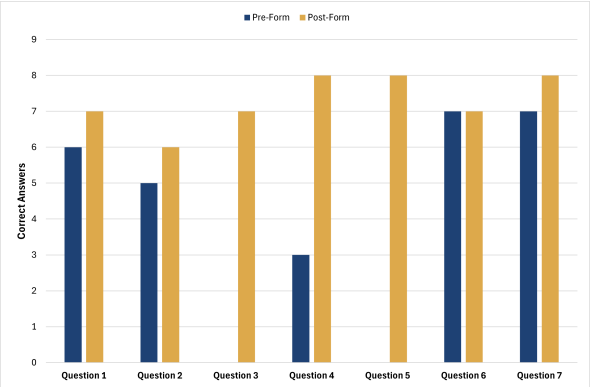

Figure 52: "Non-Local" Participants rate of correct answers in the winemaking questions.

5.3 Project Limitations and Future Work

Although this project had a successful outcome, it faced a number of limitations. As spoken throughout both of the Analysis, the small sample size limited the certainty of the findings. Furthermore, with the goal of dissemination towards a rather large age group, this project failed to garner any participant of the older teen age bracket. Future projects should procure a more varied and diverse sample size, especially when the target audience is in a nation diverse scale.

Another limitation encountered is the lack of method to evaluate if the knowledge is retained over time. Although the game can disseminate knowledge, it has difficulty in testing if the participant retains the knowledge. This can be further compounded by different age groups memory retention. Addressing this on future works can lead to better ways of utilizing Knowledge Transfer in games for longer knowledge retention.

A final limitation stems from its local setting. In the context of this project, the dissemination is not just for traditional winemaking for families, but in specific to Madeira Island. This brings a problem that can go against the goal of preservation and dissemination, where Non-Locals inherently are not emotionally attached to the location and so they may have a lower interest in the topic. Future projects that seek to adapt a CH with these same goals need

to create a method to create an emotional bond with their Non-Locals, be it with the use of a story or characters.

6 Conclusion

This dissertation showcases the creation, development and testing of "*Back Then - In a Winepress*", a puzzle game with the goal of preserving and disseminating the family tradition of wine making of Madeira households.

The family tradition of wine making on Madeira island, although being an important as part of its history, has had little work done in the realm of education, dissemination, and preservation of the processes in more modern contexts. Although some efforts have been made to preserve these processes, as an intangible CH, they lack effective ways of preservation, however, with the rise of new technologies, new avenues for preservation have already been explored, and a quite successful one being games.

With the use of GBL and its learning principles, mainly knowledge transfer, seven different mini-games were designed and iterated upon tackling different stages of the winemaking process to provide a fun and engaging environment for users to learn about the topic.

The game was then tested in two different phases, one in its prototype stage to determine its early problems and gather feedback, and a later one to use questionnaires as metrics to test knowledge transfer effectiveness. These results would also determine if a game of this type is able to leverage GBL learning principles to achieve the project goals

Results from these test suggest a notable transference of knowledge was happening. Participants demonstrated an increased interest in the game which facilitated the dissemination of information presented in the game. We conclude that while faced with limitations, this type of game makes a positive impact not only as a dissemination tool, but as a teaching tool if adapted further.

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